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NON-PERFORMING LOANS IN SERBIA: Economic Issues and Some Econometric Results

Original Scientific Article

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This paper provides econometric results of modelling the non-performing loans in the Serbian banking sector for the period: 2008 Q3 – 2015 Q1. The methodological framework is based on cointegration and common trend analyses that are employed on quarterly data for the following variables: the ratio of non-performing loans to the aggregated loan portfolio of banks, GDP level, unemployment rate, inflation, depreciation rate, key policy rate and net interest margin. Our results imply that in the long-run aggregate non-performing loans in Serbia are affected separately by prices and the nominal exchange rate. Their short-run dynamics are mostly determined by the depreciation rate and the interest rate channels. GDP growth rate is found to have important contemporaneous effect on the short-run variations of aggregate non-performing loans. A significant impact of bad asset management is also estimated.

Key words: cointegration, macroeconomic factors, non-performing loans, Serbian banking sector.
JEL CLASSIFICATION: E44, E59, C32

1. INTRODUCTION

Since the onset of the Global financial crisis, when non-performing loans (NPLs) in many countries skyrocketed, the low quality of the banking sector credit portfolio has remained a substantial burden for economic recovery. Therefore, the issue of the growth of NPLs is seriously

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tackled by the national regulatory and supervisory authorities for banks with the aim of not only monitoring the health of the banking system from the regulatory perspective, but even to provide different regulations and regulatory measures for stimulating the cleaning-up of banks' balance sheet of bad assets.

Determinants of banking sector credit risk are examined in numerous empirical studies but also within the macro stress-testing frameworks in central banks, especially solvency stress-tests. The most frequent indicator employed is the ratio of non-performing loans to total loans. Contrary to this, some authors (Bofondi and Ropele 2011) have focused on the ratio of new bad loans to the outstanding amount of loans in the previous period. Among the majority of research the impact of the macroeconomic conditions on the ratio of NPLs is explored and, in particular analyses of the influence of bank-specific characteristics.

The purpose of our paper is to econometrically determine factors that significantly influenced the level and dynamics of aggregate non-performing loans in Serbia in the recent past. Our data set consists of the following variables: the ratio of non-performing loans to the particular loan portfolio of banks, seasonally adjusted GDP level, unemployment rate, price level, nominal exchange rate, key policy rate and net interest margin. Data are collected quarterly for the period: 2008 Q3 – 2015 Q1 the source of data being the National Bank of Serbia and Statistical Office of the Republic of Serbia. Our econometric approach follows the Johansen cointegration analysis (Johansen 1995, 2000) which provides a commonly-used framework for estimating both, long-run influences and short-term effects, among variables of interest.

The paper is organized as follows. Section 2 describes the structure and dynamics of NPLs in the Serbian banking sector over the last seven years. Key determinants of NPLs are discussed in Section 3, while literature overview is covered by Section 4. Results of our econometric modelling are contained in Section 5. Conclusions are summarized in Section 6.

2. DYNAMICS AND STRUCTURE OF NPLs IN THE SERBIAN BANKING SECTOR

Besides a highly capitalized banking sector with strong funds for financing credit growth, the ratio of non-performing loans in the Serbian banking sector has continued with its upturn pace which started in the aftermath of the financial

crisis of 2008. Consequently, contributors to this trend should not be related with the credit supply side only, but also with the quality of the demand for loans.

Similar to other emerging countries, the Serbian banking sector experienced credit expansion in the pre-crisis period due to low initial level of loans at the beginning of the transition period, when liberalization of the banking sector commenced. Toward the beginning of 2006, y-o-y real lending growth to households was around 100%, as opposed to twice slower growth in the corporate sector (44%), and in that time, many indicators did not strongly signal the potential unsustainability of credit growth (Palić 2007). On the other hand, the surge in lending had created a basis for the future build-up of credit risk.

The credit boom that occurred before the crisis was one of the most significant but not the only driver of the deterioration of the credit portfolio. A high level of euroization in total lending in the presence of financial distress in 2008 and a huge depreciation of the national currency crucially determined the jump in NPLs. Often un-hedged, enterprises and households were extremely exposed to exchange rate risk given that their high share of foreign loans in total loans amounted to around 64% and 76%, respectively, in Q3 2008. The majority of loans for both sectors was approved in euro, but even a small share of francs denominated loans (12%), which are predominantly granted to households, more precisely, mortgage loans, is worth noting. Euroization of the banking credit portfolio at a certain level derives from the structure of ownership in the Serbian banking sector where participation of foreign owned banks in total assets is 75%. Secondly, a long history of high inflation in Serbia has made lending in dinars more expensive relative to lending in foreign currency in terms of the interest rate. To protect their assets against losses due to currency depreciation risk, banks were less willing to lend in dinars. As a result, the banking sector was indirectly exposed to risk linked with currency mismatches of liabilities and income of debtors.

Deeply worsened macroeconomic conditions in 2009 in terms of real GDP decline of 3% and dinar depreciation against the euro of even 25% relative to Q3 2008, together with an abrupt drop of new lending triggered enormous bridging of low quality assets. Despite adopted NBS measures and Government measures to ease the effects of the global financial crisis, particularly a subsidized loan programme which significantly mitigated problems in the collection of receivables, the NPL ratio of total banking sector rose sharply to 16% from 10% in 2009. The NPL ratio is hard to interpret across countries regarding different national clas-

sifications rules and lack of international accepted NPL measures (European Banking Coordination "Vienna" Initiative 2012, 13). Therefore, it is more reliable to compare changes in the ratio. The plunge in the Serbian banking sector in spite of growing NPLs at end-2009 was not the largest among CEE economies (Table 1). The Serbian banking sector remained the most resilient having the highest coverage of risk-weighted assets by regulatory capital.

The rising NPL problem is mostly linked to weak economic activity after the crisis. The average real GDP growth in the period 2010-2014 was 0.3% and the economy was not only hit by decline in external demand but also with climate shocks that significantly worsened economic outlook. Along with this the growing NPLs in the Serbian banking sector have also had negative feedback on economic recovery through slowing down credit growth revival. After the escalation of the crisis, real lending severely decreased with short-term positive trends mostly as a result of Government subsidized loan programmes. The issue of high level of euroization has continued to be a drag on growth of delinquent debtors that are vulnerable to the risk of depreciation of national currency. Since Q3 2008 the dinar has depreciated against the euro close to 57%. Moreover, focusing on the cost of borrowing, its negative impact on creating assets with overdue in repayment has been stronger for dinar loans relative to this impact as opposed to FX loans. Interest rates on dinar loans, on average, are at least more than twice larger than rates on FX loans and are strongly linked with the key-policy rate which was at very high levels for a long period due to strong inflation pressures. At the moment, in the presence of a low interest rate environment, both interest rate on dinar loans and FX loans are manifesting a negative trend. In contrast to dinar cost of lending, interest rates on FX loans contribute more to slower growth of NPLs , not only because of the domination of FX loans in the credit portfolio, but also because of its relation to the EURIBOR money market rate which has now entered a negative zone.

Table 1. Bank Regulatory Capital to Risk Weighted Assets and NPL ratio in emerging and developing economies of Central and Eastern Europe, in %

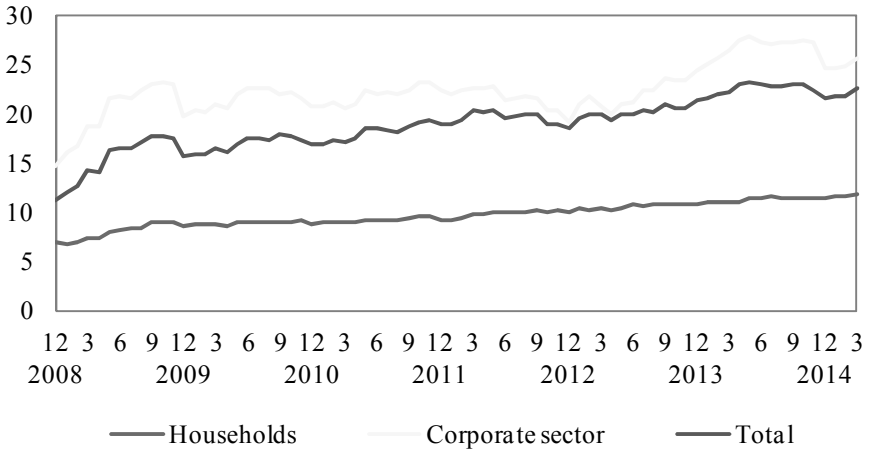
	CAR			NPL ratio		
	2008	2009	2014	2008	2009	2014
Albania	17.2	16.2	16.8	6.6	10.5	22.8
Bosnia and Herzegovina	16.3	16.1	16.3	3.1	5.9	14.0
Bulgaria	14.9	17.0	21.9	2.4	6.4	16.7
Croatia	15.1	16.4	21.5	4.9	7.7	16.7
Hungary	12.3	13.9	17.9	3.0	8.2	15.6
Lithuania	11.6	12.9	21.3	6.1	24.0	8.2
Macedonia	16.2	16.4	15.7	6.7	8.9	10.8
Montenegro	15.0	15.7	15.1	7.2	13.5	17.2
Poland	11.2	13.3	14.9	2.8	4.3	4.9
Romania	13.8	14.7	17.1	2.7	7.9	15.3
Serbia	21.9	21.4	20.4	11.3	15.5	23.0
Turkey	18.0	20.6	15.9	3.4	5.6	2.8

Source: NBS and IMF: GFSR

Being more sensitive to the economic environment in comparison to households, the corporate sector at the beginning of the crisis recorded much higher NPLs ratios with larger increase given that firms were struggling with huge problems of lack of liquidity and refinancing. The undeveloped financial market has constrained sources of funding of the firms, whose financing was, generally, bank oriented.

Up to now, average corporate sector growth of NPLs has determined the trend of the banking sector NPLs ratio based on its largest portion in total NPLs (See Chart 1). At the current level of NPLs, the most severely affected sectors in corporate NPLs is the construction sector which recorded by far the highest NPL ratio of 51%, while manufacturing and retail and wholesale trade contributed cumulatively to the total NPLs of 60%. A better situation is in the households NPL ratio. It has remained more than two times lower than the indicator for firms. This was due to lesser problems in servicing mortgage loans among other types of loans which, also, accounted for around 50% of whole household loans.

Chart 1. Sector composition of non-performing loans ratio (in %)



Source: NBS.

3. DETERMINANTS OF NON-PERFORMING LOANS

There is almost no disagreement in the literature in regards to perceiving macroeconomic performance as the key determinant of asset quality. The building-up of systemic risk caused by bank assets deterioration, in general, commences in times of economy overheating and credit expansion when lending rates considerably exceeds real growth rates. Monetary and supervisory authorities in some countries have recognized the risk of unsustainable credit growth and adopted a number of mitigating measures, mostly, without success as the majority of them were applied on the eve of the financial crisis (Gersl and Seidler 2012). Theoretical literature suggests that during credit expansion moral hazard and asymmetric information problems become widely spread. Additionally, banks profit motivation creates an incentive for bad management and a further hike in lending. Consequently, while asset prices are rising and increasing borrower's net wealth, the value of the collateral becomes overestimated. Later, when the economy is threatened by adverse shock, a quick weakening of banks assets is triggered by a downturn in the stock market through diminished collateral value. Banks' balance sheet exposure to the stock market is linked to the drop in the net worth of borrowers (ECB 2011, 135). The subsequent rise in NPLs leads the economy into recession and slower economic recovery. Stronger bank balance sheet deterioration builds risk aversion in banks

operations and postpones the creation of new healthy lending needed for real economic growth. On the opposite side, the intensity of lending recovery lag is also related to the expectation of debtors concerning future economic activity. More precisely, it depends on their risk awareness. Thereafter, spillover of increasing NPLs on real economic movements is mainly transmitted through the lending channel (Klein 2013), which is also empirically confirmed in some studies (Plašil, Radkovský and Řežábek 2013, 128).

Loan repayment in countries with high stock of foreign currency denominated debt is significantly affected by the exchange rate risk that depends on the sources of macroeconomic weaknesses. Firstly, countries with a higher exposure to risk are those with inflation targeting as a monetary policy framework and flexible exchange rates (Beck, Jakubik and Piloiu 2013). Risk has been even more pronounced in cases of current account imbalances and high degrees of external debt, particularly short-term debt. In addition, permanently generated fiscal deficits resulting in rising public debt are an important factor in analysing possible exchange rate shocks which can lead to loss of confidence and investors' capital withdrawal. Finally, vulnerability of the value of national currency does not always have a direct link with domestic economic performance, but with the external risk stemming from a country's financial system interconnections. It certainly arises from the level of share of foreign owned banks in total banking assets. If the foreign country is under macroeconomic distress, its banks may withdraw capital from the country in which they operate and induce depreciation pressures.

Besides exchange rate risk determination of the NPLs, interest rate risk has an important role. Interest rate changes affect the ability to repay the debt, especially if they are floating which is often the case in long-term loans in comparison to short-term ones. The floating part of the interest rate is usually dependent on the money market rate while the fixed part covers operational cost. Therefore, it is hard to link the interest burden impact on NPLs with asset management efficiency, but easier to relate it to money market conditions. Changes in key policy rates in countries with inflation targeting monetary frameworks with high participation of FX loans in the banking credit portfolio have minor effects on NPLs, partly because of their weak transmission on average lending interest rates (Beck, Jakubik and Piloiu 2013). Therefore, the contribution of the interest rate channel on movements

of NPLs should be analysed separately for FX loans and loans approved in domestic currency.

Finally, shortcomings of banking regulation and bad management of assets have broadly pushed up excessive lending before the wake of the financial crisis. The rise of competition in the financial sector due to deregulation of financial markets and information technology development has lowered cost of borrowing, turning the banks' focus on quick profitability improvements (Rinaldi and Sanchis–Arellano 2006). A high level of distressed assets, still present in the banking sector, has also originated from a lack of banks' incentives to clean up their books and incur losses. This is partly due to regulatory obstacles. It results, for example, in a high share of "old" NPLs on banking books and a small level of write-offs.

4. LITERATURE OVERVIEW

An extensive literature explores factors influencing NPLs movements, but the major part of it, identifies business cycles and financial market conditions as key drivers, especially for aggregated portfolio data sets. In addition to macroeconomic environment, other authors have analysed implications of bank-specific variables in order to explain differences of NPLs variations across banks and they have often employed financial soundness indicators for that purpose.

The evolution of NPLs over time is two-folded. It is influenced by economic growth which improves the debt servicing capacity of debtors and increases healthy lending in the future. A number of studies find support for this by applying different economic activity indicators such as real GDP growth, GDP gap or even the industrial production index. Klein (2013) has investigated the NPLs in Central, Eastern and South-Eastern Europe (CESEE) in the period of 1998–2011 and has estimated the strongest response to real GDP growth, and, additionally, unemployment, and inflation. Similarly, Nkusu (2011) has focused on the linkages between NPLs and macroeconomic performance from a sample of 26 advanced countries and has also found the largest reaction of NPLs to adverse shock of GDP growth among other macroeconomic indicators.

The unemployment rate is commonly assigned as a substantial determinant of household NPLs due to its impact on households' earnings capacity. A vast number of empirical studies have confirmed this. Bofondi and Ropele (2011) have

used a single-equation time series approach to examine the macroeconomic determinants of banks' loan quality in Italy in the past twenty years for households and firms separately. Contrary to previous findings, they have detected the unemployment rate as the main individual contributor to the variability of firms' NPLs, and surprisingly, only as second in importance for households. Fainstein and Novikov (2011) have applied a vector equilibrium error correction model to discover the influence of macroeconomic and real estate market variables on the level of non-performing loans in the three Baltic States. Significant long-run effect of the unemployment rate has been estimated on the NPL ratio in the Estonian banking sector.

As already discussed in Section 3, one of the important threats to the quality of the credit portfolio has roots in exchange rate risk, particularly in countries with a high share of foreign-currency denominated loans. Beck, Jakubik and Piloiu (2013) using a novel panel data set have studied the macroeconomic determinants of non-performing loans across 75 countries during the past decade. These authors included interaction of the nominal effective exchange rate with a dummy variable representing different levels of foreign currency denominated loans (high versus low) and have obtained results of strong significance. De Bock and Demyanets (2012) have assessed the vulnerability of credit portfolio quality to macroeconomic shocks in 25 emerging markets from 1996 to 2010. Their finding, based on a panel VAR model, suggests a strong response of NPLs to exchange rate shock.

Furthermore, interest rate dynamics affect the borrowers' ability to repay the debt, especially if it floats. Louzis, Vouldis and Metaxas (2012) used dynamic panel data methods to examine the determinants of NPLs in the Greek banking sector, separately for different loan categories (consumer loans, business loans and mortgages). They found that NPLs in the Greek banking sector can be explained mainly by interest rates and other macroeconomic fundamentals such as GDP and the unemployment rate. Other authors, such as Bofondi and Ropele (2011) have observed an unexpected result of the main explanation of household NPLs through the change in interest rate.

In some studies, both macroeconomic indicators and bank-specific variables are explored in the explanation of credit risk. Aforementioned authors, Louzis, Vouldis and a Metaxas (2012) have also showed a significant effect of bad management on NPLs which is tested through the impact of return on equity. Similarly, Makri, Tsagkanos and Bellas (2014) have investigated the factors affecting the NPL

in the euro zone during the pre-crisis period. They analyzed both macro-variables and bank-specific variables (e.g. loans to deposits ratio, return on assets, and return on equity). Regarding macro variables, they have observed a significant impact of public debt, GDP growth and the unemployment rate. Among micro data, returns on assets and capital adequacy ratio have exerted a powerful influence on NPLs.

Recently, key determinants of NPLs in separate country analyses have been considered in Baholi, Dika and Xhabija (2015), Prasanna (2014) and Olayinka and Mofoluwaso (2014).

5. ECONOMETRIC RESULTS

5.1. Long-term causality analysis

Our empirical research was conducted in order to assess effects of macroeconomic determinants on the non-performing loans in the Serbian banking sector. We assume that the NPLs share common stochastic trends with at least one of the main macroeconomic variables, and, for this reason, vector equilibrium error correction model (VECM) has been applied as a reliable one for estimating both long-term and short-term macroeconomic drivers of NPLs (Juselius 2006). VECM representation of lag-length equals to k is defined as:

$$(1) \qquad \Delta x_t = \Gamma_1 \Delta x_{t-1} + \Gamma_2 \Delta x_{t-2} + \ldots + \Gamma_{k-1} \Delta x_{t-k+1} + \Pi x_{t-1} + \varepsilon_t, \ \varepsilon_t \sim NI(0, \Omega)$$

where x_t is a vector of a subject time series, matrices Γ_i, (i=1,2,…,k-1) refer to short-run parameters, matrix Π resembles long-run effects and ε_t is normally distributed vector error component uncorrelated at lag different than 0. More comprehensive, matrix Π is decomposed into a product of matrix with adjustment parameters (α) and matrix with long-term parameters (β). is the first difference operator.

The data set consists of the following variables: NPLs ratio for aggregate banking sector portfolio (NPL), macroeconomic indicators: seasonally-adjusted real GDP level (GDP), unemployment rate (UR), consumer price index (CPI), nominal exchange rate of dinar against euro so that growth means depreciation[1] (ER) and key policy rate (KPR), and net interest margin relative to gross operating

1 Nominal exchange rate is calculated as the average of the daily data for the last month in each quarter.

income[2] (NIM) as a possible indicator of the quality of the banking asset management. Sample covers period: 2008 Q3–2015 Q1. All variables are transformed by applying natural logarithm function. Since the one of the main prerequisites for the adequate implementation of the cointegrated VAR framework is non-stationarity of the time series set, the analysis has been started with the original time series that are I(1) integrated processes. Cointegration analyses are conducted in CATS in RATS econometric software (Dennis 2006).

The determination of the cointegration rank is a critical part in the empirical analysis and it will influence our inference about sources of the non-stationarity of the NPLs. Hence, the trace test or the Johansen test is employed (Johansen 1995). Accounting for the test results sensitivity due to small sample size, the trace test is done by following "specific to general" procedure in three steps. In the first step the test results are calculated for NPLs ratio (Table 2) with each explanatory variable separately for different lag lengths, regarding quarterly data frequency. A constant is restricted to be a part of cointegration space. The Johansen test results emphasize strong cointegration of NPLs with each independent variable for the most of the model lag lengths.

The conclusion about variables in cointegration relations is not valid without taking into account the test of weak exogeneity, sings restrictions and significance of long-run and adjusting parameters. For this reason, within the second step, Table 3 encompasses the information about matrix Π adequacy and results of the weak exogeneity testing under the determination of one cointegration vector for the models that showed one or two significant cointegration relations. We expect in the long-term that growth of the unemployment rate, exchange rate, consumer price index, key policy rate and net interest margin will change the non-performing loans in the same direction. Conversely, the long term increase in GDP is assumed to have the opposite effect. Thus, specifications that are not in line with our sign restrictions criteria are rejected. Additionally, results that have not exerted acceptance of weak exogeneity of a particular macroeconomic indicator and negative sign and significance of adjustment parameter are assigned as improper.

2 We have also considered indicator as operating expense to gross operating income but we have not found any significant conclusions and, hence, these results are not reported.

Table 2. Johansen trace test for aggregate NPLs ratio with one macroeconomic determinant

Time series	Lag length	Critical test value 20.164 - Ho: r>0		Critical test value 9.142 - Ho: r>1	
		trace test statistics	p-values	trace test statistics	p-values
real s.a. GDP level	2	29.767	0.001	4.452	0.361
	3	23.003	0.019	6.213	0.181
	4	40.004	0.000	8.910	0.056
	5	14.952	0.234	3.969	0.429
	6	20.287	0.048	8.736	0 060
unemployment rate	2	35.418	0.000	11.975	0.013
	3	12.863	0.383	2.795	0.627
	4	43.634	0.000	3.807	0.453
	5	21.316	0.034	4.451	0.361
	6	26.687	0.005	3.501	0.503
consumer price index	2	34.156	0.000	6.646	0.151
	3	43.618	0.000	10.928	0.022
	4	32.085	0.001	11.090	0.020
	5	18.827	0.077	4.772	0.320
	6	19.734	0.058	3.366	0.525
exchange rate	2	29.605	0.001	6.652	0.150
	3	24.934	0.009	4.370	0.372
	4	25.144	0.008	8.062	0.082
	5	27.684	0.003	6.154	0.185
	6	43.088	0.000	6.442	0.164
key policy rate	2	22.962	0.019	5.744	0.219
	3	25.002	0.009	7.997	0.084
	4	18.553	0.084	7.530	0.103
	5	18.195	0.094	3.193	0.555
	6	24.124	0.012	5.686	0.224
net interest margin	2	26.264	0.005	9.303	0.046
	3	19.613	0.060	9.306	0.046
	4	15.831	0.186	7.249	0.117
	5	21.563	0.031	10.371	0.028
	6	32.870	0.000	11.785	0.014

Focusing on the matrix Π adequacy interpretation, we have found sign of long-term coefficient estimate only for the GDP level which does not meet our expectations. Among other determinants, unsatisfied weak exogeneity precondition is obtained for the unemployment rate and key policy rate. Despite acceptance of weak exogeneity for the net interest margin as well as, the correct sign for long-term effect, we have abandoned these results owing to instability obstacles that could not be resolved with dummy variables and the very poor explanatory power of models. In the end, adequate matrix Π with non-rejected null hypothesis of weak exogeneity is attained for the consumer price index and the exchange rate. According to misspecification tests, models with three and six lags were chosen in the specifications with the consumer price index and the exchange rate respectively.

Table 3. Test of weak exogeneity and matrix Π adequacy

Time series	Lag length	Test Ho: weak exogeneity	Matrix Π			
			Adjustment parameter		Cointegration parameter	
		p-value	Estimate	Significance test value	Estimate	Significance test value
real s.a. GDP level	2	0.894	-0.369	-5.944	9.194	4.789
	3	0.564	-0.458	-4.543	10.433	6.356
	4	0.035	-0.656	-7.777	9.159	11.411
	6	0.128	-0.094	-0.899	5.357	3.201
unemployment rate	2	0.001	-0.353	-4.491	1.086	1.901
	4	0.000	-0.509	-3.150	2.851	17.718
	5	0.001	-0.625	-1.623	2.752	16.230
	6	0.000	0.209	0.503	2.440	18.665
consumer price index	2	0.534	-0.673	-6.485	0.781	8.530
	3	0.446	-0.847	-6.845	0.769	14.541
	4	0.538	-1.004	-4.690	0.735	15.532
	5	0.020	-0.211	-1.450	0.488	4.875
	6	0.001	-0.004	-0.049	-0.034	-0.198
exchange rate	2	0.002	-0.468	-2.747	1.553	11.451
	3	0.000	-0.143	-0.594	1.669	14.466
	4	0.081	0.133	3.939	3.666	5.348
	5	0.881	-0.311	-5.997	1.244	5.396
	6	0.160	-0.722	-9.046	1.281	21.620

Time series	Lag length	Test Ho: weak exogeneity	Matrix Π			
			Adjustment parameter		Cointegration parameter	
		p-value	Estimate	Significance test value	Estimate	Significance test value
key policy rate	2	0.122	-0.115	-4.426	1.720	3.213
	3	0.003	0.021	0.468	-2.302	-5.679
	6	0.047	-0.186	-2.532	0.100	0.250
net interest margin	2	0.554	-0.435	-4.885	1.860	2.870
	3	0.985	-0.449	-3.302	3.342	5.067
	5	0.528	-0.109	-2.697	8.006	5.790
	6	0.004	0.027	0.573	7.551	7.727

Relying on the second step results, the cointegration rank test for two macroeconomic indicators is employed with the separate presence of the consumer price index and exchange rate that is further combined with the rest of variables within our third step. None of the estimated models improved the explanation of the long-term variations of NPLs due to sign constraints and/or misspecification found (results are not reported due to limitations of space). Thereafter, we narrow our specifications on the one that refers to cointegration of NPLs with the consumer price index and the other one in which NPLs are explained in the long-term by the exchange rate.

5.2. Robustness check and regime switching impacts

Parameter instability is an important factor in empirical analyses, which can strongly affect final conlusions. In order to find out whether the coefficients in our specifications are stable, we, firstly, identify three main potential sources of structural breaks that capture economic policy interventions and banking sector regulatory changes:

1. Introduction of Basel II standards in Q4 2011;
2. Revoking licensing of Nova Agrobanka in Q4 2012;
3. Assignment of due receivables to entities outside the financial sector in Q1 2013;

In terms of the regulatory area of the banking supervision, the National Bank of Serbia has adopted a set of regulations and decisions by introducing Basel II

standards applied as of 31 December 2011. Together with the novelties in NPLs reporting, this regulatory change has substantially improved credit risk evaluation in the banking sector. Revoking licensing of Nova Agrobanka in October 2012 had a sizable effect on the lowering of NPLs ratio given its share in Serbian banking sector assets which at major part was transferred outside the banking sector. Finally, important regulatory change within the National Bank of Serbia efforts in NPLs resolution was the assignment of due bank receivables to non-financial sector entities that has largely helped cleaning-up bank balance sheet of bad assets and has slowed down the rising NPLs trend.

Structural breaks in cointegration relations can appear in long-term parameters β and/or in level (constant term). Diagnosing β parameter non-constancy is explored by forward recursive test known as the max test of β-constancy (Juselius 2006, 159). Figure 1 and 2 reflect that the null hypothesis of constant parameters cannot be rejected in each sector regarding that test statistic is below the rejection line of 1.0 for all tested period. Constant term instability is assessed by first including corresponding dummy variable in cointegration space and then testing its significance. The results show that no significant structural change in the level has occurred within the specification with consumer price index (Table 4). We consider the changes of constant term in specification with exchange rate to be negligible despite its significance, due to the inclusion of addition instability issues and misspecification outcomes.

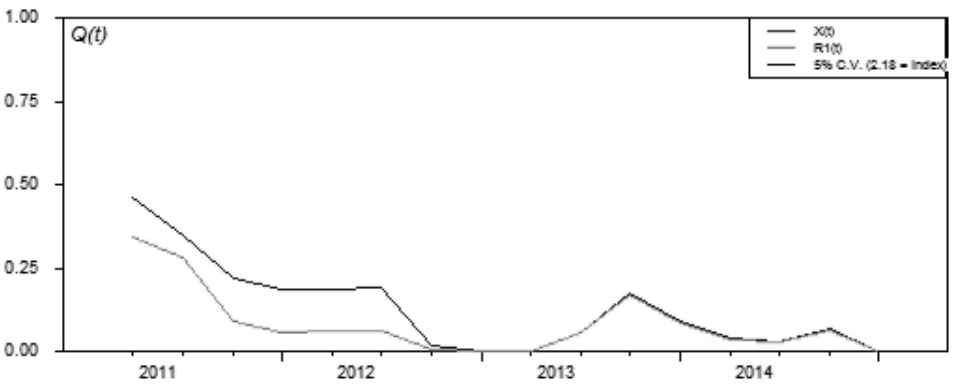


Figure 1. The max test of β-constancy for specification of cointegration with consumer price index

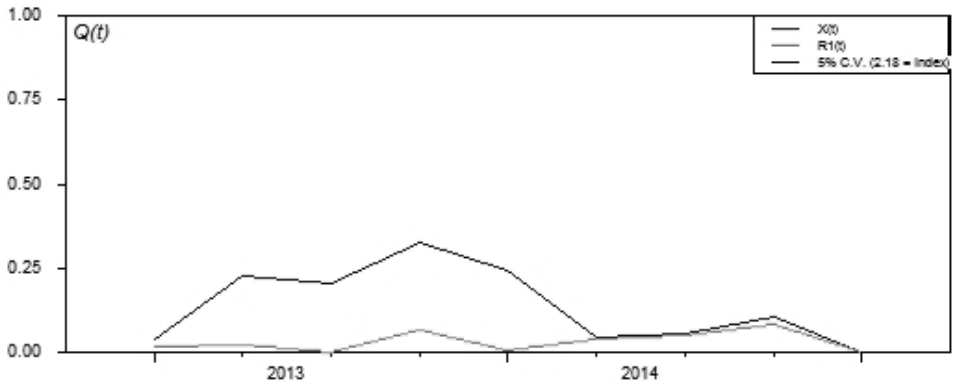


Figure 2. The max test of β-constancy for specification of cointegration with exchange rate

Table 4. Structural break test in the level of cointegration space

Break	Cointegration with consumer price index			Cointegration with exchange rate		
	Constant term estimate	Constant term change estimate	Significance test statistics of change	Constant term estimate	Constant term change estimate	Significance test statistics of change
Q4 2011	-1.223	-0.035	-1.428	-4.525	-0.034	-2.892
Q4 2012	-1.232	-0.040	-1.929	-1.087	0.045	3.500
Q1 2013	-0.873	-0.022	-0.938	-2.147	0.024	1.648

Figure 3 and 4 encompass our final VECM specifications for both cointegration with the consumer price index (CPI) and exchange rate (ER) separately and corresponding misspecification test (p-values or test significance statistics are in parentheses). Both systems are stable given that the eigenvalues of the companion matrix are all inside the unit circle (Figure 4 and 6). Zero estimates on the particular lags are under constraint of the exclusion on the basis of their insignificance.

$$\begin{bmatrix}\Delta NPL_t\\ \Delta CPI_t\end{bmatrix}=\begin{bmatrix}\mathbf{-0.892} & (-7.217)\\ -0.037 & (-0.595)\end{bmatrix}\begin{bmatrix}1 & (\text{NA})\\ \mathbf{-0.797} & (-16.166)\\ \mathbf{0.576} & (2.579)\end{bmatrix}\begin{bmatrix}NPL_{t-1}\\ CPI_{t-1}\\ C\end{bmatrix}+$$

$$+\begin{bmatrix}\mathbf{0.257} & 0.082\\ (2.981) & (0.173)\\ -0.005 & \mathbf{0.506}\\ (-0.122) & (2.105)\end{bmatrix}\begin{bmatrix}\Delta NPL_{t-1}\\ \Delta CPI_{t-1}\end{bmatrix}+\begin{bmatrix}0.000 & \mathbf{-2.340}\\ (0.000) & (-5.389)\\ 0.000 & 0.122\\ (0.000) & (0.554)\end{bmatrix}\begin{bmatrix}\Delta NPL_{t-2}\\ \Delta CPI_{t-2}\end{bmatrix}+\begin{bmatrix}\hat{\varepsilon}_{1t}\\ \hat{\varepsilon}_{2t}\end{bmatrix}.$$

Figure 3. The final VECM specification of cointegration with consumer price index

Note: t-ratios are reported in parentheses. Residuals are denoted as $\hat{\varepsilon}_{1t}$ and $\hat{\varepsilon}_{2t}$.

Tests for Autocorrelation
LM(1): ChiSqr(4) = 2.574 (0.631)
LM(2): ChiSqr(4) = 1.897 (0.755)

Test for Normality:
ChiSqr(2) = 4.461 (0.347)

Test for ARCH effect:
LM(1): ChiSqr(9) = 6.565 (0.682)
LM(2): ChiSqr(18) = 11.146 (0.888)

Univariate Statistics (R-Squared)

Δ*NPL*	0.753
Δ*CPI*	0.064

Test of null hypotheses of weak exogeneity
LR-Test, Chi-Square(1)

NPL	*CPI*
23.264	0.318
(0.000)	(0.573)

Test of null hypotheses of exclusion
LR-Test, Chi-Square(1)

NPL	*CPI*	Constant
24.902	20.829	4.130
(0.000)	(0.000)	(0.042)

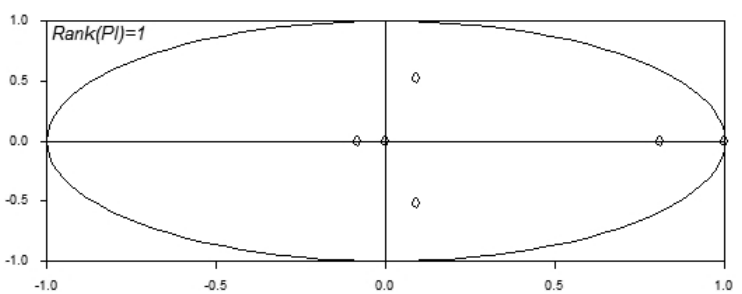


Figure 4. The roots of the Companion matrix for specification of cointegration with consumer price index

$$\begin{bmatrix} \Delta NPL_t \\ \Delta ER_t \end{bmatrix} = \begin{bmatrix} \mathbf{-0.678} & (-13.221) \\ 0.072 & (0.978) \end{bmatrix} \begin{bmatrix} 1 & (\text{NA}) \\ \mathbf{-1.241} & (-19.196) \\ \mathbf{2.797} & (9.123) \end{bmatrix} \begin{bmatrix} NPL_{t-1} \\ ER_{t-1} \\ C \end{bmatrix} +$$

$$+ \begin{bmatrix} \mathbf{0.344} & \mathbf{-1.238} \\ (5.220) & (-8.681) \\ \mathbf{0.240} & \mathbf{0.392} \\ (2.519) & (1.907) \end{bmatrix} \begin{bmatrix} \Delta NPL_{t-1} \\ \Delta ER_{t-1} \end{bmatrix} + \begin{bmatrix} 0.014 & 0.000 \\ (0.244) & (0.000) \\ \mathbf{0.141} & 0.000 \\ (1.680) & (0.000) \end{bmatrix} \begin{bmatrix} \Delta NPL_{t-2} \\ \Delta ER_{t-2} \end{bmatrix} +$$

$$+ \begin{bmatrix} \mathbf{0.096} & \mathbf{-2.144} \\ (1.977) & (-13.979) \\ 0.090 & -0.288 \\ (1.277) & (-1.302) \end{bmatrix} \begin{bmatrix} \Delta NPL_{t-3} \\ \Delta ER_{t-3} \end{bmatrix} + \begin{bmatrix} \mathbf{0.485} & \mathbf{0.474} \\ (10.616) & (2.559) \\ 0.084 & 0.025 \\ (1.278) & (0.092) \end{bmatrix} \begin{bmatrix} \Delta NPL_{t-4} \\ \Delta ER_{t-4} \end{bmatrix} +$$

$$+ \begin{bmatrix} 0.000 & \mathbf{-0.989} \\ (0.000) & (-7.549) \\ 0.000 & 0.148 \\ (0.000) & (0.782) \end{bmatrix} \begin{bmatrix} \Delta NPL_{t-5} \\ \Delta ER_{t-5} \end{bmatrix} + \begin{bmatrix} \hat{\varepsilon}_{1t} \\ \hat{\varepsilon}_{2t} \end{bmatrix}.$$

Figure 5. The final ECM specification for cointegration with exchange rate

Note: t-ratios are reported in parentheses. Residuals are denoted as $\hat{\varepsilon}_{1t}$ and $\hat{\varepsilon}_{2t}$.

Tests for Autocorrelation
LM(1): ChiSqr(4) = 0.917 (0.922)
LM(2): ChiSqr(4) = 2.220 (0.695)

Test for Normality:
ChiSqr(4) = 9.278 (0.055)

Test for ARCH effect:
LM(1): ChiSqr(9) = 9.918 (0.357)
LM(2): ChiSqr(18) = 16.317 (0.570)

Univariate Statistics (R-Squared)

ΔNPL	0.940
ΔCPI	0.648

Test of null hypotheses of weak exogeneity
LR-Test, Chi-Square(1)

NPL	*ER*
43.022	0.912
(0.000)	(0.340)

Test of null hypotheses of exclusion
LR-Test, Chi-Square(1)

NPL	*ER*	Constant
23.941	16.890	11.094
(0.000)	(0.000)	(0.001)

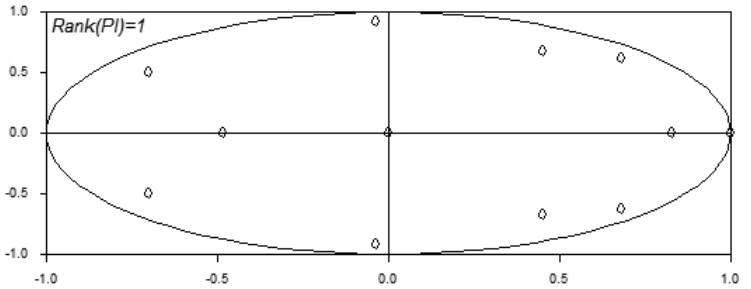


Figure 6. The roots of the Companion matrix for specification of cointegration with exchange rate

5.3. Short term dynamics and final VECM specification

Causality analyses conducted have shown that aggregate NPLs are adequately explained in the both long-run specification by only one macroeconomic variable. Different variables may emerge as prevailing drivers of the NPLs short-run evolution and should not be neglected. For that reason, we have investigated the possibility of improving the VECM specification by involving the significant effects of stationary representations of other explanatory variables from our data set. At first, sign restrictions for short run estimates of additional indicators are defined. We expect positive sign for the exchange rate in specification of cointegration with consumer price index and vice versa. Also, a reversal effect is assumed for the GDP. In case of the unemployment rate, positive and negative influences are supposed to appear in both models. The net interest margin is expected to have positive long term effect. For a given estimates of cointegration parameters, building the final VECM specification is followed by the approach of gradual inclusion of the most significant explanatory variables that satisfies the necessary sign constraints and residual properties. Table 5 describes the proposed VECM specifications for both specifications that are in line with our expectations and misspecification tests.

Table 5. The final specifications with enriched short run effects

Dependent variable: The first difference of the NPLs ratio					
Cointegration with consumer price index			**Cointegration with exchange rate**		
Explanatory variable	**Coefficient estimate**	**p-value**	**Explanatory variable**	**Coefficient estimate**	**p-value**
COINCPI(-1)	-0.341	0.000	COINER(-1)	-0.381	0.000
ΔGDP	-1.076	0.001	ΔGDP	-0.856	0.016
Δ*UNR*(-3)	-1.744	0.000	Δ*UNR*(-3)	-1.673	0.000
Δ*KPR*(-1)	-0.098	0.009	Δ*KPR*(-1)	-0.143	0.002
Δ*KPR*(-2)	0.087	0.011	Δ*KPR*(-4)	0.106	0.015
Δ*NIM*(-3)	0.789	0.000	Δ*NIM*(-3)	0.855	0.000
ΔNPL(-2)	0.121	0.034	ΔLER(-1)	-0.530	0.003

Note:
*COINCPI=NPL-0.797*CPI+0.576*
*COINER=NPL-1.241*ER+2.797*

Tests for Autocorrelation
BLJ-Test,Q-stat(4) = 5.218 (0.266)

(adj.R-Squared) = 0.881

Test for Normality:
ChiSqr(2) = 1.032 (0.597)

Tests for Autocorrelation
BLJ-Test,Q-stat(4) = 4.241 (0.374)

(adj. R-Squared) =0.901

Test for Normality:
ChiSqr(2) = 4.348 (0.114)

5.4. Interpretation of results

The application of the Johansen cointegration test has detected the consumer price index and the exchange rate as key macroeconomic factors of long-term behaviour of aggregate NPLs. The level of GDP, that is found in a number of empirical studies as a major determinant of credit risk, especially, in the corporate sector, in our analysis has not entered the cointegration relations. Still, GDP growth has a huge direct impact on aggregate NPLs given its significance in short-run dynamics.

There are at least, two main reasons for rejecting the long-term determination by GDP. The first one is clear and derives from almost opposite trends in real GDP growth and NPLs evolution in the post-crisis period. As already stated, the average real GDP growth in the period 2010–2014 was 0.3%, while NPL ratio stood at 15% at end-2009 and has largerly increased since then. Consequently, a positive and implausible long-term relationship between NPLs and GDP level has been identified in our results. The enormous gap between NPLs upward trend and GDP movements derives from the unfavourable distribution of contributors to GDP growth. The average growth of 0.3% originates from only the positive contribution of net export (0.9 p.p) and partly by government spending in contrast to the lack of positive contribution of investments that together with private consumption have negatively contributed to GDP growth. The second reason for the absence of cointegration between NPLs and GDP level has its roots in the time horizon covered that does not include the full financial cycle, but only the downturn phase.

Economic theory emphasizes that the rise in inflation causes decline of indebtedness level by reducing the real value of outstanding debt. This influence is small in countries with a high level of foreign currency debt and cannot have long-lasting effect having in mind that inflation diminishes the purchasing power of debtors and their ability to repay the debt. Therefore, we believe that in the long-term there is no trade-off between inflation and credit risk and the direct long-term impact of the consumer price index we have found in empirical analyses has met our assumptions. In Figure 3 it is estimated that 1% of inflation rise in the long-term increases the NPLs by 0.80% and the dynamics of the NPLs is adjusted to equilibrium level each quarter by approximately 34% (Table 5). There is also a trade-off in the short-run. More precisely, taking into account the persistency of NPLs, we have calculated contemporaneous transitory effects in structural vector moving average representation to be -1.35. Negative transitory effect is crucial for providing fulfillment of the misspecification test in the final model and providing valid empirical results. The estimate is probably due to the fact that it reflects mostly indirect effects of weak real economy growth that through the channel of low aggregate demand represents one of the main determinants of low inflation in recent times.

Cointegration of the NPLs with the exchange rate has not been rejected. The result resembles the strong vulnerabilty of the corporate sector and households on the depreciation of the national currency regarding high level of FX loans in the

banking sector credit portfolio. In addition, a positive trend of the NPLs ratio for the observed period is to a large extent caused by large average depreciation of the dinar at the same time. Cointegration estimates imply that in the long run 1% of growth of the exchange rate is associated with 1.24% of increase in aggregate NPLs ratio. This means, that in the long-run, NPLs are more sensitive to exchange rate changes. Additionally, 38% of variations of NPLs are corrected to equilibrium level each quarter, which is a slightly stronger adjustment than in the case of cointegration with CPI.

Contrary to the model based on cointegration with CPI, estimated short-run dynamics from the long-run determination with exchange rate shows high negative influence of the currency depreciation rate at lag one on the NPLs dynamics. This is probably due to the period of the opposite dynamics of NPLs in comparison to exchange rate that is not driven by permanent interventions like the one we have tested within the robustness check. Such periods in the recent past covered the second half of 2013 and 2014. The first period is described by a relatively stable exchange rate, while negative credit growth and the exhaustion of effects of the subsidized loan programme from the end of 2012 exacerbated loan repayment by debtors. In the second half of 2014, depreciation pressures were observed, but a new government subsidized loan programme created fresh liquidity for firms and diminished their NPLs. Still, these effects were not enough to attain a trade-off in the short-run, and the estimated contemporaneous transitory effect in structural vector moving average representation is postive and equals to 0.313. This might have been the result of the low contribution of the dinar depreciation on net export growth (Tasić and Zdravković 2008).

A small number of empirical papers examined long-term variations of NPLs within the cointegrated vector framework. In Section 4, we emphasized that Fainstein and Novikov (2011) have estimated cointegration of NPLs of the aggregate banking sector portfolio with unemployment rate in the Estonian banking system. Plašil, Radkovský and Řežábek (2013) were looking at characteristics of the effect of demand and supply factors on bank loans to non-financial corporations in order to find a forecasting model for the main variables linked with corporate loans. One of their results is a cointegration of NPLs in the corporate sector with the credit-to-GDP ratio. Rinaldi and Sanchis-Arellano (2006) have focused on household NPLs in a sample of euro area countries within an error-correction framework. They examined positive long-term relationships between household

NPLs and inflation, unemployment rate, real lending rate and leverage. Olayinka and Mofoluwaso (2014) have analysed factors that drive NPLs in Nigeria and have found real GDP growth as long-term determinants of NPLs. Erjavec, Cota and Jakšić (2012) have estimated VAR model applying stationary representations of time series and have found sizable effects of real GDP growth, real lending rate and inflation rate on NPLs. Misljenovic (2014) has investigated long-term variability of aggregate NPLs in the Serbian banking sector on a monthly based data set and has found cointegration of NPLs with the consumer price index.

In order to improve econometric result for NPLs we have extended models (Table 5) by incorporating stationary transformations of other explanatory variables in the short-run for a given estimate of cointegration relations. As already emphasized, instant and strong impact of GDP growth is found in both specifications. As expected, negative effect of the growth of the unemployment rate is estimated and explains attaining liquidity needed for the repayment of corporate sector debt after reducing the number of employees. A significant effect of the key policy rate with positive and negative estimates has been found in both models. Positive and faster effects describe the exchange rate channel given the speed and the direction of the response of the exchange rate to key policy change. Moreover, the exchange rate channel effect is larger relative to the interest rate channel and this can be associated with the level of euroization of the corporate credit portfolio (NBS 2014, 115). On the other side, a positive long-run effect of the net interest margin appears not to be significant, while positive short-run influence after three quarters is exerted. The result is in accordance with our expectation regarding the fact that net interest margin is one of the indicator of the banking sector profitability and, hence, as an asset quality management indicator should be considered only in short-run variations of NPLs.

6. CONCLUSION

This paper has discussed the construction of a vector equilibrium error correction model that describes the evolution of the determinants of non-performing loans in the Serbian banking system in the post-crisis period. Long-term drivers of the NPLs among various macroeconomic indicators are identified in two different specifications.

Our results have showed that the NPLs long-term variations are associated with the consumer price index and exchange rate movements so that more than 30% of the NPLs dynamics is adjusted each quarter to the equlibrium level with these variables. We note that in the long-run a trade-off between rising inflation and declining NPLs is not plausible. Also, we exclude a possible long-run trade-off between depreciation of the dinar and declining NPLs. We found that in the long-run NPLs are more sensitive to the exchange rate in comparision to the consumer price index. Both long-run relations are robust to regime switching impacts.

We have determined a sizable short-run trade-off between inflation and NPLs. Although the GDP level is not associated with the NPLs in the long-run, its strong and contemporaneous effect is found in the short-run variations. Furthermore, a significant effect of bad asset management on the short-run growth of NPLs is estimated on the basis of the positive sign of the net interest margin coefficient. In the short-term key policy represents the exchange rate and interest rate channel and resemble the euroization of the banking sector loan portfolio.

The article enhances our picture of credit risk in the Serbian banking sector, measured by the non-performing loans ratio, which previously had not been mapped through the more comprehensive approch like the one that enables a vector equilibrium error correction model. We consider our results to be useful for policy makers and for the macro stress-testing framework.

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Rezime:
PROBLEMATIČNI KREDITI U SRBIJI: ekonomska pitanja i pojedini ekonometrijski rezultati

U radu su dati ekonometrijski rezultati modeliranja problematičnih kredita bankarskog sektora Srbije za period: T3 2008 – T1 2015. Metodološki okvir rada zasniva se na primeni kointegracione analize, kao i analize zajedničkih stohastičkih faktora. Korišćeni su tromesečni podaci sledećih veličina: udeo problematičnih kredita u ukupnim bankarskim kreditima, nivo BDP, stopa nezaposlenosti, cene, devizni kurs, referentna kamatna stopa i kamatna marža. Dobijeni rezultati sugerišu da su na dugi rok vremenske serije cena i deviznog kursa pojedinačno kointegrisane sa ukupnim problematičnim kreditima. Njihova kratkoročna dinamika većim delom se može objasniti kanalima deviznog kursa i kamatne stope. Ocenjen je i značajan uticaj stope rasta BDP. Rezultati dodatno ukazuju na to da loše upravljanje aktivom bankarskog sektora ima značajan efekat na kratkoročnu dinamiku problematičnih kredita.

Ključne reči: kointegracija, makroekonomski faktori, problematični krediti, srpski bankarski sektor

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