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Interbank Network as a Channel of Credit Contagion in Banks: Is Moral Hazard Transferable?

Abstract: The objective of this research is to examine the interbank network of clients as a channel for credit risk transmission by groups of banks in Serbia characterized by different levels of credit risk (clusters). Two of the four observed groups of banks have experienced increase in NPLs through the channel of contagion spread in the interbank network. The spread of the infection through the banking network is a consequence of the impact of the economic connection among clients. The third group of banks (banks with high levels of credit risk) takes over the effects of systemic factors and transfers their influence to the second and the first group (banks with average and below-average credit risk level) through the banking network channel. There were different models of bank behaviour, from a group of banks that fully aligned their risk taking with risk capacity to a group of banks that exhibited an excessive risk propensity far beyond their own risk-taking capacity. There is also the confirmation that moral hazard was an important determinant of credit risk and an additional impulse to spread credit contagion.

Keywords: Credit Contagion, Interbank Network, Economic Connection, Moral Hazard, NPL.

JEL Classification: G21, G28, G32, D82

1. Introduction

Following the last financial crisis, the issue of risk management has regained its importance. Numerous studies have been published addressing the factors that have determined credit risk growth at the level of individual countries or regions.

The research is mainly focused on analysing and modelling aggregate values at country and regional levels, or cross-country comparisons. The focus of this research is one country - the banking sector of the Republic of Serbia, and investigating the possibility that specially formed homogeneous groups of banks (parts of the banking sector) that differ by credit risk levels, have different behaviour and confirm the existence of the interbank network as channel for spread of credit contagion. Particularly, it investigates which behavioural model fits a particular homogeneous group of banks, if there is a moral hazard in a particular model of bank behaviour, the influence of the present behavioural model of banks on the credit risk level, and the interrelationship between the homogeneous groups of banks that we have formed.

The rest of the paper is organized as follows. The second part gives a brief literature review and the next section deals with the description of the data set. In the fourth part we present the methodology and the empirical results of the research, and the fifth part is reserved for concluding remarks.

2. Literature Review

We will first mention papers that analyse the interbank network and the spread of contagion. The theory and evidence of bank contagion has been studied by Kaufman (1994). Giesecke and Weber (2006) analysed the impact of credit contagion on credit losses. Credit lines as a channel of contagion are presented in an article prepared by Müller (2006). Jorion and Zhang (2007) prepared a paper on credit contagion in case of credit default swaps, and late also discussed counterparty risk as channel of credit contagion (Jorion and Zhang, 2009). Egloff and Leippold (2007) analyse the relationships between clients in the portfolio and the impact of those relations on credit contagion. Chakrabarty and Zhang (2012) analyse the Lehman Brothers' Bankruptcy and spread of contagion through the counterparty channel and the information transmission channel.

Moral hazard in banking might be identified when banks with a high level of NPL have higher growth rate of credit compared to the average growth level. According to Jensen and Meckling (1976), there are two sources of moral hazard in banking. The first one stems from managers' objective to obtain higher salaries and bonuses which motivates them to make more risky loans. The second one is related to the interest of shareholders to maximize profit with risky loans which is not aligned with the interest of depositors. There are also some behavioural explanations of moral hazard based on Kahneman and Tversky's (1979) Prospect theory and Cumulative prospect theory (Tversky and Kahneman, 1992) that have

determined experimentally that people are risk-seeking when they are exposed to certain losses.

Empirical research of Zhang, Cai, Dickinson and Kutan (2016) aims to identify the presence of moral hazard in banks with high level of NPL in the sample of Chinese banks. They assume that large banks have more competent staff to evaluate debtors and should be less exposed to moral hazard, but this is offset by the opposing effect of the too-big-to-fail argument. The second assumption is that the higher share of deposits in total bank's financial sources induces higher moral hazard. The empirical results confirm the presence of moral hazard since banks with a high level of NPL have above normal growth rate of credits.

The same conclusion was reached by Cincinelli and Piatti (2017) for Italian banks. In addition, they propose the following measures to overcome the moral hazard problem. First, banks should be forced to increase the amount of required capital such that they reduce the amount of loans and especially risky loans. Second, the Italian supervisory authority should increase the control of banks that surpass certain threshold value of NPL. Third measure relies on market design argument and proposes the development of market for NPL.

Some important determinants of moral hazard in banks were identified by Nier and Baumann (2006). The first factor is the probability that a bank will be bailed out by the government and higher probability of bailout increases the moral hazard. Second, if banks are rated by credit agencies, this reduces the adverse incentives by managers to grant risky loans. Third, the effect of competition is ambiguous. Higher competition among banks increases the incentive to grant risky loans, but on the other hand, the market discipline resulting from competition may discipline managers to avoid moral hazard.

The role of collateral in the moral hazard problem was studied by Manove, Padilla and Pagano (2001). The presence of collateral might reduce bank's incentive to screen out good from bad borrowers. This moral hazard problem is aggravated with the higher level of competition in the banking industry. The remedy for this kind of adverse incentive by collateral is to limit the right of the creditor to take the collateral in possession in banking industries with the high level of competition. The same role of collateral was analysed by Niinimäki (2009) in the setup where the value of the collateral is a random variable. In the case of default, the bank can cover the loss when the value of collateral is larger than the value of credit, but when it is lower than the value of loss, the bank cannot cover it from collateral.

In the context of this research, we highlight articles that analyse the moral hazard in low-capital banks, performed by Salas and Saurina (2002) and Jimenez and Saurina (2005).

The impact of collateral on the adverse selection problem was studied by Karapetyan and Stacescu (2014). The traditional idea is that information about credit history collected in credit registers and collateral are considered as substitutes. However, borrowers with bad credit history are required to provide higher level of collateral. This means that information obtained in credit agencies and on collateral might be considered as complements. This result is supported by empirical evidence provided by Doblas-Madrid and Minetti (2013) from the US market that the information collection in credit agencies increases the required collateral. The positive correlation between risk premium on credits and collateral was identified in transition countries as well by Weill and Goldewski (2009).

There is also some evidence in Serbia of the presence of moral hazard as well as the determinant of credit risk in banking sector, as studied by Jović (2017). Moral hazard indicator is defined as measures of a bank's tendency to overestimate good assets. It is a number that measures how much a client's rating in a observed bank is better than a rating in a reference bank – bank with conservative credit risk policy that exists in the market. The results of the econometric model confirm that banks with a higher value of this indicator with some time lag show a higher default rate (higher level of credit risk). We especially highlight the papers dealing with the issue in the banking sector of the Republic of Serbia (Tanasković and Jandrić, 2015; Živanović, Đulić and Jolović 2020; Grubišić, Kamenković and Kaličanin, 2021; Grubišić, Kamenković and Kaličanin; 2022). This finding raised the question of whether credit risk from banks where moral hazard was confirmed could be transferred to other banks in the system through an interbank network. We will try to provide the answer to this question in the next sections of this paper.

3. Data

Bearing in mind that the presence of moral hazard as a determinant of credit risk in Serbia has been previously confirmed, the examination of the possibility of transferring moral hazard from one bank to another bank will begin with data regarding the level of credit risk and characteristics of certain groups of banks.

For the purpose of measuring the credit risk level, we will use the bank non-performing loans to total gross loans indicator, as well as the total value of non-

performing loans in the banking sector of the Republic of Serbia for the period from December 2008 to December 2014. The choice of this period is determined by the following facts: 1) 2008 is the beginning of the spillover effect of the World Financial Crisis on the banking sector of the Republic of Serbia and the moment from which public official records of non-performing loan data started to be recorded, and 2) 2014 is the last calendar year before the implementation of the Government of the Republic of Serbia's NPL Resolution Strategy and the National Bank of Serbia's Action Plan for the Implementation of the NPL Resolution. Data are presented in quarterly frequency.

Based on the value of the non-performing loans to total gross loans indicator for each individual bank in the banking sector, we can segment the banking sector into homogeneous groups of banks (Table 1), and with the reference to the maximum value of the bank non-performing loans to total gross loans indicator for the observed period, banks are classified into one of four homogeneous groups.

Table 1: Classification of banks into homogeneous groups

Group of banks	Maximum value of NPL%	Credit risk level	Number of banks
First group (NPL1)	[0,20%]	Low	5
Second group (NPL2)	[20%,30%]	Medium	7
Third group (NPL3)	[30%, 50%]	Increased	9
Fourth group (NPL4)	Above 50%	High	12

Source: National Bank of Serbia

To get a closer look at what distinguishes a particular homogeneous group of banks, we give an overview of some of the basic characteristics of banks in these homogeneous groups.

Table 2: Characteristics of banks by homogeneous groups

Group of banks	% of defaults (default rate)	% of delicensed banks	% of state-owned banks	% of private domestic banks	% of foreign-owned banks with problems in the group
First group (NPL1)	0%	0%	0%	0%	0%
Second group (NPL2)	0%	0%	29%	0%	0%
Third group (NPL3)	44%	11%	22%	22%	44%
Fourth group (NPL4)	67%	25%	58%	0%	25%

Source: National Bank of Serbia

From the above overview, we can see that the first homogeneous group includes banks owned by foreign entities with no significant financial problems identified

at the group level. In this group, there are no banks that were in default or delicensed due to problems in operations during the observed period. The second homogeneous group of banks consists of the combination of the prevailing majority (71%) of banks owned by foreign entities with no significant financial problems identified in the group's operations. A smaller proportion of this group (29%) is made up of state-owned banks. The change in the structure of banks by ownership, in terms of the presence of state-owned banks, was reflected in that the second group had a higher share of non-performing loans than the first group. However, in the second group as in the first, there were no cases of default and bank delinquency. The third homogeneous group of banks is composed largely of foreign-owned banks with identified problems in parent group operations (44%), state-owned banks (22%) and banks owned by domestic private individuals (22%). In the third group, only 11% of banks are banks owned by foreign entities with no significant problems identified in parent group operations. This group comprises about 44% of defaulters and 11% of banks that were delicensed by the competent regulatory authority during the observed period. The majority of the fourth group consists of state-owned banks (58%), followed by banks owned by foreign entities that had problems in their parent group operations during the observed period. In the fourth group, about 2/3 of the banks were in default and about 1/4 were delicensed by the competent regulatory authority at some point during the observed period.

We mentioned earlier that higher values of the indicator of overestimation of good assets, as a measure of a bank's moral hazard, influence a higher default rate. The third and fourth group of banks have a high share of banks in the default, around 44% and 67%, respectively (Table 2), which gives us an overview of banks that were prone to moral hazard. A large number of these banks ended up in default while the rest remained out of default but with an extremely high level of credit risk (the share of bad loans above 30%, well above the market average). In all these cases, we assume the credit risk level was well above acceptable levels, as a result of banks' behaviour model which is based on moral hazard.

Jović (2017) also confirmed in his study that a higher default rate was experienced by banks that entered the observed period with lower levels of capital. These banks were taking on credit risk (risk appetite) beyond the possibilities offered by the available capital level (risk-taking capacity).

We continue our analysis by examining the factors that determined the level of credit risk for each bank group, with particular reference to whether there is an impact from one group to another. The following macroeconomic variables will be used to analyse the impact of certain credit risk factors on the NPL level by ho-

mogeneous groups of banks: seasonally adjusted GDP (GDPsac), nominal Euro exchange rate (FXE), inflation rate (IR), benchmark interest rate (InR), unemployment rate (UR) and actual net earnings (E). These variables are taken from publicly available databases and reports of the National Bank of Serbia and the Statistical Office of the Republic of Serbia.

4. Methodology and Empirical Results

The results of the empirical analysis will be presented for a group of banks where the main macroeconomic determinants of credit risk are identified for each group.

First group of banks. Analysing the behaviour of the previously selected macroeconomic variables and their impact on the trends of NPL level indicators for the first group of banks, we apply the classical linear regression model to the first time series differences. Below we provide a specification of the model:

$$d(\widehat{NPL1}_t) = \beta_1 d(FXE_t) + \beta_2 d(NPL3_t) \quad (1)$$

Table 3: Summary of the results of linear regression model for the first group of banks

$d(\widehat{NPL1}_t)$	Coefficients
$d(FXE_t)$	1.434 (0.50)
$d(NPL3_t)$	1.108 (0.19)
Observations	24
Adjusted R^2	0.84
JB test for normality	0.87
Q-test for autocorrelation (12)	0.19
Breusch-Pagan-Godfrey test for *heteroskedasticity*	0.68
Ramsey RESET test	0.16

Source: Eviews report, data calculated by the authors.

From the obtained results, we can conclude that only one macroeconomic variable is significant, namely the nominal Euro exchange rate at the end of the period. Also, the trend of NPL level indicator in the first group of banks is strongly influenced by the trend of NPL level indicator in the third group of banks.

Analysis of the mutual impact of macroeconomic variables on the NPL level indicator in the first group of banks will be carried out by applying the vector autoregression (VAR) model, starting from the causality test, and proceeding with variance decomposition and the impulse response function. Using the Granger causality test, we obtained the following results:

Table 4: Causality analysis for the first group of banks

Granger causality test	p-value
Impact of the nominal Euro exchange rate (FXE) and the NPL level in the third homogeneous group of banks (NPL3) on the NPL level in the first group of banks (NPL1)	0.02
Normality and autocorrelation tests	p-value
Doornik-Hansen test for normality	0.84
Portmanteau test for autocorrelation – Q(12)/adjusted Q(12)	0.85/0.11

Source: Eviews report, data calculated by the authors.

Based on the results of the Granger causality test, we can see that there is a confirmed impact of the nominal exchange rate and the NPL level in the third group of banks on the NPL level in the first group of banks.

Table 5: The analysis of variance decomposition for the first group of banks

	Variance decomposition in the trend of NPL level indicator in the first group of banks (NPL1)		
Period	NPL1	FXE	NPL3
The first quarter	38.21	48.64	13.15
The second quarter	53.36	30.39	16.24
The first year	63.00	17.69	19.30
The second year	58.50	20.30	21.20
	Cholesky schedule: FXE and NPL3 to NPL1		

Source: Eviews report, data calculated by the authors.

Analysing the variance decomposition, we can observe that with almost a 49% share in the first quarter, the total trend of the NPL level in the first group of banks can be explained by the change in the nominal Euro exchange rate. This impact weakens from quarter to quarter, but the impact of the rise in the NPL level in the third group of banks increases, so from 13% in the first quarter its impact grows to 21% at the end of the second year. Accumulated impulse response function shows us that the rise in the nominal Euro exchange rate and the increase in the NPL level in the third group of banks have a cumulative effect on the increase in the NPL level in the first group of banks.

Second group of banks. By applying cointegration tests, we obtained results that rule out the possible presence of a long-term equilibrium relationship in trends between individual macroeconomic variables and the NPL level for the second group of banks. The model has the following specification (model to the first time series differences):

$$d(\widehat{NPL2}_t) = C + \beta_1 d(FXE_t) + \beta_2 d(NPL3_t) \quad (2)$$

Table 6: Summary of results of linear regression model for the second group of banks

$d(\widehat{NPL2}_t)$	Coefficients
C	0.030 (0.01)
$d(FXE_t)$	0.634* (0.34)
$d(NPL3_t)$	0.555 (0.14)
Observations	24
Adjusted R^2	0.71
JB test for normality	0.55
Q-test for autocorrelation (12)	0.66
Breusch-Pagan-Godfrey test for *heteroskedasticity*	0.72
Ramsey RESET test	0.42

Source: Eviews report, data calculated by the authors.

* FXE is statistically significant only at the 10% confidence level, while other variables are significant at the 1% confidence level.

The nominal Euro exchange rate appears as the only significant macroeconomic variable affecting the NPL level in the second group of banks. However, in the first model, the nominal Euro exchange rate shows its statistical significance only at a confidence level of 10%, while the change in the NPL level in the third group of banks shows a statistical significance at a confidence level of 1%.

By setting the VAR model and applying the Granger causality test, we obtain that the seasonally adjusted GDP (GDPsac) represents a macroeconomic variable with low impact. The Granger test shows no statistical significance with the nominal Euro exchange rate, unlike with the previous models developed for this group of banks. A statistically significant variable is also the NPL level for the third group of banks.

Using the Granger causality test, we obtained the following results:

Table 7: Causality analysis for the second and third group of banks

Granger causality test	p-value
Impact of the NPL level in the third homogeneous group of banks (NPL3) on the NPL level in the second group of banks (NPL2)	0.03
Normality and autocorrelation tests	p-value
Doornik-Hansen test for normality	0.51
Portmanteau test for autocorrelation - Q(12)/adjusted Q(12)	0.68/0.14

Source: Eviews report, data calculated by the authors.

Granger causality test shows the existence of two-way causality - the NPL level for the third group of banks affects the NPL level for the second group of banks and vice versa.

Table 8: The analysis of variance decomposition for the second group of banks

	Variance decomposition in the trend of NPL level indicator in the second group of banks (NPL2)	
Period	NPL2	NPL3
The first quarter	74.56	25.44
The second quarter	82.48	17.52
The first year	90.04	9.96
The second year	94.52	5.48
	Cholesky schedule: NPL3 to NPL2	

Source: Eviews report, data calculated by the authors.

Based on the analysis of variance decomposition, we can conclude that at the end of the first quarter, about 25% of trends in the non-performing loan level for the second group of banks can be explained by the trend of the non-performing loan level for the third group of banks. After the first quarter, this impact is present but weakens. Analysing the accumulated impulse response function, we can determine that the increase in the non-performing loan level for the third group of banks influences the increase of non-performing loans for the second group of banks. This impact increases cumulatively over the period.

Third group of banks. Based on the cointegration tests, it can be determined that there is a long-term equilibrium relationship in the trend of non-performing loan levels for the third group of banks and the level of seasonally adjusted GDP. That is why we use the Error Correction Model (ECM). The Error Correction Model developed has the following specification:

$$d(\widehat{NPL3}_t) = \beta_1 R_{t-1} + \beta_2 d(GDPsac_t) + \beta_3 d(FXE_t) + \beta_4 NPL2_t + \beta_5 V_{0904} \quad (3)$$

Table 9: Summary of the results of error correction model for the third group of banks

$d(\widehat{NPL3}_t)$	Coefficients
R_{t-1}	-0.071 (0.03)
$d(GDPsac_t)$	-1.291* (0.56)
$d(FXE_t)$	0.589** (0.29)
$d(NPL2_t)$	0.540 (0.11)
V_{0904}	-0.108 (0.04)
Observations	24
Adjusted R^2	0.84
JB test for normality	0.76
Q-test for autocorrelation (12)	0.29
Ramsey RESET test	0.10

Source: Eviews report, data calculated by the authors.

* The variable is statistically significant at a 5% confidence level (more precisely 3.23%).
** The variable is statistically significant at a 10% confidence level (more precisely 5.87%).

The used Error Correction Model shows that the trend of the NPL level for the third group of banks can be explained by the long-term trend of seasonally adjusted GDP but also by its short-term trend so that the decline in GDP influences the increase in non-performing loans within this group. The rise in the nominal Euro exchange rate and the rise in the NPL level for the second group of banks have an impact on the rise in non-performing loans for the third group of banks. The previously mentioned 2009 fourth-quarter event, presented through a dummy variable, has an effect on reducing the NPL level for the third group of banks. Using the Granger causality test, we obtained the following results:

Table 10: Causality analysis for the third group of banks

Granger causality test	p-value
Impact of seasonally adjusted gross domestic product (GDPsac), NPL level in the second group of banks (NPL2) and nominal Euro exchange rate (FXE) on the NPL level in the third group of banks (NPL3)	0.00
Impact of seasonally adjusted gross domestic product (GDPsac), NPL level in the third group of banks (NPL3) and nominal Euro exchange rate on the NPL level in the second group of banks (NPL2)	0.00
Normality and autocorrelation tests	p-value
Doornik-Hansen test for normality	0.97
Portmanteau test for autocorrelation – Q(12)/adjusted Q(12)	0.97/0.14

Source: Eviews report, data calculated by the authors.

Granger causality test shows an impact of seasonally adjusted GDP, the NPL level in the second group of banks, and the nominal exchange rate on the NPL level in the third group of banks. Also, the impact of seasonally adjusted gross domestic product, the trend of non-performing loans in the third group of banks and the nominal Euro exchange rate on the NPL level in the second group of banks were confirmed.

Table 11: The analysis of variance decomposition for the third group of banks

	Variance decomposition in the trend of NPL level indicator in the third group of banks (NPL3)			
Period	NPL3	GDPsac	NPL2	FXE
The first quarter	100,00	0,00	0,00	0,00
The second quarter	54,51	42,98	0,69	1,82
The first year	21,86	49,75	7,23	21,16
The second year	12,69	36,47	13,04	37,79
The third year	11,25	33,94	14,21	40,61
	Cholesky schedule: GDPsac, NPL2, FXE to NPL3			
	Variance decomposition in the trend of NPL level indicator in the second group of banks (NPL2)			
Period	NPL3	GDPsac	NPL2	FXE
The first quarter	14,62	8,14	77,23	0,00
The second quarter	8,20	7,49	81,33	2,98
The first year	3,72	7,36	71,78	17,14
The second year	2,15	5,27	63,67	28,92
The third year	1,81	5,13	60,99	32,07
	Cholesky schedule: GDPsac, NPL3, FXE to NPL2			

Source: Eviews report, data calculated by the authors.

Variance decomposition analysis shows that the impact of the change in seasonally adjusted GDP on the change in the NPL level in the third group at the end of the first year of observation is somewhere around 50%. This impact grows until the first year and starts weakening thereafter. The impact of the change in the NPL level in the second group of banks on the NPL level in the third group of banks grows during the observation period and has its strongest impact at the end of the third year at about 14%. The change in the nominal Euro exchange rate influences the change in the NPL level in the third group of banks with about 40% between the second and third year of observation. The impact of the change in seasonally adjusted GDP on the NPL level in the second group of banks grows but is exceptionally weak and at the end of the first quarter amounts to about 8%. The impact of change in NPLs in the third group on the NPL level in the second group at the end of the first quarter amounts to about 15%. The change in the nominal Euro exchange rate exerted its strongest influence at the end of the third year, at which point it amounted to about 32%. The accumulated impulse response function shows that there is a negative correlation between the trend of seasonally adjusted GDP and non-performing loans in the third group of banks with the tendency to amplify the negative impact. There is a positive correlation between the trend of non-performing loans in the second and the third group of banks. The trends of the nominal Euro exchange rate and the NPL level in the third group of banks are in a positive correlation, which confirms that the rise in the Euro exchange rate influences the increase in non-performing loans within this group of banks.

Fourth group of banks. Cointegration tests confirmed the existence of a long-term equilibrium relationship in the trends between individual macroeconomic variables and the NPL level in the fourth group of banks. Applying the classical linear regression model to the first time series differences, we obtain that the only variable significant that explains the movement of non-performing loans in the fourth group of banks is the change in non-performing loans in the third group of banks. The developed model has the following specification:

$$d(\widehat{NPL4}_t) = \beta_1 d(NPL3_t) + \beta_2 V_{1202} + \beta_3 V_{1304} \qquad (4)$$

Table 12: Summary of results of linear regression model for the fourth group of banks

$d(\widehat{NPL4_t})$	Coefficients
$d(NPL3_t)$	1.339 (0.17)
V_{1202}	-0.470 (0.09)
V_{1304}	-0.442 (0.09)
Observations	24
Adjusted R^2	0.80
JB test for normality	0.66
Q-test for autocorrelation (12)	0.71
Breusch-Pagan-Godfrey test for *heteroskedasticity*	0.57
Ramsey RESET test	0.44

Source: Eviews report, data calculated by the authors.

The used model has a high explanatory power, measured by the adjusted coefficient of determination, of about 80%. In addition to the change in non-performing loans in the third group of banks significant to explain the trends of non-performing loans in the fourth group of banks, there are two other dummy variables, the first relating to the delicensing of Agrobank and the second related to the delicensing of Privredna banka a.d. Beograd. The Granger causality test gave the following results:

Table 13: Causality analysis for the fourth and third group of banks

Granger causality test	p-value
Impact of seasonally adjusted gross domestic product with one-quarter delay (GDPsac (-1)) and change in the NPL level in the third group of banks (NPL3) on the NPL level in the fourth group of banks (NPL4)	0.04
Normality and autocorrelation tests	p-value
Doornik-Hansen test for normality	0.84
Portmanteau test for autocorrelation - Q(12)/adjusted Q(12)	0.94/0.13

Source: Eviews report, data calculated by the authors.

Based on the results of the Granger causality test, we confirm the presence of unilateral causality, i.e. the impact of seasonally adjusted GDP product with one-quarter delay and the change in the NPL level in the third group of banks on the NPL level in the fourth group of banks. We then proceed to analyse the variance decomposition.

Table 14: The analysis of variance decomposition for the fourth group of banks

	Variance decomposition in the trend of NPL level indicator in the fourth group of banks (NPL4)		
Period	NPL4	NPL3	GDPsac(-1)
The first quarter	94.49	3.98	1.52
The second quarter	82.88	2.91	14.21
The first year	71.54	1.91	26.55
The second year	62.30	1.47	36.23
The third year	58.51	1.49	40.01
	Cholesky schedule: GDPsac and NPL3 to NPL4		

Source: Eviews report, data calculated by the authors.

Based on the variance decomposition analysis, we conclude that the change in seasonally adjusted GDP with a two-quarter delay influences the increase in non-performing loans in the fourth group of banks and has its strongest influence at the end of the third year of observation. Delayed manifestation of this influence indicates that there is a certain delay or prolongation of the actual effects, i.e. their delayed time recognition. There is a positive insignificant correlation between the trend of non-performing loans in the third and the fourth group of banks. Based on the accumulated impulse response function, we can see that there is a negative correlation in the trend of seasonally adjusted GDP and the NPL level in the fourth group of banks. From all this, it follows that the decline in GDP with a two-quarter delay influences the increase in non-performing loans in the fourth group of banks.

During the period under review, the entire banking sector had high rates of credit growth. The average annual growth rate of loans granted to corporates in the pre-crisis period (before 2008) was about 23%, while in the first years of the crisis period (2008 to 2010) it was about 14%. The differences between banks in credit growth rates were not significant, so econometric models did not recognize the relationship between credit growth rates and default rates.

5. Conclusion

If we collectively look at the results of the analysis by groups of banks, we can conclude that the NPL level in the third and fourth group was predominantly influenced by macroeconomic factors coming from the real part of the economy, while the NPL level in the first and second group of banks were predominantly affected by macroeconomic factors coming from the monetary sphere of the

economy. The decline in economic activity in the downward phase of the business cycle, as measured by the level of GDP, can be used as a factor accounting for about 50% of the increase in non-performing loans within the third group of banks and about 40% of the increase in non-performing loans within the fourth group of banks. About 49% of the increase in non-performing loans in the first group of banks and about 32% of the increase in non-performing loans in the second group of banks can be attributed to the rise in the nominal Euro exchange rate. The rise in the nominal Euro exchange rate is the second most significant factor that can also explain about 40% of the change in the NPL level in the third group of banks.

The secondary impact of the decline in economic activity on the increase in non-performing loans within the first and second group of banks is reflected in the impact of the increase in non-performing loans in the third group on the increase in non-performing loans to the first and second group of banks. The impact of changes in the third group on the first and second group is due to the effect of economic connection, stemming from the fact that the same clients are in both groups of banks or that there are strong debtor-creditor relationships among the clients that cause one client and, subsequently, its economically related clients to enter default status. The existence of economic connection among clients confirmed in this way is also the evidence of the contagion spread through the banking sector network. The third group of banks (banks with high levels of credit risk) takes over the effects of systemic factors and transfers their influence to the second and the first groups (banks with average and below-average credit risk level) through the banking network channel. The first and second group of banks have conservative credit policies but not recognizing the need for protection against credit contagion makes them less effective. The fourth group shows the autonomous movement with respect to the other three groups.

In this research we confirm that all four groups of banks had similar rates of credit growth, so moral hazard did not come from above average credit growth rates but through credit growth (risk appetite) which was not in line with the banks' risk taking capacity. Bank groups with lower and average levels of credit risk have a behavioural model characterized by full compliance of the risk appetite with the risk-taking capacity, which is based on the existence of adequate corporate governance and risk management system, so that banks from these groups did not have any recorded cases of default during the observed period. Banks in the fourth group were prone to take risks far beyond their risk-taking capacity, as a result of inadequate corporate governance and numerous weaknesses in the risk management system, which resulted in the majority of these banks being in default status over the period of observation. This model of behaviour is an exam-

ple of moral hazard that is not transmitted as a contagion through the interbank network. Banks in the third group have significant number of default cases but less than the fourth group. The third group of banks shows a different behaviour in this market, characterized by a tendency to take risks beyond their capital capacity. This type of behaviour is a confirmation of the existence of moral hazard in this market, which is transmitted through the interbank network to the first and second group of banks. The observed level of credit risk in each group of banks was merely a consequence of the applied behaviour model. These findings indicate that the regulator should focus more on the quality of corporate governance in banks in order to eliminate potential moral hazard in certain models of bank behaviour and on techniques to protect the bank from the risk that can be transmitted through the interbank network.

The question remains for further research as to what extent the impact of the increase in non-performing loans within groups of banks with higher credit risk on the increase in non-performing loans in the group of banks with lower credit risk is a consequence of the transition of clients at a certain level of indebtedness to banks with a milder risk management policy. Is the resulting effect of the increase in non-performing loans with banks with a lower level of credit risk a kind of "collateral damage" from the existence of banks who have a more liberal investment approval policy and how can banks be protected against it? And, finally, which policies should regulators adopt to prevent these contagion effects?

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