

Drivers of moral hazard in banks

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ABSTRACT

The objective of this research is to identify factors that determine the moral hazard in banks by using discrete choice models (probit and logit regression). A specially constructed indicator was used to quantitatively assess moral hazard as the average difference between the better rating of a client in a bank and the most conservative rating of the same client in the banking sector. This is an example where moral hazard manifests itself as the tendency of management in banks to underestimate credit risk. The results showed that state-owned banks and foreign privately-owned banks with evident problems at the level of their headquarters had higher values of this quantitative indicator of moral hazard. Also, banks whose financial result and capital are highly sensitive to a small increase in non-performing loans, as well as banks that at any time in the observed period had a problem with meeting regulatory capital requirements, showed a greater propensity to moral hazard, as measured by this indicator. In the above cases, in the absence of quality corporate governance, management in banks tends to show performance better than it actually is. The obtained results for Serbia in comparison with the previous research give the possibility to quantitatively confirm additional specific factors important for explaining moral hazard (composite variable of the type of ownership and capital restrictions, variables that perform only the transmission of certain forms of management behaviour, size, capital and profit sensitivity, credit risk level, etc.), in addition to the common factors of moral hazard, such as the type of ownership in the bank, capital restrictions, etc.

KEYWORDS

moral hazard, non-performing loans, underestimate credit risk, corporate governance, Serbia

JEL CLASSIFICATION INDICES

E32, E51, G01, G21, G31

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1. INTRODUCTION

Commercial banks have a role as financial intermediaries to reduce information asymmetry in the financial market. Although some low-quality clients are ready to accept higher interest rates on loans, a bank will reject such clients through credit rationing (Stiglitz – Weiss 1981, 1992). The necessary assumption for the realization of this task of banks is that the interests of the owners and management of the bank are aligned. Through proper corporate management, the conflict between principal and agent is avoided (Jensen – Meckling 1976; Fama – Jensen 1983). If the interest of a bank's management deviates from its owner's interest, we can talk about the presence of moral hazard as a form of information asymmetry (Kene 1990; Shleifer – Vishny 1997; Freixas – Rochet 2008).

Financial crises are recognized in the economic theory as the cause of the increase in information asymmetry in financial markets (Mishkin 1990, 1992). Negative selection and moral hazard are increasing in the bank's relations with clients. Also, the possible tendency of bank management to moral hazard may increase. The last financial crisis of 2008, widely known as the Great Recession, is often cited in literature as an example of the existence of moral hazard in banks. Numerous bank defaults due to the increase in credit risk also raised the question of the extent to which information asymmetry increased during the crisis years. In most cases, the credit risk losses suffered by banks during the crisis are linked to the presence of moral hazard. The existence of moral hazard is most often implicitly derived from the consequences – credit losses of banks. Studies dealing with specially constructed measures of moral hazard are rare. The research challenge that should cover the gap in the existing literature is finding such a measure, which is not a credit loss but can affect the level of bank credit losses.

In the developed financial markets, there are institutions that produce private information that can reduce information asymmetry (e.g., rating agencies). In the emerging markets, such opportunities do not exist, and it is necessary to develop alternative ways to assess the credit quality of the client, such as an internal rating or a rating defined by a regulatory body. The possibility that two banks assess the same client differently can be an indication of the existence of moral hazard in the bank that rated the client better. Given that during the last financial crisis of 2008 there was an increase in the level of credit risk which led to the default of many banks, a particular challenge is to examine whether banks in such circumstances were prone to underestimating credit risk as a form of moral hazard.

Moral hazard in banks has been the subject of numerous studies, which we will present in more detail in the literature review. The goal of our research is to fill the gap in the literature in this area by constructing a special indicator that will more closely link moral hazard with the banks' tendency to underestimate credit risk. This research will go further in researching the phenomenon of moral hazard in banks, constructing clusters of banks according to the level of this indicator and determining the factors that influence its value (type of bank ownership, capital level, etc.). The empirical analysis aimed at obtaining an answer to this question was conducted on the banking sector data of the Republic of Serbia during the financial crisis, from 2008 to 2014 (and additionally for the period from 2008 to 2018).

This paper contributes to the empirical literature in four ways. First, as far as we know, this is the first research that deals with a specially constructed measure for assessing the underestimation of credit risk as a form of manifestation of moral hazard. In addition to confirming the presence of moral hazard, the research goes deeper – by applying econometric models. Banks



were classified into homogeneous groups based on the tendency to this type of moral hazard and the identified drivers of moral hazard. Second, in addition to the determinants of banks' moral hazard already confirmed in the literature (type of ownership, capital restrictions, etc.), this research reveals some new drivers of moral hazard (composite variable of the type of ownership and capital restrictions, variables that perform only the transmission of certain forms of management behaviour, size, capital and profit sensitivity, credit risk level, etc). Third, the findings of this research are particularly characteristic of the emerging markets, which to a greater extent use inefficient and insufficiently supervised internal models for assessing the credit quality of the client. Fourth, the conclusions of this research can be useful for improving corporate governance in banks and for economic policy makers in general.

The rest of the paper is organized as follows. In the first section of the paper, we present an overview of the relevant literature. The second section defined an adequate measure for the coverage of moral hazard in banks, in order to create precondition for econometric modelling. The third section contains an overview of the applied methodology and data describing each bank (size, level of capital, type of ownership, etc.). The results of the probit and logit models, in which the impact of bank characteristics on the presence of moral hazard was estimated, are given in the fourth section. The final section sets out the basic findings, recommendations for further research, improvement of corporate governance in bank supervision and relevant economic policies.

2. LITERATURE REVIEW

The theoretical and empirical literature regarding moral hazard in banks can categorize in three basic groups. First, there are studies that deal with the impact of moral hazard on other financial and economic variables, through which the significance of this phenomenon is seen. The second group includes papers dealing with the forms of manifestation of moral hazard, the third one includes research dealing with the factors that determine moral hazard.

Although the theoretical premise of moral hazard is well known in economic theory (Mishkin 1990, 1992), it has gained particular importance since the financial crisis of 2008. Stiglitz (2010) stated that the deregulation of financial markets, which led to an increase in information asymmetry (negative selection and moral hazard), could be considered the cause of the world financial crisis of 2008. Myerson (2012) defined a model for the analysis of moral hazard in financial institutions as a driver of credit cycles and credit cycles as the triggers of crises. In this way, the author incorporated the microeconomic theory of banking into the macroeconomic theory of business cycles in order to explain the causes of macroeconomic instability (see also, Freixas – Rochet 2008). In their research, Niu – Hua (2019) showed that the agency problem and credit risk were not independent, as some theoretical models assume. The present conflict of interests of bank managers and owners leads to moral hazard of management and the occurrence of large but rare credit losses. Estimated losses enter the calculation of agency costs (and managers' incentives) and are incorporated into credit contracts, by increasing the credit spread as a measure of the default rate.

There are empirical studies that connected the increase in credit risk and the financial crisis of 2008. In most of them, macroeconomic and microeconomic factors of credit risk growth are investigated. However, empirical studies in which moral hazard is singled out as a separate credit



risk factor are rare. The bankruptcy of banks, as a consequence of large credit losses, is associated with the moral hazard of bank management. This is an implicit recognition of the impact of moral hazard in banks, derived from its consequences such as, credit risk, credit losses, bank failure and the financial crisis. This gave us the right to classify this type of research in the second group that deals with the forms of manifestation of moral hazard, which can manifest in overestimation of the value of the bank's assets, underestimation of credit risk, tendency to lend to riskier clients, etc.

The recent financial crisis has provided rich material for researching moral hazard, which manifests itself as a kind of underestimation of the risks that exist in the bank's assets, recognizable as the difference between the assessment of assets made by the bank and the market value of those assets. In that connection, we cite the work of [Hauzinga – Leaven \(2012\)](#), which showed how banks in USA overestimated the value of real estate in their balance sheets in relation to the market value using the mortgage crisis data.

Especially important for this research are those studies that examine the underestimation of credit risk as a form of moral hazard. [Ninimaki \(2012\)](#) explored the relation between hidden credit losses and moral hazard. [Kladakis et al. \(2020\)](#) showed that a low level of asset quality is associated with less transparency in the presentation of bank information. The authors recognized the discrepancy between the ratings of external rating agencies that banks use as a form of confirmation that real information about asset quality is not presented. The importance of timely disclosure of hidden losses, after the financial crisis of 2008, can be seen in the work of [Pollák – Popper \(2021\)](#) through the application of stress tests in the Hungarian banking sector. Hidden credit losses are a subsequently discovered source of underestimation of credit risk.

A special inspiration for this research came from a paper that dealt with the issue of credit risk underestimation in the conditions of the financial crisis. [Brezigar et al. \(2015\)](#) recognized banks with various incentives for underestimating risk in the conditions of the financial crisis in the banking sector of Slovenia. They based their findings on a comparison of the results of internal rating models that banks use to assess credit risk.

A study conducted by [Zhang et al. \(2016\)](#) using data on the banking sector in China indicated that the increase in non-performing loans (NPLs) accompanies the growth of riskier lending as a behaviour of banks that confirms the presence of moral hazard. In this paper, moral hazard was recognized as the tendency of banks to riskier lending, which leads to an increase in NPLs.

Research of the crisis period in the banking sector of the Republic of Serbia has shown that a significant factor in the default of banks is the increase in the value of the indicator that measures the underestimation of credit risk in banks ([Jović 2017](#)). This indicator was used as a quantitative measure of moral hazard in banks during the crisis.

In most of the aforementioned research, moral hazard was recognized with a time lag, through its negative effects on the bank. Additional space for research was opened by defining a current measure of moral hazard so that information about the existence of moral hazard does not arrive late. The methodological approaches used by [Brezigar et al. \(2015\)](#) and [Jović \(2017\)](#) can represent a starting point for further research. Although the quantitative techniques used in these two papers are different, they are essentially based on the quality of the internal rating for assessing the bank's customers. If the bank uses its discretionary right to rate the client better than his actual rating, the bank underestimates the credit risk. These findings give us the



possibility to go further, by analysing the factors that can influence the tendency of banks to moral hazard.

Some general market circumstances may be a determinant of banks' greater propensity to moral hazard. Among other things, [Nier – Baumann \(2006\)](#) pointed out the high level of state support and competition among banks as possible reasons for approving riskier loans. [Antzoulatos – Tsoumas \(2014\)](#) also confirmed that the expected state support encouraged the moral hazard of banks. In addition, they emphasized the importance of the quality of institutions in this context. [Gaballo et al. \(2016\)](#) found that the increase in state financing of banks affected the increase in moral hazard and the decrease in the efficiency of bank bailouts. In his research, [Hott \(2022\)](#) comes to the conclusion that the regulatory restrictions regarding leverage can reduce the number of systemically important banks but cannot mitigate the level of moral hazard in systemically important banks. He sees risk adjusted requirements as an opportunity to reduce moral hazard. [Jović – Lutovac Đaković \(2022\)](#) present evidence that through the interbank channel, the negative effect of moral hazard can be transferred from one bank to another.

We highlight a work from 2007, which confirmed that the problem of moral hazard in banks can be effectively solved if the bank is sufficiently capitalized ([Brusco – Castiglionesi 2007](#)). This paper examined a link between the level of capital and moral hazard, where different options of bank investment in safe assets and gambling assets were analysed. Among other things, the paper shows that at a lower level of bank capital there will be a driver of moral hazard.

Comparing the rating models of foreign-owned banks and national (i.e. nationally-owned) banks in Slovenia, [Brezigar et al. \(2015\)](#) concluded that there were certain factors that can explain the tendency of banks to underestimate credit risk. Foreign-owned banks applied models to assess customer ratings more accurately than national banks. The above results are obtained by comparing the results in two homogeneous groups of banks: state-owned banks and foreign banks. Also, the authors noted that the predictive power of credit risk assessment models decreased during the financial crisis, which is related to the tendency of banks to underestimate credit risk. The researchers found the motives of bank management for underestimating credit risk in the high exposure of banks to NPLs and restrictions on capital increase.

Based on the literature review, we can state that moral hazard is a significant factor in explaining credit risk, bank failures and financial crises. However, studies that deal with the forms of manifestation of moral hazard and its determinants mostly provide implicit and ex-post confirmation. We recognize the possibility of further research in terms of earlier identification and quantification of moral hazard.

3. QUANTITATIVE MEASURE OF MORAL HAZARD

[Jović \(2017\)](#) defined a specially constructed variable that measured the difference between a conservative client rating in the banking sector and a client rated by a bank, in order to capture credit risk underestimation. This indicator can be calculated for each individual bank, as

$$IOA_{tk} = \sum_{i=1}^4 W_{k \rightarrow k+i} \cdot \left(\frac{k+i}{k} \right)$$



where:

IOA_{tk} – indicator of the overvaluation of good assets (underestimation of credit risk) which the observed bank classified as k in period t ,

k – category of classification of assets in the observed bank,

$k + i$ – category of classification in a hypothetical reference bank,

$w_{k \rightarrow k+i}$ – share of clients who are classified in category k according to the classification rules of the observed bank, whilst classified as $k + i$ according to the classification rules of a hypothetical reference bank,

t – mark of a year for which the indicator is being calculated.

A prerequisite for calculating this indicator is the existence of a comparable rating scale for all banks in the analysed banking sector (National Bank of Serbia 2017a). This is the case in countries where the regulator has prescribed a regulatory scale for customer ratings, such as the previously discussed cases of Slovenia and Serbia, and similar emerging countries. Alternatively, the indicator can be constructed if there is a group of banks in the banking sector that has developed its own internal rating system that includes the application of a universal definition of defaults or stages according to International Financial Reporting Standard 9 (IFRS 9).

This indicator is formed on the basis of an algorithm that includes the following steps:

- in the banking sector, look for the bank with which the client with the worst rating and that rating becomes the reference rating for that client,
- the client's rating in every other bank is compared with the reference rating and the value of the deviation of the rating from the reference rating is expressed in the appropriate value,
- based on the value of these deviations for each individual bank, the total value of these deviations is calculated (in percentage value) and this becomes an indicator of the underestimation of bad assets (underestimation of credit risk).

3.1. Methodological framework

In previous research, banks' tendency to underestimate credit risk was linked to the level of capital, type of ownership, restrictions on capital, level of NPLs, etc. These findings were reached by creating two groups of banks and by comparing their performances. If one group of banks had a higher tendency to undervalue bad assets, then all the characteristics of that group of banks, such as the type of ownership (national vs. foreign), restrictions regarding recapitalization, level of NPLs, etc. were accepted as determinants. This is a top-down approach.

In the present research, a different methodological approach was used. We used the previously defined specially constructed indicator of credit risk underestimation as a dependent variable in our model. Then we used the bottom-up approach, evaluating whether the variables that describe the banks' operations are statistically significant for explaining the value of the indicator of credit risk underestimation. This allowed us to include some new variables in addition to the variables included in the top-down approach.

Our hypotheses were as follows:

- is it possible to discriminate between banks that have a greater tendency to underestimate credit risk and banks that do not, based on the value of this indicator?



- in addition to the already confirmed drivers of moral hazard, can we identify any new variables that can explain the pronounced tendency of banks to underestimate credit risk?

Bearing in mind these hypotheses, the need to differentiate between banks that are prone to moral hazard and banks that are not, the binary choice models are the most often used methodological approach in such cases (Wooldridge 2010; Greene 2017). Based on the value of the indicator of credit risk underestimation, we classified banks into two possible choices: 1 – banks that have a pronounced tendency to undervalue credit risk and 0 – other banks.

Below is a general specification of a regression model based on binary choice:

$$p_i = F(b^T x)$$

where p_i (probability of occurrence of event 1) gives values in the range between 0 and 1, b^T represents the regression coefficients and x as the values of the independent variables.

In the case of the logit model, we have the following setting:

$$p_i = F(b^T x) = \frac{e^{b^T x}}{1 + e^{b^T x}}.$$

The setting in the case of the probit model is as follows:

$$p_i = \Phi(b^T x) = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{b^T x} e^{-\frac{1}{2}\left(\frac{x}{\sigma}\right)^2} dx.$$

Defined variable I (IOA) in Section 2: Quantitative measure of moral hazard was used as a dependent binary variable. Specific characteristics of banks, such as the level of capital in the bank (CAP), ownership of the bank (OWN), the level of NPLs (NPL), capital restrictions (CR), undercapitalization of the bank (DEF), bank size (SIZE), profit sensitivity (PROFAM), etc., were examined as independent variables in the model. Qualitative variables that describe the specific characteristics of banks are translated into quantitative values using WOE or the k-nearest neighbors' algorithm, regulatory requirements, etc.

The developed probit and logit models have the following specification:

$$\hat{I}_t = C + \beta_1 DEF_t + \beta_2 CAP_t + \beta_3 NPL_t + \beta_4 SIZE_t + \beta_5 OWN_t + \beta_6 PROFAM_t.$$

3.2. Data

We used data from the banking sector of the Republic of Serbia for the period from September 2008 to June 2018 (Figure 1). This period includes the phase in which the negative effects of the global financial crisis played out (2008–2014), as well as the post-crisis phase (2015–2018). Since the beginning of the crisis, the level of NPLs increased from about 10% (2008) to about 23% in 2014, after which a national strategy was defined in 2015 and the process of successful NPL reduction began (National Bank of Serbia 2017).

As we can see from Figure 1, the indicator for the entire banking sector had a tendency to strong growth at the beginning of the financial crisis. After this initial growth, there was a decline of indicators as a result of the conducted comprehensive supervision by the regulator in the second half of 2009. Supervision activities were conducted in accordance with the Financial Sector Assessment Program (FSAP) mission of the World Bank and the IMF (IMF 2010). After that, the value of this indicator remained stable on average during the crisis phase, except



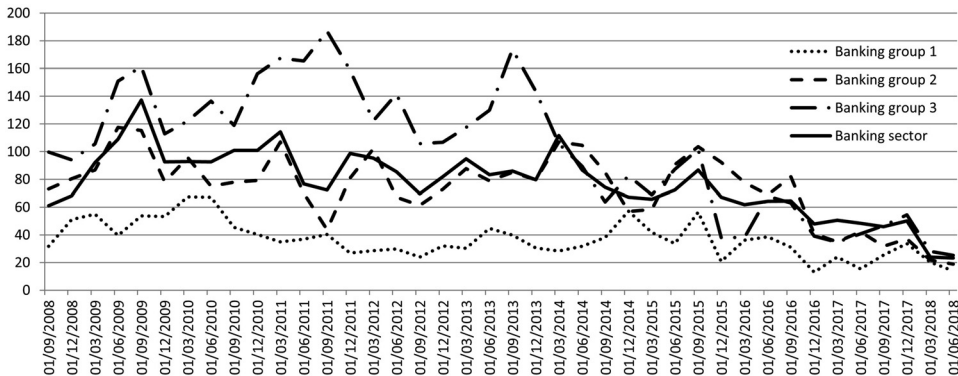


Fig. 1. Indicator of credit risk underestimation (%)

Source: Data calculated by the author. If not indicated otherwise, the source for Tables and Figures is National Bank of Serbia.

for the one-off declines on the dates when the licenses of individual banks were revoked (end of 2012, first and fourth quarters of 2013 and first quarter of 2014). Based on the individual values of this indicator, banks are classified into three homogeneous groups: 1 – low indicator values, 2 – average indicator values and 3 – high indicator values. We identified banking group 3 that had extremely high values above the average for the entire banking sector which predominantly determines the movement of this indicator at the level of the banking sector during the crisis phase. In the post-crisis phase, the indicator for the entire banking sector experienced a rapid drop, while the values of this indicator by bank groups increasingly converged towards the average value for the banking sector.

If the indicator of credit risk underestimation at the level of the banking sector is viewed as a measure of the average behaviour of the banking sector in the credit risk assessment process, then the behaviour of the banking group 3 can be treated as a strong tendency to moral hazard. If we assign a value of 1 to each bank from the third group and assign a value of 0 to each bank from the first and second groups, we get a binary variable that can be further treated by applying the discrete choice model (binary model) – probit or logit model. The binary variable thus obtained will be denoted as I .

In Figure 2, we will show the average capital adequacy ratio by previously formed banking groups.

We can see that the banks which had the highest tendency to underestimate the credit risk (banking group 3) at the beginning of the period had the highest value of capital adequacy ratio and after that came to a level below the regulatory requirements (below 14.5%). Therefore, banking group 3 in the second part of the crisis phase has a capital adequacy ratio below the average of the banking sector and below regulatory requirements. Banking group 3 initially underestimated the credit risk, leading to an overestimation of capital levels. Over time, hidden losses manifested themselves and reduced the level of capital. The reduction of capital in the presence of restrictions on the acquisition of new capital could only be an additional incentive to continue underestimating credit risk. We find a certain confirmation of this in Figure 3.



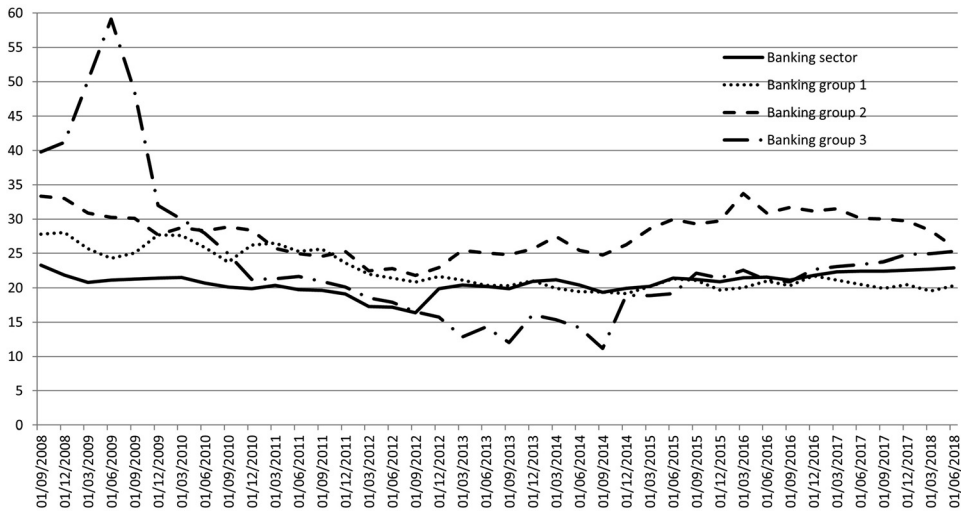


Fig. 2. Capital adequacy ratio by banking groups (%)

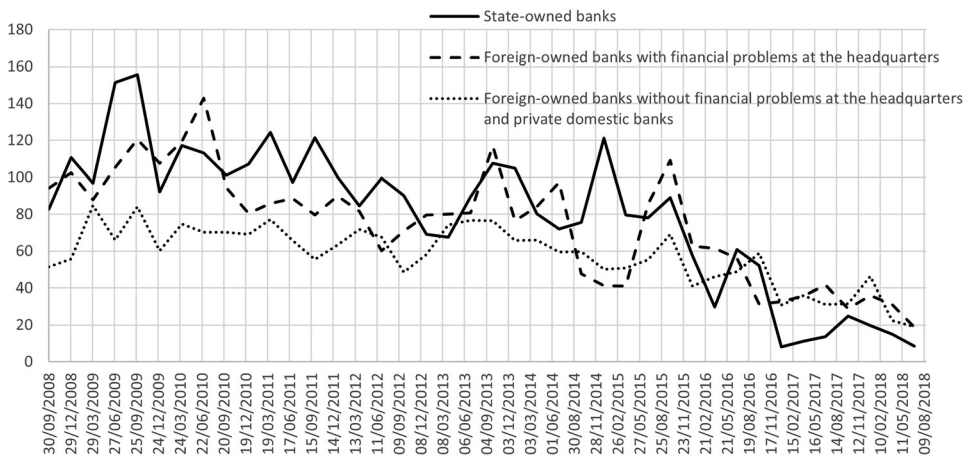


Fig. 3. Indicator of underestimation of bad assets by type of bank ownership (%)

As we can see in Figure 3, state-owned banks had a higher propensity to underestimate credit risk than other groups of banks. Also, banks with financial problems at the level of their headquarters had a greater tendency to underestimate credit risk than other foreign and domestic private banks. Both mentioned groups of banks had a restrictive access to additional capital.

In the search for independent variables that could be statistically significant in describing banks' strong propensity to moral hazard, we will start with the variables already used in the literature, such as the level or constraint of capital and the type of bank ownership.



Banks are classified into three groups according to the level of capital (Table 1). The criterion for classification into banks with a low level of capital was regulatory requirements. The value of the capital adequacy ratio of 14.5% was obtained as the sum of the minimum capital adequacy ratio and the capital conservation buffer (Basel I capital requirements) (Table 2).

The next variable that we must consider is the limited possibility for recapitalization of the bank. The following table (Table 3) provides an overview of capital constraints by previously formed groups of banks.

According to the data on restrictions on access to capital for recapitalization, banks are classified into two groups. In the group, where banks with restrictions on access to additional capital were classified, there were banks for which the regulator has a note in the records on the need for recapitalization, which entails numerous restrictions on obtaining additional capital.

Banks are classified into three groups according to ownership (Table 4). The group of banks that had financial problems at the level of headquarters includes banks whose headquarters are in Greece, Cyprus or individual banks for which there was publicly available information on the financial difficulties of the headquarters. Bearing in mind that this variable, in addition to the type of ownership, also includes capital restrictions, we will consider it as a composite variable.

After considering the variables that have already appeared in the literature during the analysis of credit risk underestimation, we also include other specific characteristics at the level of banks.

Table 1. Classification of banks into groups by level of capital (CAP)

Group of banks	Capital adequacy ratio (%)
Group of banks with a low level of capital	[0; 14.5]
Group of banks with a medium level of capital	[14.6; 18.0]
Group of banks with a high level of capital	>18.0

Table 2. Capital restrictions by banking group

Group of banks	Share of banks with capital restrictions (%)
Banking group 3	86.8
Banking group 2 and Banking group 1	40.5

Table 3. Classification of banks into groups by capital restrictions (CR)

Group of banks	Capital restrictions
Group of banks with restrictions on access to additional capital	1 – Yes
Group of banks without restrictions on access to additional capital	2 – No



Table 4. Classification of banks

Level of credit risk	Type of bank ownership (OWN)	Default (DEF)	Level of NPLs (NPL)	Size (SIZE)	Profit sensitivity (PROFAM)
High	State-owned banks	Yes	NPLs above 30%	Medium and large banks	Extremely sensitive to changes in NPLs
Medium	Foreign-owned banks with financial problems at the headquarters	No	NPLs below 30%	Small banks	Moderately sensitive to changes in NPLs
Low	Foreign-owned banks without financial problems at the headquarters				Low sensitive to changes in NPLs

Depending on whether they defaulted during the observed period, banks were divided into two groups. Bank default means that at some point during the observed period the bank had a capital adequacy ratio below 12% (regulatory requirement in accordance with Basel I – applicable regulatory standard).

Banks are divided into two groups according to the NPL ratio. Based on the size of the bank, banks are divided into two groups. Based on the ability of profits to absorb expenses due to changes in NPLs, banks are classified into three groups. Profit sensitivity is measured with a 10% increase in NPLs. All changes in profit up to 10% are considered as low sensitivity. Changes in profits greater than 100% are considered as high sensitivity.

The previously discussed data were used to develop probit and logit models.

4. EMPIRICAL RESULTS

We present the results of the probit and logit models for the crisis period (2008–2014) and the extended period (2008–2018).

The following were singled out as statistically significant variables for explaining the value of the indicator of credit risk undervaluation: number of recorded cases of default (undercapitalization) of the bank, level of capital, level of NPLs, size of the bank and type of ownership (which includes capital restrictions). In the models that include the crisis period, profit sensitivity is the only significant variable at the 10% significance level.

The previously presented results of the probit and logit models show that the McFadden pseudo-determination coefficient for models is about 45% for the crisis period and about 33% for the extended period (including the post-crisis period). Statistics based on the likelihood ratio (LR) show that all models are statistically significant. Based on the Hosmer Lemenshow (H-L) test, we conclude that the quality of all models is good. In the case of the Andrews Statistic, the logit model for the extended period shows low values (about 3%), which may be a characteristic of this test for smaller samples (Table 5).

With a selected marginal value (cut-off) of 0.5, we obtained that the percentage of accurate predictions of models that include the crisis period is slightly above 80%, while both models



Table 5. Summary of the results of probit and logit models

$\hat{I}_t$	2008–2014		2008–2018	
	Probit	Logit	Probit	Logit
C	–2.27*** (0.63)	–4.14*** (1.08)	–1.67*** (0.26)	–3.19*** (0.51)
DEF _t	1.76*** (0.19)	3.12*** (0.36)	1.35*** (0.15)	2.42*** (0.27)
CAP _t	–1.33*** (0.18)	–2.22*** (0.30)	–0.96*** (0.12)	–1.58*** (0.21)
NPL _t	–0.58*** (0.19)	–9.99*** (0.34)	–0.26*** (0.12)	–0.44*** (0.20)
SIZE _t	1.51*** (0.21)	2.69*** (0.36)	1.09*** (0.14)	2.01*** (0.36)
OWN _t	0.62*** (0.09)	1.03*** (0.15)	0.47*** (0.06)	0.80*** (0.11)
PROFAM _t	0.31* (0.18)	0.52* (0.30)		
Observations	727	727	1,077	1,077
Obs with Dep = 0	442	442	768	768
Obs with Dep = 1	285	285	309	309
Pseudo R ²	0.45	0.45	0.33	0.33
LR statistics	439.6	436.1	428.4	424.9
LR statistics (P-value)	0.00	0.00	0.00	0.00
Logarithm of the reliability function without limitation	–267.0	–268.8	–431.3	–433.1
Logarithm of the reliability function with limitation	–486.8	–486.8	–645.5	–645.5
Average logarithm of reliability function	–0.4	–0.4	–0.4	–0.4
Akaike info criterion	0.75	0.76	0.81	0.82
Schwarz criterion	0.80	0.80	0.84	0.84
Hannan-Quinn criterion	0.77	0.78	0.82	0.83
Hosmer Lemenshow test (P-value)	0.76	0.20	0.34	0.11
Andrews statistic (P-value)	0.14	0.07	0.08	0.03

Source: Eviews report, data calculated by the author.
 Notes: ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.



have an advantage over the model that would contain only a constant of close to 50%. In the case of the developed models that include the extended period, the percentage of correct predictions of the model is also around 80%, while the advantage of this model over other models that include only the constant is somewhere around 32% (Table 6).

An additional quality check of the developed models was performed using the CAP (Cumulative accuracy profile) curve, based on which the AR (Accuracy ratio) value was calculated (Figure 4).

As we can see, AR has higher values in the models covering the crisis period (slightly above 81%) than in the models covering the extended period (between 73 and 74%). Overall, looking at all model quality tests, we can conclude that the models developed in the crisis period have a higher quality compared to the models developed for the extended period. Most models have satisfactory quality. However, we single out the results of the Andrews statistic from the logit model that includes the extended period as an example of an extremely low value, which can only be accepted at the lowest significance level of 1%. Such model results also have their own economic interpretation. As we can see in Figure 1, two things happened in the post-crisis period: the indicator of credit risk underestimation was markedly reduced and the groups of banks that until then had different values of this indicator began to converge towards similar values. The post-crisis period brought an improvement in the general economic situation,

Table 6. Percentage of accurate forecasts (cut off = 0.5)

Probit model		2008–2014			2008–2018		
		Actual		Total	Actual		Total
		I = 0	I = 1		I = 1	I = 0	
Predicted	I = 0	365	67	432	684	127	811
	I = 1	77	218	295	84	182	266
	Total:	442	285		768	309	
Percentage of accurate forecasts (%)		82.58	76.49	80.19	89.06	58.90	80.41
Advantage of the model in comparison with the model with a constant (%)				49.47			31.72
Logit model		Actual		Total	Actual		Total
		I = 0	I = 1		I = 0	I = 1	
		I = 0	I = 1		I = 0	I = 1	
Predicted	I = 0	365	67	432	684	127	811
	I = 1	77	218	295	84	182	266
	Total:	442	285		768	309	
Percentage of accurate forecasts (%)		82.58	76.49	80.19	89.06	58.90	80.41
Advantage of the model in comparison with the model with a constant (%)				49.47			31.72

Source: EvIEWS report, data calculated by the author.



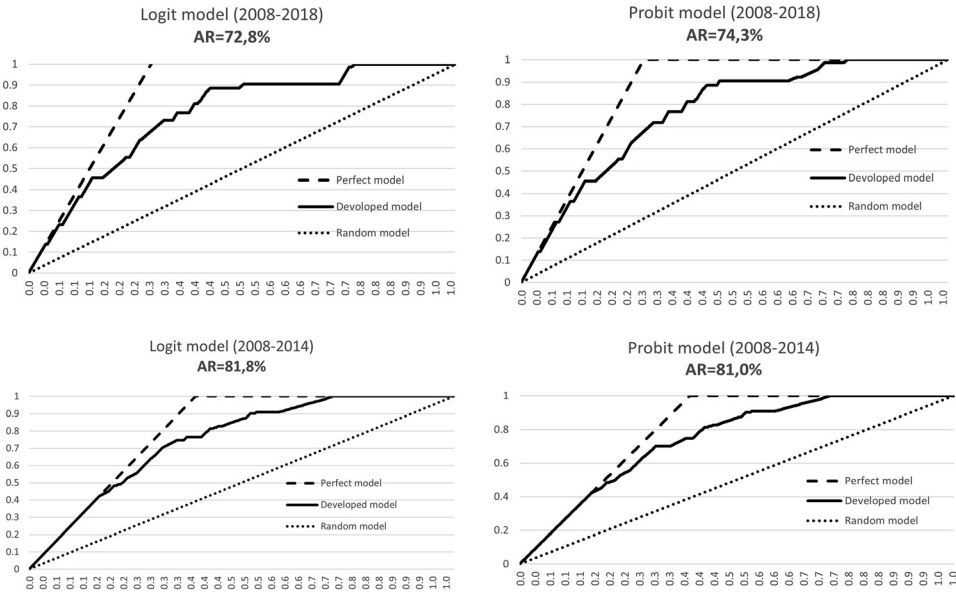


Fig. 4. Cumulative accuracy profile (CAP) curve

especially a reduction in the non-performing loans, which left banks that had a tendency to this type of moral hazard without enough incentives for this type of behaviour.

Banks that were undercapitalized (defaulted) at any point in the observed period had a greater tendency to underestimate credit risk. Also, banks with a lower level of capital were more prone to underestimate credit risk. Banks saw that recognizing real losses would lead them to undercapitalized status, which was an incentive for management to hide the true quality of the bank's assets.

The share of NPLs in total bank loans proved to be significant in explaining the level of underestimation of bad assets. There is a negative relation between the movements of these two variables. The explanation for such a relationship can be found in the fact that in the conditions of underestimated credit risk (low indicator values) there is a false low share of NPLs, and vice versa.

Medium and large banks were somewhat more inclined to underestimate credit risk than small banks. The highest tendency to underestimate credit risk was shown by banks with state participation in their ownership, followed by foreign banks that had certain financial problems at the level of their headquarters. The lowest tendency to underestimate credit risk was shown by banks that are foreign-owned without identified financial problems in the functioning of their headquarters and banks in private ownership of domestic persons. This is a confirmation of the combined effect of the type of bank ownership and capital restrictions.

In the crisis phase, the sensitivity of profit to the growth of bad loans by 10% is shown to be statistically significant for explaining the bank's tendency to underestimate credit risk.



5. CONCLUSION

Although the literature has already recognized certain factors that influence the tendency of banks to underestimate credit risk as a form of moral hazard, this research makes a contribution in the methodological issue and in the part of empirical findings. In the methodological sense, a specially constructed indicator of credit risk underestimation, offers more opportunities for broader and deeper insights into the behaviour of banks and drivers of moral hazard. First, we can monitor the values of this indicator as a measure of this type of moral hazard, instead of implicitly deriving confirmation for the presence of moral hazard from the consequences it creates. Second, the values of this indicator are higher and tend to increase in times of crisis, with a clear quantitative discrimination between banks that have significantly high values of this indicator and banks that are around or below the average. In this way, banks that have a greater tendency to this type of moral hazard than other banks are separated. This gives us an opportunity to consider the possible influence of various specific factors onto which of the above two groups the bank will belong (bottom-up approach).

In the previous research it was confirmed that national banks have a greater tendency to underestimate bad assets than foreign-owned banks. Our research makes an additional distinction within foreign-owned banks and confirms that foreign-owned banks with problems at their headquarters had a tendency to underestimate bad assets more similar to domestic banks than to other foreign-owned banks. The additional value of the findings was obtained due to the introduction of a composite variable that simultaneously considers the type of ownership and capital restrictions.

The level of capital was previously recognized in the literature as a determinant of this type of moral hazard. This research goes a step further – in addition to the level of capital, an additional variable that carries information about the behaviour of banks is also considered. It is a variable that describes whether the bank was in a default status (undercapitalization) during the observed period. By confirming its statistical significance, we can conclude that the management stated incorrectly the quality of the bank's assets, due to the awareness that the bank can get into a state of undercapitalization. The variable that describes whether the bank was in default during the observed period is only a transmitter of information about this type of banks' behaviour.

In the literature, NPLs are mostly cited as a consequence of certain forms of moral hazard. In our findings, NPLs are confirmed as a determinant of banks' propensity to underestimate credit risk. However, it was confirmed in a specific type of relationship – as a low level when the bank has a tendency to underestimate the credit risk, and vice versa, so it is more a confirmation of the management's determination to hide the true image of the bank's performance.

It was identified that the sensitivity of the bank's capital and profit to changes in the level of credit risk encourages the bank's management to underestimate the credit risk. It was confirmed that medium and larger banks had a more pronounced tendency to this form of moral hazard.

The findings of the research indicate certain preferences of managers in banks that lead to moral hazard and can be valuable to bank owners in improving corporate governance. Also, they can help the bank regulator and economic policy makers in improving the bank supervision process. Although this research is focused on the emerging countries that apply internal and regulatory defined ratings to assess clients, the findings may also be useful in the context of applying client classification in accordance with IFRS 9.



This research has several limitations, but we will highlight the two most important ones. First, the limitation regarding the number of observations, which is determined by the number of banks operating in the country that was the subject of consideration. Second, the application of this type of research requires deep penetration into the databases of banks, which is often not possible due to the lack of public availability of this type of data.

Our research provided only a part of the answer in the literature dealing with moral hazard, as well as a deeper and more detailed analysis of only one of its many manifestations. There remain many open questions that arose before this paper, but also some questions that can only be opened by this research. This relates primarily in the field of systemic factors of moral hazard, as well as some other forms of manifestation – inadequate coverage of the bank client's economic connections, inefficiency of collateral, etc.

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