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Contents

Abstract

This paper describes the model of credit growth in the sector of commercial banks in Poland making use of panel data from Senior Loan Officers Opinion Survey (SLOS). The main aim of the model is short-term forecasting of the loan growth at the disaggregated (for particular banks) and aggregated (commercial banks' sector) level using qualitative information about expected banks' loan policy. The model was estimated on the sample of quarterly panel data spanning the period from mid-2005 to 2014 and involving about 30 banks covering more than 80 percent of the Polish banking sector loan portfolio. The model framework includes equations of credit growth in particular segments of loans – corporate, consumer and housing, enhanced by the equations of ordered-choice loan policy, which reflect respondents' expectations for the next quarter.

JEL: C23, C25, E58, G2

Keywords: credit growth, senior loan officers opinion survey

1. Introduction

Forecasting of the loan growth in the economy is a demanding exercise as the lending growth depends not only on market participants' interactions but also on regulations imposed on the market by financial authorities or specific individual banks' policy. In such circumstances, modelling credit growth which is based only on typical market factors such as price, income, investment prospects, cost of substitution etc. is not enough. Qualitative data from banks describing the supply side of loan growth would significantly improve forecasts, therefore the best solution seems to be gathering and application of bank survey information.

This paper presents a model which is aimed at short-term forecasting of commercial banks' lending growth in Poland at bank-level with the use of survey data from Senior Loan Officer Opinion Survey (SLOS).

The first part briefly sums up the recent literature on the use of SLOS data with particular emphasis on loan growth forecasting. The second shortly describes the survey which, in general, does not differ much from similar surveys in other countries. The third part presents the outline of the model and econometric methodology and the fourth sums up the results of estimation, backtesting and forecasting performance. The paper ends up with conclusions.

2. Literature

There is a broad literature on investigating credit growth with the use of Senior Loan Officer Opinion Survey. The majority of research uses aggregated data. For example, several papers use aggregated responses given by banks in SLOS to analyze the effect of supply of credit on economic fluctuations. Such data from national bank lending surveys are included in the research by Lown et al. (2000), Lown and Morgan (2006) and Ciccarelli et al. (2010).

Recently, the euro area data, with Bank Lending Survey (BLS), contribute to the literature. Ciccarelli et al. (2010) fed them into the VAR model in order to investigate the effectiveness of the credit channel of monetary transmission and to explore credit fluctuations during the recent crisis in the US and in the euro area. Hempell and Sørensen (2010) used these data to disentangle loan supply and demand effects. Bondt et al. (2010) examined empirically the information content of the euro area Bank Lending Survey for aggregate credit and output growth. The responses of the lending survey, especially those related to loans to enterprises, were a significant leading indicator for euro area bank credit and real GDP growth.

Only a handful of papers have taken advantage of bank-level data, as they are confidential with limited access. By applying a cross-country panel-econometric approach to such data Hempell and Sørensen (2010) have provided evidence that factors related to banks' balance sheet positions have a significant influence on the growth of loans to firms and households in the euro area. Blaes (2011), Del Giovane et al. (2011), Ferrari et al. (2013) and Bassett et al. (2014) used bank-level credit data combined with individual responses to the lending survey to investigate credit growth in Germany, Italy, Belgium and the United States.

However, all recent studies implicitly or explicitly agree that the information content in lending survey for loan growth predictions is unique.

This paper contributes to research analyzing banks' lending survey data. It presents one of the first attempts to build a more complex systemic tool to forecast bank-level credit growth using SLOS data. It is for the first time that such an exercise is

taken for Poland, as previous research on lending growth in Poland did not include SLOS bank-level data (see, for example, Łyziak et al. 2014, Wdowiński 2011).

3. Senior Loan Officer Opinion Survey

The main goal of Senior Loan Opinion Survey (SLOS) is the surveillance of tendencies in the credit market, in particular with respect to loan availability and bank lending policy. It allows to identify the direction and scale of changes in lending policy from the perspective of financial stability. As it includes questions about future trends it can be helpful in forecasting the value of credit in the economy.

Senior Officer Loan Opinion Survey is regularly carried out by Narodowy Bank Polski since 2003 Q4. It is directed at CEOs/executives chairing credit committees at commercial banks and the content is similar to analogous ECB and Fed surveys. Aggregate results are presented in the form of diffusion indices (net percent of answers) published on NBP website.[1] Depending on supervisory needs, the survey contains additional "descriptive" questions. Usually such national surveys cover a large part of loan portfolio of the banking system. The Polish survey covers 26-30[2] commercial and cooperative banks responsible for more than 80% of existing credit portfolio. It covers three market segments: corporate loans (distinction between SMEs and large enterprises with regard to lending standards), housing loans and consumer loans. The survey includes questions on changes in lending standards (minimum standards of creditworthiness set by banks that a prospective borrower must meet in order to obtain a credit) and on loan terms (features of loan contracts which are subject to negotiation between bank and borrower, such as price, amount and maturity of the loan).

Questions refer to the previous three months or address the expected situation in the following three months. The first group of questions is especially important for ex ante projection of lending growth. Table 1 presents a sample question from the survey.

As the questions in the survey concern changes in the particular bank's policy in a relatively short period of time (from quarter to quarter), it is the obvious that the

[1] See NBP website: http://www.nbp.pl/homen.aspx?c=/ascx/subgen.ascx&navid=5060

[2] The number of institutions kept changing in time due to mergers.

majority of answers in the sample indicated lack of change (between 50 and 80% depending on the question asked) – see Figure 3. The largest percent of not-applicable answers (coded as 6) was recorded in the case of housing loans, as some banks had not been extending housing loans at all. The most rare answer option among banks was "eased considerably", which means that banks were reluctant to ease drastically their policy from quarter to quarter.

The above-mentioned inertia of loan policy is distinctive when analyzing Markov transition matrices of responses from the survey. For each question concerning loan policy (excluding the "not applicable" state), the highest probability is associated with state 3 ("remained basically unchanged") – see Table 2.

4. Outline of the model

4.1. Bird's eye view

The loan portfolio of the banking sector was divided into two parts (see Figure 1): surveyed and non-surveyed banks. The first part which stands for over 80% of the portfolio was modelled using stochastic equations with the data from the survey. The loan growth of the second part was forecasted with the assumption of the same rate of growth as in the modelled part. This assumption for the changes in loan value is a good proxy as seen in Figure 2.

Credit growth in specific lending segments: corporate, consumer and housing,[3] was purposefully expressed with the use of macroeconomic data and survey data excluding microeconomic (banking) data. This was mainly due to difficulties during ex ante forecasting of the latter variables for particular banks.

Microeconomic data are used in an additional equation - the equation of bank lending policy. Therefore, potential forecast errors of microeconomic data should not have a significant impact on the final forecast of lending in particular segments.

The lending policy equation improves the quality of the ex ante forecasts of loan growth in the initial quarters of the forecasting periods. Dynamic specification of models together with the usage of survey answers for the next quarter allow us to apply a two-step procedure of forecasting: forecasts from the banks' policy equation at period "t+2" (achieved due to the expectation for "t+1" as regressor) can be used to forecast growth of loans at period "t+3". Therefore, the best forecasting performance of the mentioned models is three quarters ahead assuming relatively good forecasts of macroeconomic variables and a lack of significant structural breaks.

[3] The model for Polish banking system described in this paper includes only Polish zloty housing loans in the stochastic part, as foreign currency lending had almost totally stopped due to supervisory regulations.

The above-mentioned two equations are separately estimated econometric models. The loan growth in particular segments of loans is forecasted on the basis of an estimated conventional unbalanced panel model and the loan policy (banks' answers from the survey) is projected with an auxiliary, ordered-choice unbalanced panel model.

The imbalance of panel data in both equations is mainly due to mergers in the banking sector. As the number of missing observations is relatively small, it should not have a significant influence on the properties of the estimator.[4]

Loans were modelled in constant prices: corporate loans were adjusted using the PPI, while consumer loans and housing loans[5] - with the use of the CPI. To achieve better dynamic properties, in particular to assure stationarity and to adjust the period of change in volumes to answers from the survey,[6] we used quarter-to-quarter rates of loan growth.[7]

From the broad list of tested regressors (see Table 3), only part of them passed the significance test. Variables which had significant influence were included into final forecasting equations. These were macrovariables such as the GDP, the CPI, the consumer sentiment indicator, the WIG Index and microdata - answers from the survey concerning the expected credit policy, the CAR, interest rates, and the funding gap.

4.2. Econometric methodology

The econometric framework consists of two approaches to panel data – (dynamic) panel regression (credit growth equation) and dynamic ordered-choice panel model

[4] The Hausman test of sample selection bias: not rejecting the H_0 hypothesis in all specifications entails no sample bias.

[5] We also took into consideration the housing prices index. However, the CPI is recommended in that case as the data are more reliable.

[6] The survey asks about quarterly changes.

[7] Previous research presented in the literature usually applies year-to-year growth rates.

(loan policy equation). Both equations were estimated with the use of unbalanced panel data.

Let us assume the model:

$$y_{it} = \mathbf{x}_{it}' \boldsymbol{\beta} + \alpha_i + \varepsilon_{it} \quad (1)$$

where t=1,2,...,T and i=1,2,...,N, $[\mathbf{x}_{it}]_{1xK}$, $[\beta]_{Kx1}$, $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$.

The problem of incompleteness was solved using a Tx1 vector of selection indicators:

$s_i = (s_{i1}, \ldots, s_{iT})'$, where $\boldsymbol{s}_{it} = 1$ if $(\mathbf{x}_{it}, \mathbf{y}_{it})$ is observed and zero otherwise. Such indicators are included into the parameters' estimator.

Equations of lending growth were estimated with the use of the OLS while allowing the standard errors (and variance–covariance matrix of the estimates) to be consistent when the disturbances from each observation are not independent, and specifically, allowing the standard errors to be robust to each bank having a different variance of the disturbances and to each bank's observations being correlated with those of the other banks through time. Nevertheless, some of the equations are dynamic. Dynamic panel regression with AR(1) can be presented as:

$$y_{it} = \delta y_{i,t-1} + x_{it}' \beta + \alpha_i + \varepsilon_{it} \quad (2)$$

where δ is a scalar.

In the case of the OLS method, the estimator is biased and inconsistent since y_{it} is a function of α_i. It immediately follows that $y_{i,t-1}$ is also a function of α_i.

Econometric literature raised many times the problem of inconsistency of dynamic panel estimators. Some papers investigate how large N vs. T should be while other publications offer the solution to the bias in the form of corrections. Nickell (1981) wrote about the problem of the bias of the Within estimator, which is inconsistent for N large and T small. However, he noticed, as T gets large the fixed effects estimator becomes consistent. The properties of IV and GMM estimators hold when N is large, so they can be severely biased and imprecise in panel data with a small number of cross-sectional units. Arellano and Bond (1991), Kiviet (1995), Judson and Owen (1999) demonstrate that LSDV, although inconsistent, has a relatively

small variance compared to IV and GMM estimators. As *T* should be large, a question arises what "large T" means. Judson and Owen (1999) used Monte Carlo experiments (*N*=20 or 100) to conclude, among others, that for *T*=30 the bias could be as much as 20% of the true value of the coefficient of interest. For small data sets literature offers bias-corrected LSDV estimators. Some authors suggest estimating the extent of the bias by using a preliminary consistent estimator – see Kiviet (1995), Hansen (2001), Hahn and Kuersteiner (2002) and finally, for unbalanced panels and short *T* - Bruno (2005a).

Bruno (2005) suggests a method for obtaining a consistent bias-corrected estimator by finding consistent estimators[8] for the variance of the irregular component and the slope parameter of autoregression of order 1, plugging them into the bias-approximation formulas, and then subtracting the resulting bias approximation estimates, $\hat{B}_i$, from LSDV in the following manner:

$\mathrm{LSDVC_i} = \mathrm{LSDV} - \widehat{\mathrm{B}}_\mathrm{i}$, $\quad i$=1,2 and 3,

where LSDV – Least Squares Dummy Variables estimator and i – indicator of bias approximation (the larger the i, the higher the level of accuracy). Such correction was made to the initial estimator of loan growth equations with a dynamic specification. The equation of housing loans' growth, displaying an AR(1) property, was estimated with the use of Bruno's correction.

The equation of loan policy has the form of an ordered response panel model. Let y be an ordered response taking on the values {0; 1; 2; . . . ; J} for some known integer J. The ordered logit/probit model for y (conditional on explanatory variables **x**) can be derived from a latent variable model. Assume that a latent variable y^* is determined by

$$y_{it}^{*} = x_{it}' \beta + \alpha_i + \varepsilon_{it} \qquad (3)$$

where $\varepsilon_{it} \sim \Phi$, ($\Phi$ is logistic or normal distribution) and observable y_{it} takes on the values:

[8] Possible consistent estimators are Anderson-Hsiao`s, Arellano-Bond`s, Blundell-Bond`s and own initial values.

$$y_{it} = \begin{cases} 0 & \text{if } k_0 \le y_{it}^* < k_1 \\ 1 & \text{if } k_1 \le y_{it}^* < k_2 \\ 2 & \text{if } k_2 \le y_{it}^* < k_3 \\ \vdots & \vdots \\ J & \text{if } k_J \le y_{it}^* < k_{J+1} \end{cases} \quad (4)$$

Let us consider the following cut points (or threshold parameters): $k_0 = -\infty$ and $k_{J+1} = +\infty$ and $k_0 < k_1 < \ldots < k_{J+1}$, which, together with parameters of equation (3), are estimated using the Maximum Likelihood (ML) method. For each observation the probability of taking the value *j* can be computed as:

$$P(y_{it} = j) = P(k_j \le y_{it}^* < k_{j+1}) = P(y_{it}^* < k_{j+1}) - P(y_{it}^* < k_j) \quad (5)$$

The forecast of y_{it} is such a state of y_{it} from the set {0; 1; 2; . . . ; J}, which has the highest probability for this particular observation *it*. As the credit policy equation is dynamic, the standard estimating approach raises the initial conditions problem. This problem was well-recognised in the estimation of dynamic discrete choice models (Heckman 1981a, 1981b, Wooldridge 2005, Orme 2001). Its cause is the presence of both the past value of the dependent variable and an unobserved heterogeneity term in the equation and the correlation between them. The strict exogeneity assumption for regressors, standardly used in static discrete choice models in order to marginalise the likelihood function with respect to the unobserved heterogeneity, cannot be used. Skrondal and Rabe-Hesketh (2014) recommend a conditional model with the use of the auxiliary model:

$$\alpha_i = \delta_{y_0} y_{i0} + \boldsymbol{\delta}'_{x_0} \mathbf{x}_{i0} + \boldsymbol{\delta}'_{\bar{x}} \bar{\mathbf{x}}_{\boldsymbol{i}} + u_i \quad (6)$$

where y_{i0} – vector of starting values for each group, $\mathbf{x}_{i0}$ – matrix of starting values of all time-varying exogenous variables, $\bar{\mathbf{x}}_{\boldsymbol{i}}$ – matrix of group means of the time-varying covariates where the mean includes the initial values of *x*. $u_i \sim N(0, \omega)$ is independent of y_{i0}, $\mathbf{x}_{i0}$ and $\bar{\mathbf{x}}_{\boldsymbol{i}}$.

Following Skrondal and Rabe-Hesketh, such a conditional approach was applied to banks' policy equations in the model. The logit transformation was used and the random effect assumed.

5. Results of estimations and forecasting performance

Tests of significance did not reject the null of zero value for the slope parameters in the cases of the majority of variables (regressors) coming from the banking and nonfinancial sector. Moreover, some regressors did not pass the economic verification of the direction of influence. Therefore, only few variables in each equation (both policy and growth) were left having relatively good predictive potential. This potential varies depending on the sample.[9] The results of the best estimations are presented in Tables 4-9. Persistence of loan growth and loan policy turned out to be strong in the case of all equations except consumer loan growth equation.

The most significant economic predictors of corporate loan policy was the funding gap and two macrovariables – inflation, which can influence loan policy via interest margin and the rate of return on stock market index representing the overall economic sentiment towards the corporate sector. The market performance of corporates can influence banks' decisions concerning financing corporate investments.

The growth of corporate loans depends strongly on past developments in this category, banks' policy expectations from the last quarter, past GDP rate of growth, and from 2014 onwards – the government guarantee programme for SMEs. The results confirm analysts' opinions about Polish corporates' approach to financing via bank loans. Polish corporates, as they prefer financing via internal funds, opt for taking loans when economic perspectives are improving and when they receive new orders, which usually takes place a few quarters after a rebound in GDP growth.

In the case of consumer loans policy, only one microeconomic characteristics – the capital adequacy ratio – turned out to be relatively statistically important, but this depends on the sample. Increase in CAR means more capital versus risk-weighted assets. It can result in easing of the policy in this most profitable loan segment.

[9] The first estimations of the presented equations were made in 2012. The model has been undergoing slight respecification and reestimation, on average, every half of the year. Although the sample has been changing (it grows larger as new observations appear), the final set of the most significant regressors is almost unchanged.

Consumer lending policy has strong inertia, and is also sensitive to Financial Authority regulations.

Growth of consumer loans depends on past banks' policy and on the last-quarter change of consumer sentiment indicator. Consumer loans are the short-term financing of consumer goods, these are loans at current accounts, credit card accounts, etc. The higher the optimism concerning the following months, the more prominent the rise of household expenses , as households predict that their credibility will improve.

Modelling the segment of housing loans is the most demanding, as this domain is strongly affected by regulations. Therefore the variable representing the government programme supporting families (and financing part of the interest of their housing loans) turned out to be strongly significant. Banks' housing loans policy has a strong inertia. The influence of microeconomic variables is weaker.

In the case of both types of loans for households (consumer and housing), the CAR influence on loan policy is relatively weaker than other variables' and its effect changes, depending on the sample. This conclusion is partly consistent with recent results by Olszak at al. (2014) obtained on the sample of large EU banks. According to their research, lending sensitivity to capital ratios is slightly increased during contractions, while more restrictive regulations and more stringent official supervision reduce the magnitude of the effect of capital ratio on bank lending.

Commercial banks' lending policy equations have relatively good predictive *in sample* performance (see Table 4). In the case of ordered-choice panel models it can be measured with the use of *count* R^2 and *adjusted count* R^2 (Greene and Hensher 2010):

$$Count\ R^2 = \frac{number\ of\ correct\ predictions}{n} \tag{7}$$

$$Adjusted\ Count\ R^2 = \frac{number\ of\ correct\ predictions - n_j^*}{n - n_j^*}, \tag{8}$$

where n is the number of all predictions and n_j^* is the count of the most frequent outcome.

Skrondal and Rabe-Hesketh modification has improved slightly the forecasting performance of corporate loan policy equation and housing loan policy equation (see Table 4 and 6). Modification I is a straightforward application of Skrondal and Rabe-Hesketh suggestion and Modification II is a result of the search for better forecasting performance by excluding some variables from Modification II.

In order to match the best estimator for the loan growth in a particular segment, we tested LSDV estimator effectiveness using a panel DW test of autocorrelation of order 1, as well as a Wald Chi-square heteroscedasticity test (see Table 7). The results suggest using heteroscedasticity robust standard errors in all cases and autocorrelation robust estimators in the case of corporate loans and zloty housing loans equation.

The results of the Hausman test indicate that in the case of the housing and corporate segments, the random effect approach should be rejected in favour of the fixed effect. In the case of consumer loan equation, both random and fixed effects estimators provide similar results. Therefore, in all cases fixed effect estimators have been applied. According to Wald chi-square test results, parameters of all mentioned loan growth models are jointly statistically significant.

The third loan growth equation concerning the zloty housing loans and constituting a dynamic, unbalanced panel equation was also estimated with Bruno's parameter correction. As expected, the correction has moved the autoregression parameter downward, but the forecasting performance of the equation deteriorated.

Summing up all statistical features of the specified equations, relatively best statistical quality was obtained for equations of corporate loan growth. This affected better forecasting performance – the median of group forecast errors of quarter-to quarter growth (for particular banks) amounted to as little as about 18% compared

to almost 35% or 38% in the case of the consumer and housing segments, respectively.

Using the panel regressions to forecast loan growth has advantages and drawbacks. The advantage consists in the possibility of obtaining granular information on the results of simulations or forecasts of particular loan components (segments, banks). The disadvantage usually consists in a higher error of forecasts when compared to methods applied directly to aggregate values. This case is similar – the RMSPE of aggregated nominal loans from forecasted panel models presented above is higher than from a simple AR(1) model of the same aggregated loan category (18.1% vs. 8.6%).

6. Conclusions

This paper described the specification, economic relations and statistical properties of the model of credit growth in the sector of commercial banks in Poland. The main idea of the concept was to use survey information in the form of panel data from Senior Loan Officers Opinion Survey (SLOS). The main objective of the model was a short-term forecasting of the loan growth at the disaggregated (for particular banks, different types of loans) and aggregated (the commercial banks' sector) level. The model framework comprises three loan segments – corporate, consumer and housing loans, utilizing bank-by-bank data. All subcategories can be aggregated to overall loan growth in the banking sector.

For each segment of loans two equations were assumed – a credit policy equation and a loan growth equation.

From the broad list of tested regressors, only part of them passed the significance test. Variables with significant impact were included into final forecasting equations. However, their significance varies with increasing number of observations. Relatively best statistical quality was obtained for equations of corporate loan growth. Although using granular (panel) approach to loan growth modelling provides relatively less satisfactory statistics and forecasting performance in comparison with aggregate approach (for example with the use of a simple AR(1) to overall loan growth), it still provides more detailed information to financial supervisory institutions and important input to stress testing of the banking system.

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Figure 1

An outline of the model

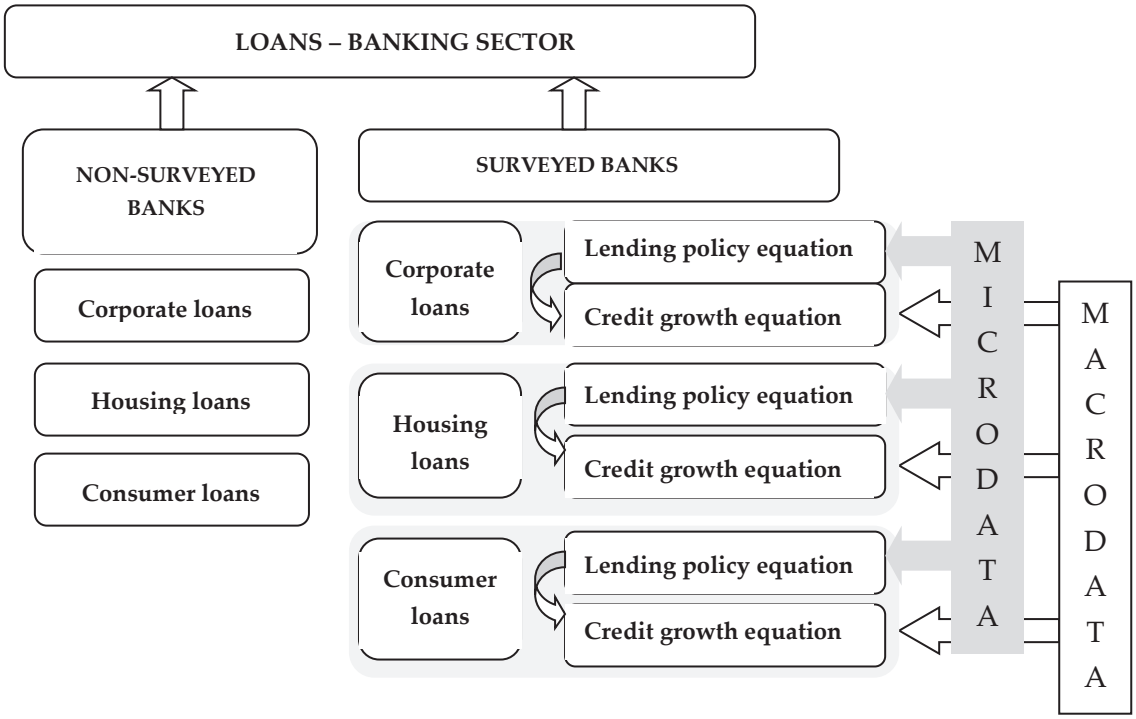


Figure 2

Loans in the Polish banking sector and its surveyed part. Corporate, housing and consumer loans

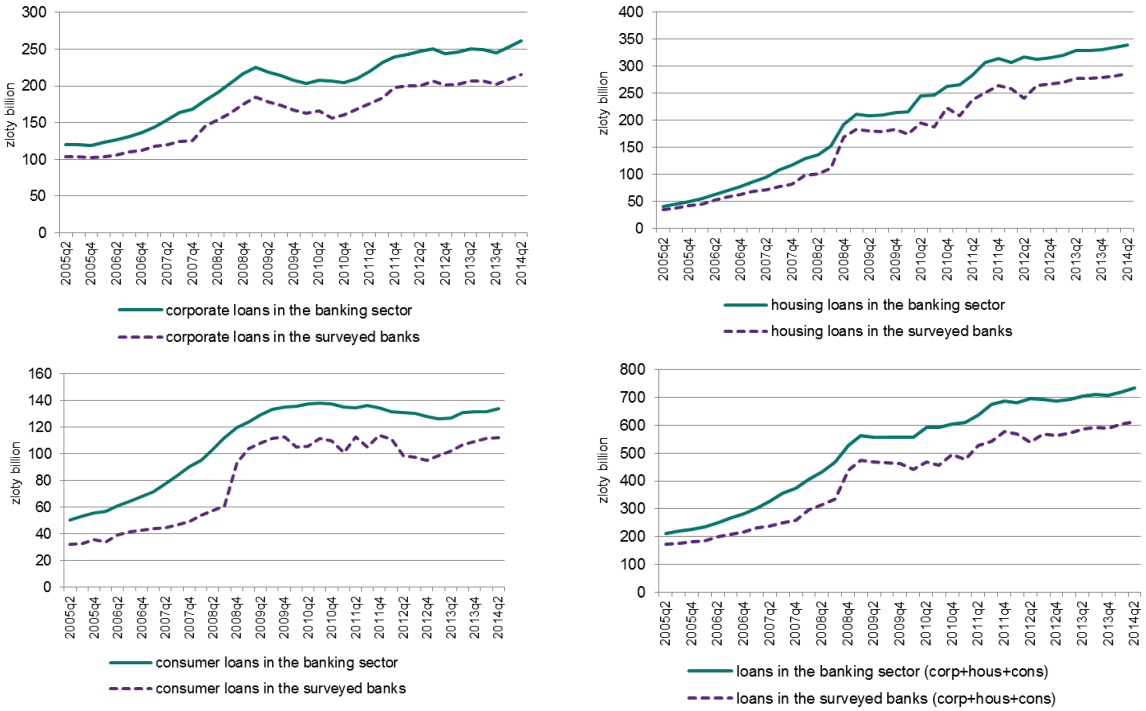
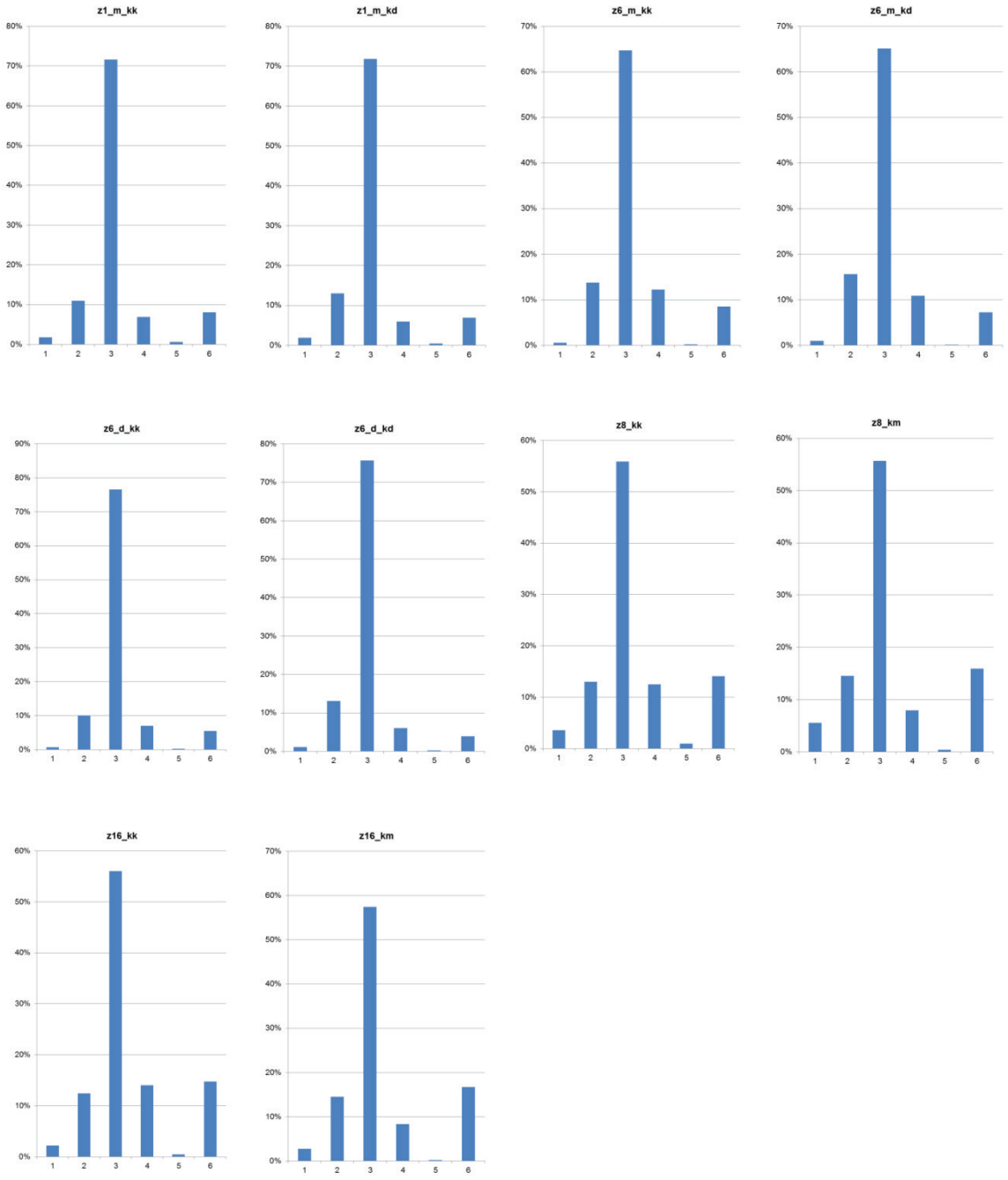


Figure 3

Responses in the survey – shares of particular answers.



Answers: 1-“tightened considerably”, 2-“tightened somewhat”, 3-“remained basically unchanged”, 4-“eased somewhat”, 5-“eased considerably”, 6-“not applicable”.

Table 1

Sample question from the survey

Over the last three months, how have your bank's **credit standards** for approving applications for loans or credit lines to large enterprises and SME changed? If your bank's policies have not changed over the last three months, please report them as unchanged even if they are restrictive or accommodative relative to longer-term norms. If a type of loan is not offered by your bank, please use the answer ''not applicable''.

Corporate credit standards	Large enterprises		Small & medium-sized enterprises	
	Short-term loans	Long-term loans	Short-term loans	Long-term loans
Tightened considerably				
Tightened somewhat				
Remained basically unchanged				
Eased somewhat				
Eased considerably				

Source: NBP

Table 2

Markov transition matrices of responses from the SLOS. Variables (questions) tested in the model. Transition from quarter to quarter.

	1	2	3	4	5	6
z1_m_kk – current credit policy concerning short-term loans to SMEs						
1	**29.412%**	23.529%	35.294%	11.765%	0.000%	0.000%
2	6.667%	**35.238%**	52.381%	5.714%	0.000%	0.000%
3	0.744%	8.929%	**83.333%**	6.250%	0.149%	0.595%
4	0.000%	2.941%	69.118%	**22.059%**	5.882%	0.000%
5	0.000%	0.000%	83.333%	0.000%	**16.667%**	0.000%
6	0.000%	0.000%	1.370%	0.000%	0.000%	**98.630%**
z1_m_kd - – current credit policy concerning long-term loans to SMEs						
1	**31.579%**	26.316%	31.579%	10.526%	0.000%	0.000%
2	4.839%	**41.935%**	50.000%	3.226%	0.000%	0.000%
3	0.741%	9.333%	**83.556%**	5.333%	0.296%	0.741%
4	1.724%	3.448%	72.414%	**20.690%**	1.724%	0.000%
5	0.000%	0.000%	50.000%	25.000%	**25.000%**	0.000%
6	0.000%	0.000%	0.000%	1.639%	0.000%	**98.361%**
z6_m_kk – expected credit policy concerning short-term loans to SMEs						
1	**16.667%**	50.000%	16.667%	16.667%	0.000%	0.000%
2	1.600%	**50.400%**	44.800%	2.400%	0.800%	0.000%
3	0.347%	9.549%	**80.382%**	9.028%	0.000%	0.694%
4	0.000%	1.818%	52.727%	**44.545%**	0.909%	0.000%
5	0.000%	0.000%	0.000%	100.000%	**0.000%**	0.000%
6	0.000%	0.000%	0.000%	1.370%	0.000%	**98.630%**

z6_m_kd - expected credit policy concerning long-term loans to SMEs						
1	**18.182%**	45.455%	27.273%	9.091%	0.000%	0.000%
2	3.597%	**48.201%**	46.043%	2.158%	0.000%	0.000%
3	0.171%	11.282%	**78.462%**	9.060%	0.171%	0.855%
4	1.020%	1.020%	57.143%	**40.816%**	0.000%	0.000%
5	0.000%	0.000%	100.000%	0.000%	**0.000%**	0.000%
6	0.000%	1.639%	0.000%	0.000%	0.000%	**98.361%**
z6_d_kk - expected credit policy concerning short-term loans to large companies						
1	**16.667%**	33.333%	50.000%	0.000%	0.000%	0.000%
2	3.333%	**45.556%**	48.889%	1.111%	1.111%	0.000%
3	0.291%	6.250%	**86.773%**	5.087%	0.000%	1.599%
4	0.000%	1.563%	57.813%	**39.063%**	1.563%	0.000%
5	0.000%	50.000%	0.000%	50.000%	**0.000%**	0.000%
6	0.000%	4.444%	8.889%	2.222%	0.000%	**84.444%**
z6_d_kd - expected credit policy concerning long-term loans to large companies						
1	**10.000%**	40.000%	50.000%	0.000%	0.000%	0.000%
2	5.128%	**41.026%**	49.573%	3.419%	0.000%	0.855%
3	0.440%	8.798%	**84.604%**	4.545%	0.293%	1.320%
4	0.000%	5.660%	58.491%	**35.849%**	0.000%	0.000%
5	0.000%	0.000%	100.000%	0.000%	**0.000%**	0.000%
6	0.000%	6.452%	12.903%	0.000%	0.000%	**80.645%**
z8_kk – current consumer loans policy						
1	**33.333%**	19.444%	41.667%	5.556%	0.000%	0.000%
2	10.317%	**38.095%**	42.063%	7.937%	1.587%	0.000%
3	1.727%	10.365%	**75.240%**	10.557%	0.576%	1.536%
4	0.000%	11.200%	48.000%	**37.600%**	3.200%	0.000%
5	0.000%	0.000%	70.000%	30.000%	**0.000%**	0.000%
6	0.000%	0.000%	0.787%	0.787%	0.000%	**98.425%**
z8_km - current housing loans policy						
1	**38.182%**	21.818%	32.727%	7.273%	0.000%	0.000%
2	8.148%	**37.778%**	47.407%	5.926%	0.741%	0.000%
3	3.416%	11.006%	**76.091%**	6.641%	0.190%	2.657%
4	2.564%	17.949%	43.590%	**34.615%**	1.282%	0.000%
5	0.000%	16.667%	50.000%	16.667%	**16.667%**	0.000%
6	0.000%	0.704%	3.521%	0.000%	0.000%	**95.775%**
z16_kk - expected consumer loans policy						
1	**33.333%**	19.048%	33.333%	14.286%	0.000%	0.000%
2	7.080%	**47.788%**	41.593%	3.540%	0.000%	0.000%
3	0.980%	9.608%	**75.882%**	11.569%	0.392%	1.569%
4	0.000%	4.065%	48.780%	**45.528%**	1.626%	0.000%
5	0.000%	0.000%	40.000%	60.000%	**0.000%**	0.000%
6	0.000%	0.000%	0.787%	0.787%	0.000%	**98.425%**
z16_km – expected housing loans policy						
1	**24.000%**	24.000%	44.000%	8.000%	0.000%	0.000%
2	8.462%	**36.154%**	46.154%	9.231%	0.000%	0.000%
3	1.530%	11.472%	**77.055%**	7.266%	0.000%	2.677%
4	0.000%	22.667%	45.333%	**29.333%**	2.667%	0.000%
5	0.000%	0.000%	50.000%	50.000%	**0.000%**	0.000%
6	0.000%	0.000%	4.225%	0.000%	0.000%	**95.775%**

Table 3

Variables tested in the model and their transformations used in final estimations (in parentheses).

abbreviation	description	details
Macrodata		
(D)CSI	consumer sentiment indicator (quarter-to-quarter change)	Source: Polish Central Statistical Office
(G)GDP	gross domestic product (rate of growth, constant prices)	Source: Polish Central Statistical Office
(G)WIG	Warsaw Stock Exchange Index (rate of change)	Source: Reuters
CHF/PLN, EUR/PLN, USD/PLN	exchange rates	Source: NBP
CONS	consumption	Source: Polish Central Statistical Office
CPIY	consumer products inflation (y/y)	Source: Polish Central Statistical Office
ECI	economic climate indicators	Source: Polish Central Statistical Office
EMPL	number of employed in the corporate sector	Source: Polish Central Statistical Office
INC	households' disposable income	Source: Polish Central Statistical Office
ROE,ROA,ROS	profitability ratios of corporates	Source: Polish Central Statistical Office
U	unemployment rate	Source: Polish Central Statistical Office
WAGE	average wage	Source: Polish Central Statistical Office
WIBOR3M, LIBORCHF3M, LIBOREUR3M	interbank interest rates	Source: NBP, Reuters
Microdata (panel data)		
(D)GAP	total interbank loans of the bank minus its total interbank borrowings, as fraction of bank's assets (quarter-to-quarter change)	Source: NBP
(G)LOANSC	consumer loans (quarter-to-quarter growth, constant prices)	Source: NBP
(G)LOANSCR	corporate loans (quarter-to-quarter growth, constant prices)	Source: NBP

(G)LOANSH	housing loans (quarter-to-quarter growth, constant prices)	Source: NBP
CAR	capital adequacy ratio	Source: NBP
FLIAB	liabilities from foreign financial institutions	Source: NBP
govp	Binary variable. Government support plan for families buying their first flat ("Rodzina na swoim")	Source: own computations
minimis	Binary variable. Government support for SMEs in the form of loans guarantee plan. ("1" from 2013, "0" otherwise)	Source: own computations
MRGNC, MRGNH, MRGNCR	credit margins: consumer, housing, corporate segments	Source: NBP
NPLC	non-performing loans ratio - consumer loans	Source: NBP
NPLCR	non-performing loans ratio - corporate loans	Source: NBP
NPLH	non-performing loans ratio - housing loans	Source: NBP
PROV	provisions to loans	Source: NBP
RC	interest rate – consumer loans	Source: NBP
RCR	interest rate – corporate loans	Source: NBP
rect	Binary variable ("1" from second half of 2013, "0" otherwise). Adjustment to Recommendation T of the Polish Financial Authority which eased the standards of consumer loans	Source: own computations
RH	interest rate – housing loans	Source: NBP
z1_m_kd	current credit policy concerning long-term loans to SMEs	Source: NBP
z1_m_kk	current credit policy (credit standards) concerning short-term loans to SMEs	Source: NBP
z16_kk	expected consumer loans policy	Source: NBP
z16_km	expected housing loans policy	Source: NBP
z6_d_kd	expected credit policy concerning long-term loans to large companies	Source: NBP
z6_d_kk	expected credit policy concerning short-term loans to large companies	Source: NBP
z6_m_kd	expected credit policy (credit standards) concerning long-term loans to SMEs	Source: NBP
z6_m_kk	expected credit policy concerning short-term loans to SMEs	Source: NBP
z8_kk	current consumer loans policy	Source: NBP
z8_km	current housing loans policy	Source: NBP

Table 4

Results of estimation of the equation of banks' corporate loans policy

z6_m_kk	no modification	modification I	modification II
$y_{i,t-1}$ - z6_m_kk(-1)	0.695 (0.000)	1.313 (0.000)	1.307 (0.000)
x_{1t} - GAP	-0.002 (0.019)	0.105 (0.881)	-0.083 (0.900)
x_{2t} - CPIY(-1)	-0.215 (0.000)	-0.449 (0.000)	-0.444 (0.000)
x_{3t} - GWIG	0.020 (0.002)	0.040 (0.001)	0.039 (0.001)
y_{i0}		-0.062 (0.757)	-0.112 (0.508)
x_{10}		-1.841 (0.625)	
x_{20}		0.296 (0.312)	
x_{30}		-0.018 (0.550)	
$\bar{x}_1$		3.553 (0.031)	3.646 (0.025)
cut1	-22.312 (0.000)	-16.503 (0.593)	-46.068 (0.000)
cut2	-20.464 (0.000)	-12.814 (0.678)	-42.373 (0.000)
cut3	-17.861 (0.000)	-8.131 (0.792)	-37.693 (0.000)
cut4	-15.873 (0.000)	-3.725 (0.904)	-33.287 (0.000)
Number of level 1 units	796	775	775
Number of level 2 units	31	31	31
Level 2 variance of random effects	0.075 (0.038)	0.301 (0.150)	0.319 (0.156)
Count R^2	0.593	0.578	0.590
Adjusted Count R^2	0.303	0.225	0.325

The table presents coefficient estimations with probabilities in brackets (P>|z|). Matrix of group means of the time-varying covariates includes only one variable. Such a mean should depend on the group (bank). The other two variables are dropped as they do not change with the group number (macrovariables) causing colinearity in the model. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 5

Results of estimation of the equation of banks' consumer loans policy

z8_kk	no modification	modification I	modification II
$y_{i,t-1}$ – z8_kk(-1)	0.851 (0.000)	0.762 (0.000)	0.762 (0.000)
x_{1t} - CAR(-2)	0.222 (0.191)	-0.100 (0.434)	-0.103 (0.427)
x_{2t} - rect	1.198 (0.000)	1.329 (0.000)	1.331 (0.000)
y_{i0}		0.064 (0.517)	
x_{10}		0.033 (0.019)	0.035 (0.012)
$\bar{x}_1$		5.084 (0.000)	5.130 (0.000)
cut1	-0.764 (0.099)	0.003 (0.996)	-0.179 (0.671)
cut2	1.098 (0.008)	1.888 (0.001)	1.706 (0.000)
cut3	4.486 (0.000)	5.303 (0.000)	5.121 (0.000)
cut4	7.581 (0.000)	8.360 (0.000)	8.177 (0.000)
Number of level 1 units	774	752	752
Number of level 2 units	31	31	31
Level 2 variance of random effects	0.057 (0.078)	0.036 (0.060)	0.039 (0.063)
Count R^2	0.502	0.453	0.477
Adjusted Count R^2	0.230	0.162	0.188

The table presents coefficient estimations with probabilities in brackets (P>|z|). Matrix of group means of the time-varying covariates includes only one variable. Such a mean should depend on the group (bank). The other two variables are dropped as they do not change with the group number (macrovariables) causing colinearity in the model. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 6

Results of estimation of the equation of banks' housing loans policy

z16_km	no modification	modification I	modification II
$y_{i,t-1}$ – z16_km(-1)	0.724 (0.000)	0.731 (0.000)	0.727 (0.000)
x_{1t} - DGAP	-0.003 (0.312)	-0.001 (0.746)	-0.002 (0.343)
x_{2t} - CAR(-1)	0.191 (0.301)	0.126 (0.484)	0.155 (0.417)
x_{3t} - govp	-0.643 (0.000)	-0.651 (0.001)	-0.640 (0.000)
y_{i0}		-0.183 (0.139)	-0.187 (-0.439)
x_{10}		-0.024 (0.151)	-0.019 (0.290)
x_{20}		0.009 (0.481)	
$\bar{x}_1$		-0.011 (0.635)	
$\bar{x}_2$		-0.125 (0.925)	
cut1	-1.871 (0.000)	-2.408 (0.000)	-2.442 (0.000)
cut2	-0.292 (0.410)	-0.233 (0.732)	-0.270 (0.666)
cut3	3.981 (0.000)	3.469 (0.000)	3.429 (0.000)
cut4	7.697 (0.000)	7.177 (0.000)	7.141 (0.000)
Number of level 1 units	691	691	691
Number of level 2 units	31	31	31
Level 2 variance of random effects	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Count R^2	0.463	0.477	0.492
Adjusted Count R^2	0.429	0.451	0.455

The table presents coefficient estimations with probabilities in brackets (P>|z|). The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 7

Results of testing of LSDV estimator's effectiveness

Loan growth equation	AR(1) panel DW test	Wald Chi-square heteroscedasticity test
Corporate loans	0.777	3.9E+0.5 (0.000)
Zloty housing loans	0.996	16753.15 (0.000)
Consumer loans	1.986	3.0E+0.7 (0.000)

In brackets – probabilities of a Wald Chi-square test

Table 8

Results of estimation of the equation of corporate loans growth

GLOANSCR	Coef.(prob.)
GLOANSCR(-4)	0.366 (0.001)
z6_m_kk(-1)	2.678 (0.047)
GGDP(-2)	0.836 (0.076)
minimis	11.954 (0.001)
_cons	-10.690 (0.014)
dummies	
Number of level 1 units	602
Number of level 2 units	28
R^2	0.397
Wald chi^2	424.52 (0.000)
Hausman FE vs. RE	52.97 (0.000)
Median of group RMSPE	18.104

The table presents coefficient estimations with probabilities in brackets (P>|z|). The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 9

Results of estimation of the equation of consumer loans growth

GLOANSC	Coef.(prob.)
z8_kk(-5)	3.810 (0.005)
DCSI(-1)	0.344 (0.355)
rect	18.699 (0.037)
_cons	-13.874 (0.086)
dummies	
Number of level 1 units	616
Number of level 2 units	28
R^2	0.334
Wald chi^2	15010.3 (0.000)
Hausman FE vs. RE	4.33 (0.632)
Median of group RMSPE	34.622

The table presents coefficient estimations with probabilities in brackets (P>|z|). The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 10

Results of estimation of the equation of zloty housing loans growth

GLOANSH	Coef.(prob.)
GLOANSH(-1)	0.530 (0.000)
z16_km(-1)	0.656 (0.491)
z16_km(-3)	-1.082 (0.188)
RH(-1)	-265,872 (0.042)
_cons	24,744 (0.010)
dummies	
Number of level 1 units	427
Number of level 2 units	18
R^2	0.350
Wald chi^2	782.50 (0.000)
Hausman FE vs. RE	36.73 (0.000)
Median of group RMSPE	45.180

Table presents coefficients estimations with probabilities in brackets (P>|z|). The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of the parameter estimates was used.

Table 11

Comparison of parameter values estimated with the use of the LS estimator (LSDV) against the estimator with Bruno's correction (LSDVC) – the equation of zloty housing loans

GLOANSH	LSDV	LSDVC
GLOANSH(-1)	0.530 (0.000)	0.437 (0.000)
z16_km(-1)	0.656 (0.491)	1.416 (0.295)
z16_km(-3)	-1.082 (0.188)	-0.219 (0.908)
RH(-1)	-265,872 (0.042)	-95.875 (0.274)
Median of group RMSPE	45.180	49.745

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