Modelling the Risk-taking Channel of Monetary Policy in the Russian Economy

Irina Semina, *Lomonosov Moscow State University*
irinkasemina1998@gmail.com

The main purpose of this paper is to test the efficiency of the risk-taking channel in the Russian economy. The existence of this channel may be an additional argument for the Bank of Russia's cautious policy regarding changes in the key rate, since its sharp decline may cause financial instability, as banks reallocate their funds to riskier higher-yield assets. Z-score and the level of non-performing loans calculated according to the quarterly financial statements of credit institutions have been selected as a measure of risk. Econometric analysis revealed a shift toward riskier operations in response to a decrease in key and market interest rates. It also confirmed the hypothesis that the risk-taking channel is less effective for large banks.

Keywords: *risk-taking channel, monetary policy, financial stability, credit risk*

JEL Codes: *E44, E52*

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1. Introduction

There are several main channels for the transmission of monetary policy shocks to the real sector of the economy: interest, credit, currency, and inflation channels. Here, we will focus on the group of credit channels. Their study helps understand how monetary policy changes pass-through the financial sector, which is necessary for predicting policy outcomes in the context of ever-increasing importance of financial sector for the economy in general.

The efficiency of classic credit channels is closely related to the restrictions on borrowing faced by economic agents. However, the development of financial markets in recent years has increased the ability of banks to raise additional funds for lending, compelling us to consider alternative channels for monetary authorities to influence the real sector of the economy. One such channel is the risk-taking channel. This channel explains how monetary policy changes can affect the activity of economic agents and their attitudes toward risk. For example, if nominal interest rates are close to zero, low bank margins

result in an inflow of funds into riskier higher-yield assets, increasing national financial instability in the event of realisation of risks and difficulties in meeting obligations.

Thus, the study and evaluation of the efficiency of this channel are necessary for predicting monetary policy outcomes and managing the stability of the financial sector.

Verifying the existence of this channel is particularly relevant in Russia, where the Central Bank is pursuing a cautious policy on interest rates, lowering them gradually in increments of 0.25 to 0.50 p.p.¹ Confirming the efficiency of this channel may be an additional argument for the Bank of Russia's cautious policy regarding the key rate since its sharp decline may cause financial instability.

Unlike other credit channels, the risk-taking channel in Russia is under-researched; there are no fresh econometric estimates of the impact of lower interest rates on the level of risk acceptance by credit institutions.

This paper tests the efficiency of the risk-taking channel in the Russian economy in 2008–2019. Section 2 describes empirical studies of the risk-taking channel in different economies and highlights the empirical strategy applicable to modelling this channel on Russian data. Section 3 discusses the specifics of the Russian banking sector in terms of its exposure to risks. Section 4 demonstrates the efficiency of the risk-taking channel in the Russian economy in 2008–2019 using econometric modelling. Section 5 summarises the results of this paper and identifies possible areas for further research.

2. Review of risk-taking channel research

One of the main papers on the risk-taking channel is that of Borio and Zhu (2012), which describes its functioning. It offers non-exclusive options to explain banks' change in perception of the appropriate level of risk acceptance.

First, interest rates affect asset values, income, and cash flows. For example, lowering the nominal interest rate leads to upward revaluation of assets and collateral; profits and revenue change similarly (due to lower interest costs, for example). This increases risk tolerance for both banks and companies, resulting in the growth of lending. The impact of these effects in total is similar to that of a financial accelerator and perhaps reinforces it.

Second, a large gap between yield targets and lower market rates (nominal indicators) results in higher risk tolerance and increased investments in riskier assets with greater expected returns. One explanation of this is related to activities of institutional investors (such as pension funds and insurance

¹ On 19 June 2020 the Bank of Russia cut the key rate by 100 bps as disinflationary factors have been more profound than expected due to longer duration of restrictive measures in Russia (aimed at preventing the spread of COVID-19) and financial stability risks related to the situation in global financial markets have declined.

companies) that have normative minimum long-term returns on investments. In the context of declining market nominal rates and rigid contracts, they have to reallocate funds to riskier assets with the necessary returns. In addition, high target rates of return may be explained by the concept of money illusion and the significant lag in adjusting expectations after periods of high market rates. Thus, this direction of the risk-taking channel's impact will be efficient during a period of lower inflation and market nominal rates accompanied by a large enough difference between expected returns in previous and future periods.

Third, the policy of national Central Banks should also be considered – namely, the degree of economic agents' trust in a declared policy of the Central Bank. As the transparency of the Central Bank's actions grows, uncertainty in the economy decreases leading to lower risk premiums and further stimulating the process of revision of attitudes toward perception of risks and risk tolerance.

2.1. Empirical foreign research

Recent years have seen the emergence of quite a lot of empirical studies that test various hypotheses about the risk-taking channel. All research in this area can be divided into two large groups by the data used: 1) complete data on each bank, including databases on loan applications and their outcomes, and 2) data at the level of banks (financial statements).

Researches of the first group include that of Bonfim and Soares (2018), which used panel data at the bank-company² level in Portugal for 1999–2007. The application of different econometric methods, such as difference-in-differences, survival analysis, and the binary selection model, leads the authors to draw the following conclusions.

Bonfim and Soares (2018) demonstrate that when interest rates are low, banks take on more risk, but only in extensive terms – that is, new borrowers or borrowers with poor credit histories have greater chances of obtaining loan approval. This effect is stronger for less-capitalised banks. Similar results were previously obtained in the paper of Buch et al. (2014), where a Factor-Augmented Vector Autoregressive (FAVAR) model is applied to the US data for 1997–2008 to show that smaller banks significantly increase lending to risky borrowers in response to rate cuts while not increasing their risk premium but additionally insuring against losses by tightening contract terms (for example, introducing stricter requirements for loan collateral).

Bonfim and Soares (2018) also find some confirmation for the search for yield mechanism. Banks with large liquidity reserves are more susceptible to taking risks. We can assume this is due to failures in the incentives of managerial control of excess risk in the pursuit of higher profit (Altunbas et al., 2014; Acharya and Naqvi, 2012).

² Main source: Portuguese Central Credit Register (CRC).

In addition, when tracking loans issued over time, Bonfim and Soares (2018) revealed that loans approved during periods of consistently low interest rates had greater sensitivity to interest rate growth. Thus, banks take on a greater credit risk when expecting low interest rates over a certain horizon, and this risk is realised if the rates unexpectedly rise.

While examining the efficiency of the risk-taking channel, Bonfim and Soares (2018) controlled the heterogeneity of companies. However, taking into account the characteristics of borrowers shows mixed results, and their interpretation depends on the approach used. For example, choosing among borrowers with recent default banks are likely to grant loans to big companies. But if we consider loans to new borrowers to be riskier, then the priority is given to small companies. These results seem quite intuitive.

Jiménez et al. (2014) test the existence of the risk-taking channel using data on Spanish banks for 2002–2009, including a database on loan applications and their outcomes. The authors test the hypothesis that a decrease in short-term (overnight) rates results in banks taking on greater risks in lending by using a two-step assessment: the first step is analysing the probability of receiving loan approval from a bank, and the second step is assessing the volume of loans issued for approved applications. This empirical strategy makes it possible to assess both the qualitative and quantitative increases in banks' risk-taking. The estimates obtained support the hypothesis. Furthermore, the authors show that low short-term nominal rates make less-capitalised banks more likely (compared to well-capitalised banks) to approve significant loans to high-risk companies without sufficient collateral, meaning a high probability of future defaults on such loans.

Dell'Ariccia et al. (2017) assess the impact of interest rate cuts on banks' risk taking based on the US loan data for 1997–2011. The authors use the credit rating of banks' loan portfolios as their main measure of risk.

In several above-mentioned papers, the efficiency of the risk-taking channel is tested on data for the EU countries, thus, minimizing possible bilateral cause-and-effect endogeneity, as the impact of the economic conditions in an individual country, on the decision-making of the European Central Bank should be negligible.

To avoid endogeneity concerns for the US data, Dell'Ariccia et al. (2017) take the following steps. First, they limit sampling to states with economic cycles showing little correlation to the overall US cycle as their economic environment is less likely to affect monetary policy. Second, the authors replace the variable interest rate with the difference between the actual Central Bank rate and the rate under the Taylor rule so that financial stability considerations are taken into account indirectly, as long as they affect monetary conditions through their impact on macroeconomic conditions. Third, the authors test the results for robustness when excluding from the observation the crisis periods characterised by possible increased impact of financial stability on monetary policy.

As a result, Dell'Ariccia et al. (2017) conclude that banks take on more risk³ when short-term interest rates are low. At the same time, well-capitalised banks are more sensitive to such policies, which is consistent with the leverage theory but diverges from the empirical results of Bonfim and Soares (2018).

The dependence of the risk-taking channel's efficiency on the phase of the economic cycle in the country is tested in the paper of Fève et al. (2018) based on the US data for 1961–2015. To separate the direct impact of monetary policy shocks on aggregate output from the indirect effect associated with the changing risk attitudes of economic agents, the authors construct a hypothetical prediction of the economy's response to these shocks at fixed risk sensitivity. Comparing forecast data with actual data makes it possible to assess the significance of the risk-taking channel. The paper confirms the hypothesis that during periods of growth and booms in the economy the difference between hypothetical and actual change in output is quite large, while it is negligible in other periods.

The second body of empirical research uses data on banks' financial statements, which are less detailed than the data on loan applications but still make it possible to test the efficiency of the risk-taking channel in national economies.

Özşuca and Akbostancı (2016) study the risk-taking channel in Turkey for 2002–2012. The authors use several alternative indicators for assessing banks' level of risk acceptance. The first is the share of non-performing loans in total loans. This indicator reflects the quality of the bank's assets in terms of potential losses. It is believed that the higher is this share, the riskier is a bank's loan portfolio. However, it should be borne in mind that this indicator is retrospective. The authors also use standard deviation of return on assets and the Z-score, which simultaneously takes into account return on assets, its standard deviations, and the share of equity in assets. Another measure of risk is the Expected Default Frequency calculated by Moody's KMV (one of the divisions of Moody's Analytics). This indicator is used to assess the state of both the entire financial system and individual banks.

Econometric estimates for all discussed indicators show increased risk-taking by banks in response to short-term rates dropping below the Taylor rule benchmark. Control on the individual characteristics of banks shows that well-capitalised and more liquid banks are less likely to take greater risks in response to a policy of low interest rates.

Chen et al. (2017) also use the Z-score to assess banks' individual levels of risk acceptance. It is used to test various hypotheses regarding the efficiency of the risk-taking channel in 29 emerging economies based on unbalanced panel data for 2000–2012. The paper confirms the baseline assumption of a rise in banks' risk-taking in response to short-term interest rate cuts.

³ Risk is understood as the credit rating of new loans.

The research of Chen et al. (2017) on the influence of banking sector concentration on the efficiency of the risk-taking channel deserves special attention. On the one hand, major banks with large market shares have lower costs of information asymmetry, so the variation in the riskiness of their portfolio is quite low. On the other hand, in the most concentrated markets, players use their ability to limit the entry of new participants and generate higher margins, leading to lower incentives for unnecessary risk in pursuit of profit in periods with low interest rates. However, in some cases higher market power, on the contrary, enhances the effect of the regulator's stimulating policies. This happens if a bank considers itself too big to fail and relaxes its risk management controls.

To test the hypothesis of the banking sector structure affecting its sensitivity to low interest rate policy, Chen et al. (2017) discuss three approaches to the assessment of concentration: the Herfindahl-Hirschman Index, the share of the three largest banks by assets and the Boone indicator. The results show a decline in the importance of the risk-taking channel in more concentrated banking markets. Cubillas and González (2014) come to similar conclusions, showing that in advanced economies with strong institutions financial liberalisation policies lead to decreased stability in the banking sector, mainly due to greater competition. However, this effect is minimal in countries with fairly tight capital requirements.

Thus, the risk-taking channel has higher efficiency in response to low interest rate policies in more competitive markets.

2.2. The risk-taking channel in the Russian research

In Russia, the risk-taking channel is little researched. Research on the group of credit channels of monetary policy focuses on the broad bank lending channel – that is, a change in the supply of loans in response to the actions of monetary authorities (Borzykh, 2016a, 2016b, 2017; Perevyshina and Perevyshin, 2015; Zhabina, 2017).

The risk-taking channel is mainly discussed in researches and reviews (Sinelnikova-Muryleva and Ulyankin, 2016; Mogilat, 2017; Mehdiev, 2011; Drobyshevsky et al., 2008). There has been no complete empirical study of the efficiency of this channel. However, some papers on credit channels test separate hypotheses about possible changes in banks' behaviour regarding asset riskiness in response to monetary policy shocks.

For example, Zhabina (2017) confirms that less-capitalised banks are more likely to invest in riskier assets amid low nominal rates, potentially causing an increase in overdue debt.

Borzykh (2016a) also points toward the efficiency of the risk-taking channel in the Russian economy. The analysis of the behaviour of banks in response to higher interest rates in the economy identified a group of banks that demonstrated

a significant drop in lending volumes and an increase in funds in liquid assets and the money market, thus showing lower risk tolerance.

2.3. Key findings of existing research

Studies that attempt to test the efficiency of the risk-taking channel use two types of data – at the level of loan applications and at the level of banks' financial statements – and highlight several factors affecting the efficiency of this channel:

- the gap between nominal interest rates established by monetary authorities and long-term target rate of return for institutional investors;
- the gap between nominal interest rates established by monetary authorities and similar rates in previous periods;
- the phase of the economic cycle;
- the share of low-capitalised banks;
- concentration in the banking sector.

The efficiency of the risk-taking channel has never been tested on Russian data using methods similar to those employed in foreign studies. At the same time, certain results obtained in the study of the bank lending channel confirm the possible efficiency of the risk-taking channel in the Russian economy.

To test empirically the efficiency of the risk-taking channel in Russia, we can use an approach based on the financial reporting of credit institutions (it is used in the second group of studies described in Section 2.1). The following indicators are applicable as measures of risk: Z-score, standard deviation of return on assets, share of non-performing loans and expected default frequency.

The identification of control variables and specific factors of the efficiency of the risk-taking channel requires a more detailed analysis of the characteristics and key vulnerabilities of the Russian banking sector. This is described in the following section.

3. Stability of the Russian banking sector

Financial instability caused by problems in the banking sector may result from the realisation of one or more of the risks the sector is exposed to. The literature identifies the following risk groups:

- credit risk;
- liquidity risk;
- interest rate risk;
- currency risk;
- market risk.

The risk-taking channel of monetary policy affects the stability of the banking sector mainly through the growth of credit and market risk. Rate cuts lead to

reallocation of assets to riskier instruments with relatively high returns, such as low-quality loans (unreliable borrowers), market financial instruments, or high-risk securities. In this paper, we consider the growth of credit risk in response to monetary policy shocks.

Before building an econometric model to test the efficiency of the risk-taking channel, we need to analyse the Russian banking sector and determine the degree of its exposure to the main threats to financial stability.

Since 2016Q1, the Financial Stability Reviews of the Bank of Russia (see Bank of Russia, 2016) have regularly highlighted interest and credit risks as the most significant risks in the analysis of vulnerabilities of the Russian banking sector.

3.1. Interest rate risk

To assess the level of interest rate risk,⁴ we will look at the difference in the structure of loans and deposits in the banking sector.

Long-term loans (over three years) account for the main share in the volume of retail loans, growing steadily over the last six years from 69% in 2014 to 78% at the beginning of 2020 (see Figure 1). Long-term loans also dominate the structure of loans to non-financial institutions; since 2015, their share in the loan portfolio has consistently exceeded 50%.

Deposits, on the contrary, show a predominance of funds placed for a period of up to one year (see Figure 2). The share of short-term retail deposits increased significantly during 2014–2015 (from 35% to 56%) and continues to consistently exceed 50% (58.8% as of the beginning of October 2019). The share of short-term corporate deposits is even more substantial and has been steadily growing since 2017.

Thus, there is a stable tendency toward bank funding through short-term liabilities with a high proportion of long-term assets. This maturity structure makes the banking sector fairly sensitive to interest rate changes (interest rate risk). If interest rates rise, net interest income will drop as the interest costs of raising short-term deposits will rise, while interest income on existing long-term loans will not increase. Interest rate cuts may result in a substantial volume of applications for refinancing of long-term loans, requiring additional funds to be raised.

The current policies aimed at keeping inflation consistently low as well as key rate cuts and subsequent cuts of market rates on short-term transactions increase the attractiveness of long-term investments with a higher yield. If expectations of lower short-term interest rates and confidence in economic stability persist, longer-term investments will be more attractive, and the above-mentioned imbalance in the banking sector will gradually become less acute.

⁴ Bank of Russia (2013).

Figure 1. Share of loans with over 3-year maturity in total loans, %

Source: Bank of Russia (2020a)

Figure 2. Share of deposits with up to one year maturity in total deposits, %

Source: Bank of Russia (2020a)

3.2. Credit risk

Credit risk arises from the probability of default on contractual obligations by borrowers or counterparties of credit institutions.⁵ In the event of an emergence of a large amount of non-performing loans, a bank will receive less money back and will not be able to pay off deposits to fulfil its obligations. As a last resort, it will have to declare bankruptcy.

To manage credit risk, banks need to monitor a number of indicators:

- capital structure;
- capital adequacy ratio;
- return on assets;
- share of non-performing loans;
- loan loss provisions.

⁵ See Bank of Russia (2015).

Figure 3. Growth in lending volumes, billion rubles

Source: Bank of Russia (2020a)

Figure 4. Households' payment to income ratio, %

Source: Bank of Russia (2019)

The lending market in Russia is trending toward expansion; both retail and corporate loans are growing steadily (see Figure 3). However, the macroeconomic situation in Russia is such that the level of household disposable income is growing more slowly than the volume of received loans, leading to an increasing debt burden (see Figure 4) as an additional risk factor for the banking sector.⁶

In the context of lower interest rates, loans are issued to a wider range of borrowers, both those that already have loans and new borrowers. The new

⁶ In international comparison, the total household debt burden in Russia is relatively low (see <https://data.oecd.org/hha/household-debt.htm>).

loans are also issued to the more unreliable borrowers with a high level of risk as banks' returns on such transactions are higher. The dynamics of the share of non-performing loans during the period of key rate cuts shows a trend toward growth, which may signal an increase in the risk tolerance of credit institutions (see Figure 5 and Figure 6). This risk is more likely to be realised amid negative economic shocks, entailing an even greater increase in the share of non-performing loans in banks' assets. Such a situation occurred as a result of the 2008 and 2015 crises; the peak values of the share of non-performing loans for both individuals and legal entities are shown in Figure 5.

The issuance of loans with a higher level of risk (characterised by borrower rating, value of loan collateral) realised as higher share of non-performing loans and the reduction of return on assets is considered to be a possible unintended consequence of interest rate cuts.

Figure 5. Share of non-performing loans

Source: Bank of Russia (2020a)

Figure 6. Dynamics of the Bank of Russia key rate, %

Source: Bank of Russia (2020b)

This link between rate cuts and growing share of non-performing loans can also be explained by the false correlation that can occur in economic downturns when the monetary policy softens in response to a recession, and, at the same time, the quality of the loan portfolio deteriorates due to the same recession.

It is important to note that the Bank of Russia is taking more and more measures to monitor changes in the amount of lending and the structure of loans, is tightening the regulations on provisions for possible losses, and also consolidated its requirements for the banks in 2019 on how to calculate borrowers' payment to income (PTI) ratio.

3.3. Conclusions on the stability of the Russian banking sector

According to the Financial Stability Reviews of the Bank of Russia ('Risk Map' section; for example, see Bank of Russia, 2016, 2019), the banking sector of Russia is exposed mainly to credit and interest rate risks.

Credit risk is related to counterparties failing to meet their obligations to credit institutions. This risk is mainly realising as an increase in the share of non-performing loans. The growing household debt burden in Russia is an additional factor of credit risk. The volume of issued loans is steadily growing faster than household disposable income. During periods of lower interest rates, the share of non-performing loans increases; its peaks are observed afterward when interest rates go up during crisis events in the economy.

Interest rate risk is caused by an imbalance in the maturity structure of deposits and loans: loans are mainly issued for more than a year, while, on the contrary, deposits are dominated by short-term investments. This structure leads to increased sensitivity of interest income to changes in interest rates.

These risks are typical of the banking sector as a whole, but their impact on individual banks varies. Banks' sensitivity to monetary policy measures depends on banks' resilience to shocks, so in analysing the efficiency of the risk-taking channel it is necessary to control for the maturity structure of assets and liabilities.

4. Econometric modelling of the efficiency of the risk-taking channel

The review of existing empirical research has shown that many economies have a functioning risk-taking channel, and its impact on the economy depends both on the characteristics of economic agents at the micro level and on the overall macroeconomic situation. The efficiency of the risk-taking channel has hardly been tested on Russian data for the past 12 years. Out of the credit channels, the broad bank lending channel and balance sheet channel are the most researched.

The following hypotheses are put forward to test the efficiency of the risk-taking channel in this paper:

1. Reduction of the key interest rate leads to higher risk levels in the banking sector according to *ex post* indicators.
2. Larger banks are less likely to change their attitude to risk in response to interest rate changes, meaning the risk-taking channel is less efficient for larger banks.

4.1. Data sources

Due to the lack of data at the level of loan applications at our disposal, we decided to model the risk-taking channel using data from the financial statements of credit institutions. This method evaluates the effect of interest rate changes on the financial stability of the banking system through the realisation of credit risk.

To verify the existence of the risk-taking channel in Russia, we use the data from the quarterly financial statements of credit institutions for 2008Q1–2019Q4 from the following forms published on the Bank of Russia website:

- turnover balance sheet (form 101);
- the statement of financial performance (form 102);
- information on required ratios (form 135).

Macroeconomic data for each period are taken from the websites of the Bank of Russia and Rosstat.

4.2. Empirical strategy

As a measure of risk-taking in the first group of research models, we use the Z-score, which simultaneously takes into account the return on assets, its standard deviation and the share of equity in assets (Özşuca and Akbostancı, 2016; Chen et al., 2017; Laeven and Levine, 2009; Houston et al., 2010; Demirgüç-Kunt and Huizinga, 2010).

The Z-score is calculated according to the following formula:

$$Z_i = \frac{ROA_i + \frac{E}{TA_i}}{\sigma(ROA_i)},$$

where ROA is the return on assets, E is the equity of the company, TA is the total assets of the company, and $\sigma(ROA)$ is the standard deviation of return on assets.

The Z-score is a proxy for the likelihood of a negative shock affecting profits that may lead to default (Yeyati and Micco, 2007). The lower this figure, the higher the risk of default. The standard deviation of return on assets is

calculated with a time window of three years (Schaeck et al., 2011; Özşuca and Akbostancı, 2016; Beck et al., 2013).

The second group of models uses the amount of overdue debt as a measure of risk-taking (*ex post* measure, takes into account the increase in credit risk with a lag). The model uses the natural logarithm of the share of non-performing loans in the bank's credit assets.

The minimal rate on one-week repo auctions is used as an indicator of monetary policy since in accordance with the monetary policy system the Bank of Russia applies this rate to manage liquidity, and in 2013 it was declared as the Bank of Russia key rate (Zhabina, 2017; Perevyshina and Perevyshin, 2015).

The considered time interval has episodes of both rises and cuts of the key interest rate; however, there are more periods of gradual decrease in the key interest rate; therefore, the results obtained in the paper are mainly interpreted for key interest rate cuts.

Several approaches are considered for inclusion the key rate in the regressions. The main and simplest approach is to include the first differences of key rate in the regression. However, the literature also deals with deviations of the real monetary policy rate from the equilibrium real interest rate or deviations of the nominal rate from the rate calculated under the Taylor rule. The Hodrick-Prescott filter is used to identify GDP trends (Altunbas et al., 2014).

This paper uses simultaneous inclusion of both the first differences of the key interest rate and the difference between the key rate and the Taylor rule rate (Altunbas et al., 2014; Özşuca and Akbostancı, 2016). The Taylor rule rate for Russia is calculated in a manner similar to that in Fedorova et al. (2015).⁷ Since such an empirical strategy has its limitations (e.g. possible multicollinearity of interest rate variables), for stability testing purposes this paper additionally evaluates regressions where variables are included in the equation not simultaneously but separately. This does not change the main conclusion on the efficiency of the risk-taking channel in Russia.

Based on the 2008–2019 quarterly data, using the non-linear least squares technique, we estimate the following empirical model, which is a variation of the Taylor rule:

$$\hat{i}_t = p * i_{t-1} + (1 - p) * (\bar{i} + p_\pi * (\pi_t - \pi^T) + p_y * (Y_t - Y^T)) + \varepsilon_t,$$

where i_t is the nominal key interest rate, %; $\bar{i}$ is the equilibrium nominal key interest rate, %, which is constant; $(\pi_t - \pi^T)$ is the gap between actual inflation and the Central Bank's inflation target, %; and $(Y_t - Y^T)$ is the difference between actual GDP and potential GDP, million rubles. The potential GDP is calculated by smoothing quarterly data using the Hodrick-Prescott filter, which identifies the trend and cyclical fluctuations.

⁷ Until 2013, the Bank of Russia used the refinancing rate as an interest rate instrument.

The first group of control variables included in the regressions is macroeconomic variables reflecting the domestic economic situation. The key variable is GDP quarterly changes or its growth rate. The second group includes individual characteristics of banks. Based on the existing literature (see Table 5 in the Appendix), the model must take into account the capital to assets ratio and the size of the bank. The analysis also includes variables reflecting interest rate risk – specifically, the maturity structure of assets and liabilities.

The unbalanced panel data cover the period from 2008Q1 to 2019Q4. Only 943 (models with Z-score as a dependent variable) or 1,049 (models with the share of non-performing loans as a dependent variable) credit institutions that disclosed financial statements in the period under review are used in modelling (data for the use of lagged variables are not available for all institutions).

4.3. Relationship between financial stability and the Bank of Russia's policy

As discussed in Section 2.1, one of the possible limitations for testing the impact of monetary policy on banks' risk-taking is potential endogeneity due to the bilateral cause-and-effect. The question is whether considerations of financial stability affect the Bank of Russia's interest rate policy.

According to the information on the Bank of Russia website, 'together with price stability, the Bank of Russia also seeks to maintain a stable functioning and development of the banking sector, financial market and payment system, which form an essential basis for conducting an efficient monetary policy and for achieving the inflation targets over the long-term perspective'.⁸

The Bank of Russia identifies the following instruments for increasing financial stability:⁹

- risk weight add-ons;
- PTI ratio;
- the national countercyclical capital buffer.

Risk weight add-ons are set for individual asset categories to increase banks' loan loss reserves. This measure allows for efficient and flexible regulation of lending in the riskiest segments and improvement of financial stability.

PTI is 'the ratio of the borrower's average monthly payments on all loans and borrowings, including the newly issued loan, to their average monthly income'.¹⁰ Starting from 1 October 2019, the Bank of Russia obliged credit institutions to calculate PTI ratio for establishing additional risk weight add-ons for unsecured consumer loans.

⁸ See http://old.cbr.ru/eng/DKP/about_monetary_policy/main-objective-and-principles/

⁹ See <https://cbr.ru/finstab/instruments/> [in Russian].

¹⁰ See <https://cbr.ru/finstab/instruments/pti/> [in Russian].

The national countercyclical buffer is an addition to capital adequacy requirements that enables the formation of a capital buffer for easier passage through the phases of the economic cycle due to smoothing.¹¹ During lending expansion and high growth rates, the Bank of Russia can set an additional non-zero buffer for capital accumulation. In an economic downturn, this buffer can be used to stimulate lending and, through it, the real sector.

All these instruments are used to improve resilience of credit institutions to crisis events by maintaining the required levels of capital adequacy. They do not generally imply any changes in the key rate aimed at improving the stability of the financial sector. Exceptions can be made for major crisis events.¹²

All of the above suggests minimal risk of bilateral cause-and-effect endogeneity in recent years when the Bank of Russia started extensively using the above-mentioned instruments. However, our analysis uses a significantly longer time interval that includes periods of crisis events (2008–2009, 2015–2016), so we should not ignore the risk of endogeneity but rather use a model modification that takes it into account.

The Generalised Method of Moments (GMM) enables us to control for endogeneity on the panel data that our study is based upon. This method was first described by Holtz-Eakin et al. (1988) and Arellano and Bond (1991) and further improved by Arellano and Bover (1995) and Blundell and Bond (1998). As part of the research on the risk-taking channel, the GMM version from Arellano and Bover (1995) is applied in Altunbas et al. (2014) and Özşuca and Akbostancı (2016). To deal with endogeneity concerns, this method uses lagged dependent variables as instrumental variables.

4.4. Modelling the risk-taking channel

To test the efficiency of the risk-taking channel on Russian panel data, we estimate a number of regressions that allow us to identify the effect of lower rates on the level of risk-taking by banks. The method of Arellano and Bover (1995) is used for the estimation.

The basic version of the model (1) is as follows:

$$\begin{aligned} risk_{it} = & \alpha + \beta * risk_{it-1} + \sum_{k=0}^2 \gamma_k * \Delta KLR_{t-k} \\ & + \sum_{k=0}^2 \delta_k * GAPTeyl_{t-k} + \sum_{k=0}^2 \eta_k * \Delta LogGDP_{t-k} + \varepsilon_{it}, \quad (1) \end{aligned}$$

¹¹ See https://cbr.ru/Content/Document/File/51191/160309_in-05-35_11_e.pdf

¹² Since financial stability ultimately affects both employment and price levels, monetary authorities may take it into account when setting the rate.

where $i = 1 \dots N$, $t = 1 \dots T$ (N is the number of banks in the sample, T is the last quarter in observations), *risk* is the measure of bank risk used in the model; *KLR* is the key rate, %; *GAP_{Teyl}* is the difference between the key rate and the rate calculated under to the Taylor rule for Russia, %; and *GDP* is the nominal GDP, million rubles.

The coefficients before the variables ΔKLR and *GAP_{Teyl}* make it possible to identify the effects of the change in interest rates and the difference between the nominal rate and the Taylor rule rate on the level of bank risk.

The maximum lag in the model is a second-order lag since while testing different lags it was discovered that until the second order lags there is an increase in absolute terms of significant coefficients before variables reflecting monetary policy. The higher-order effects are significantly weaker.

We also estimate models that take into account individual characteristics of banks (models (2) and (3)) and the level of market concentration (4).

$$\begin{aligned} risk_{it} = & \alpha + \beta * risk_{it-1} + \sum_{k=0}^2 \gamma_k * \Delta KLR_{t-k} \\ & + \sum_{k=0}^2 \delta_k * GAP_{Teyl}_{t-k} + \sum_{k=0}^2 \eta_k * \Delta LogGDP_{t-k} \\ & + \zeta * GAP_{LogA}_{t-2} + \theta * GAP_{CAP}_{t-2} + \varepsilon_{it}, \quad (2) \end{aligned}$$

$$\begin{aligned} risk_{it} = & \alpha + \beta * risk_{it-1} + \sum_{k=0}^2 \gamma_k * \Delta KLR_{t-k} \\ & + \sum_{k=0}^2 \delta_k * GAP_{Teyl}_{t-k} + \sum_{k=0}^2 \eta_k * \Delta LogGDP_{t-k} \\ & * GAP_{LogA}_{t-2} + \theta * GAP_{CAP}_{t-2} + \vartheta * GAP_{LongCred}_{t-2} \\ & + \varphi * GAP_{ShortDep}_{t-2} + \varepsilon_{it}, \quad (3) \end{aligned}$$

$$\begin{aligned} risk_{it} = & \alpha + \beta * risk_{it-1} + \sum_{k=0}^2 \gamma_k * \Delta KLR_{t-k} + \sum_{k=0}^2 \delta_k \\ & * GAP_{Teyl}_{t-k} + \sum_{k=0}^2 \eta_k * \Delta LogGDP_{t-k} + \zeta * GAP_{LogA}_{t-2} \\ & + \theta * GAP_{CAP}_{t-2} + \vartheta * GAP_{LongCred}_{t-2} \\ & + \varphi * GAP_{ShortDep}_{t-2} + \psi * HHI_{t-2} + \varepsilon_{it}, \quad (4) \end{aligned}$$

where *A* is the bank's assets in thousand rubles; *CAP* is the ratio of capital to total assets in %; *LongCred* is the share of loans with over 1-year maturity in total loans in %; *ShortDep* is the share of short-term deposits (up to one year) in total deposits in %; and *HHI* is the Herfindahl-Hirschman Index.

All variables reflecting the individual characteristics of banks are multiplied by *GAP_{Teyl}* (indicated by prefix 'GAP' in the definition of variables in

models (2)–(4)) to estimate how sensitive is the impact of the too low/too high interest rate compared to the Taylor rule rate on the level of risk-taking to changes in those banks' characteristics.

The 2nd lags of the variables of individual characteristics of banks and the level of bank concentration are included in the estimated model, as the impulse from the change of the key rate two quarters ago appears to be the strongest in the regression.

The first group of models uses Z-score as a measure of risk for a certain bank. Accordingly, the higher the value of this indicator, the more stable a financial position the bank has in this quarter, meaning its behaviour a few periods ago is likely to have been less risky.

In all models of this group (1)–(4) the hypothesis on the 2nd-order autocorrelation in residuals is rejected and the hypothesis on the 1st-order autocorrelation is accepted. The Sargan test also indicates the exogeneity of instruments since the null hypothesis is accepted at all levels of significance, suggesting the validity of the Arellano and Bover (1995) method's estimates.

In Table 1 of the Appendix, we see positive significant coefficients before the key rate change and the two lags of this change. This means that the key rate cuts in the periods $[-2; 0]$ lead to a lower Z-score and, therefore, to a decline in financial stability of the banking sector measured by the index. This effect of the key rate change in the current quarter can be explained, among other reasons, by the expansion of lending and, therefore, of the bank's assets in absolute terms, resulting in a decrease in ROA and the capital/asset ratio in the short term. At the same time, it is important to note that, if two quarters ago the key rate was below the Taylor rule benchmark, it negatively affects financial stability in the current quarter (delayed effect) and increases the overall negative effect of the lower key rate on the Z-score. Thus, the coefficients before variables ΔKLR and $GAPTeyl$ and their lags jointly reflect the expansion of the volume of issued loans and the increase in the level of risk-taking by banks (the risk-taking channel) in response to an interest rate cut.

The realisation of risk and, accordingly, its identification on the banks' balance sheet data are possible not immediately but with a certain lag, as it is an *ex post* assessment. The greatest effect is observed half-a-year later, which is revealed by higher coefficients before the 2nd lags of variables ΔKLR and $GAPTeyl$.

The directions of the discussed effects are stable when adding variables reflecting the individual characteristics of banks. As shown by the estimation results for models (2) and (3), the effect of the risk-taking channel varies across banks. Major banks are generally more resilient and make fewer high-risk transaction, and the sensitivity of their risk-taking level to interest rate changes is lower.¹³ When looking at the structure of the funds raised, banks with a larger proportion of short-term deposits are on average more exposed to risk due to greater volatility in profits caused by spikes in interest costs in the event of market rate changes.

¹³ It should be stated that this assumption may be untrue in some cases, if large banks take additional risks counting on government support in the case of default (too big to fail).

When the level of market concentration in the banking sector is added to the model, it turns out that a higher *HHI* contributes to improved stability within the sector. This confirms the lesser sensitivity of major banks' risk-taking levels to interest rate changes. The more major stable players there are in the market, the more stable the sector is as a whole, as evidenced by the positive significant coefficient of the *HHI*.

To check the robustness of results, we also built models using data for 2010–2019 – that is, without taking into account the crisis of 2008–2009 accompanied by significant changes in the financial system and monetary policy. Our main conclusion, the confirmation of the efficiency of the risk-taking channel, remains the same (see Table 4 of the Appendix).

The second group of models uses the logarithm of the share of non-performing loans as a measure of risk. This variable presumably directly reflects the impact realisation of risks on lower-quality loans issued in previous periods.

Similar to the models of the first group, the models in this section are estimated by the GMM. Only the 1st-order autocorrelation of residuals is present in the models, and the hypothesis on the 2nd-order autocorrelation of residuals is rejected. The Sargan test again points to the exogeneity of instruments. The results of the models' estimation are shown in Table 2 of the Appendix.

The coefficient of the current change in the key rate in models (2) and (4) loses its significance. This can be explained by the fact that key rate changes in the current quarter do not fully transfer their impulse to the real sector and cause changes in the borrowers' solvency. Therefore, it is more correct to look at the coefficients before the first and second lags of interest rate changes, as they are positive and significant. When considering the share of non-performing loans as a measure of risk, key rate cuts cause a decrease in bank risk and vice versa. When considering models with the Z-score as a measure of risk, the effect is reversed. This difference can be explained by the fact that the Z-score reflects the complex resiliency of banks, and the share of non-performing loans is highly dependent on the increase or decrease in borrowers' solvency due to economic cycle stages and monetary authorities' measures heating up or cooling down the economy.

However, the risk-taking channel efficiency is also confirmed when considering the share of non-performing loans as an indicator of the bank's attitude toward risk. The coefficients of *GAP_{Teyl}-1* and *GAP_{Teyl}-2* are negative and significant, suggesting that if the key rate falls too low relative to the benchmark, the share of non-performing loans grows (with a 1–2 quarter lag). The coefficient of the second lag of difference between the key rate and the benchmark in all four models is greater in absolute value than the coefficient of the first lag. This means that the impulse of the reduction in the key rate to a too low level compared to a Taylor rule rate results in the realisation of the underlying risk in the financial sector two quarters later.

Models (2) and (3) add variables reflecting the individual characteristics of banks multiplied by the difference between the key rate and the benchmark.

The estimation of these models partially supports the findings of the first group of models, where the risk intensity is set by the Z-score. The risk-taking level is heterogeneous across banks; its sensitivity to interest rate changes depends on the size of the bank's assets: the larger the bank, the less excessive risk it is willing to take when the key rate falls too low compared to the benchmark. A negative significant coefficient before the capital asset ratio confirms the resilience of larger banks to risk as their capital to asset ratio is lower than average for the sample.

The coefficients before the shares of long-term loans and short-term deposits in this group of models turned out to be too low in absolute terms, meaning the dependence of the risk-taking channel on the maturity structure of funds is weak.

In model (4) we add the measure of concentration in the banking sector. We get a significant negative coefficient before *HHI* – that is, the higher *HHI*, the lower the share of non-performing loans and, therefore, the higher the level of resilience. This confirms the estimation results obtained for the first group of models with a dependent Z-score variable.

4.5. Discussion of results

As shown above, the estimation results of the effect of key rate cuts on the banking sector's stability vary across the models built with different risk measures as dependent variables. But, in general, both groups of models demonstrate the efficiency of the risk-taking channel – that is, an increase in risk tolerance in the Russian banking sector following excessive key rate cuts. This effect is most pronounced with a two-quarter lag. In models using Z-score as the measure of risk, the key rate cut adversely affects the stability of the banking sector; if the key rate was below the benchmark two quarters ago, this negative effect is amplified. In modelling the risk-taking channel using the logarithm of the share of non-performing loans as the measure of risk, banks' resilience decreases when the interest rate is below the benchmark. The difference in estimations of the effect of the risk-taking channel between model groups is explained by the specifics of the risk measures used.

It could also be concluded that larger Russian banks have more cautious policies on risk-taking, and their risk appetite does not increase as much as for smaller banks when interest rates are cut. This hypothesis is supported in the two groups of models and corresponds to the results of the studies of the risk-taking channel in other economies (Jiménez et al., 2014; Özşuca and Akbostancı, 2016).

The impact of a bank's exposure to interest rate risk on the efficiency of the risk-taking channel is significant but extremely low in absolute terms. The estimation of the models where the Z-score was used as the measure of risk shows that banks with a large proportion of funds raised for up to one year are more sensitive to interest rate changes in the context of attitudes toward risk.

The level of concentration in the banking sector significantly affects the level of risk-taking by banks. At times of higher concentration in the banking sector,

it is on average more stable and resilient (Chen et al., 2017; Jiménez et al., 2014; Özşuca and Akbostanci, 2016; Cubillas and González, 2014). This once more confirms the conclusion that the risk tolerance of larger more stable banks is less sensitive to interest rate changes.

Regressions with only the key rate change used as the variable of interest reflecting the monetary policy have also been evaluated. The results confirm the efficiency of the risk-taking channel (see Table 3 of the Appendix) and, accordingly, the main conclusion based on the regressions simultaneously using the change in the key rate and its deviation from the Taylor rule rate for Russia. The second lag of the change in interest rate has a positive coefficient, showing that the stronger the key rate cut was two quarters ago, the lower the Z-score is today.

Thus, the analysis of the Russian banking sector confirms the hypothesis on the efficiency of the risk-taking channel in the Russian economy. The impact of this channel on individual banks depends on their characteristics.

5. Conclusion

Based on the data of quarterly reports of banks and data on macroeconomic indicators in 2008Q1–2019Q4, this paper estimates the changes in the level of risk-taking by banks in response to key rate changes using the GMM.

Econometric modelling results support the hypothesis that low interest rates lead to riskier behaviour of banks. This conclusion is derived from two groups of models using different variables as the measures of risk: Z-score and the share of non-performing loans.

The efficiency of the risk-taking channel of monetary policy in Russia during the period under review has been confirmed, but there is a difference in the explanation of transmission of the impulse to the banking sector depending on the variable used as the indicator of financial stability. The Z-score models estimation shows that any key rate cut causes a decrease in the banking sector's stability, but the assessment of the models based on the share of non-performing loans demonstrates that such excessive risk-taking is only detected when the interest rate is below the Taylor rule benchmark.

In addition, the paper confirms the lower interest rate sensitivity of risk-taking for larger banks with a smaller capital to assets ratio.

The level of concentration in the banking sector has a significant impact on the resilience of credit institutions. The higher is the concentration – that is, the more major banks there are, the higher is the stability of the banking sector as assessed via Z-score or the share of non-performing loans.

The results are consistent with the preliminary analysis of trends in the Russian banking sector compared to the pursued monetary policy and the stages of business cycle.

The impact of the individual characteristics of banks and the level of concentration in the banking sector on the efficiency of the risk-taking channel is similar to the results of foreign studies of this channel based on the data of financial statements.

Accordingly, on the basis of the obtained results, we can conclude that the risk-taking channel is functioning in the Russian economy, and the Bank of Russia must take into account the impact of key rate changes on the stability of the banking sector to avoid excessive risk tolerance. Failing that, cyclical recession and realisation of risks might lead to a sharp increase in the share of non-performing loans and the number of defaults in the most vulnerable banks.

The efficiency of macroprudential policy depends on the individual characteristics of banks, so the conditions for the creation of loan loss reserves defined by the regulator differ depending on the size of the bank and the structure of its loan portfolio in terms of maturity and quality of loans.

Further research into the risk-taking channel should focus on examining its efficiency depending on the individual characteristics of banks. Data on loan applications and non-financial conditions will make it possible to take significantly more factors into account and assess changes in risky behaviour at the decision-making stage rather than *ex post*. Such a study would be more accurate and provide even more information for macroprudential policy.

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APPENDIX

Table 1. Risk-taking channel (Z-score)

	Dependent variable: Z-score			
	(1)	(2)	(3)	(4)
<i>Z(-1)</i>	0.660*** (0.000)	0.659*** (0.000)	0.659*** (0.000)	0.641*** (0.000)
<i>Constant</i>	-0.344*** (0.000)	-0.341*** (0.000)	-0.342*** (0.001)	-0.127*** (0.001)
<i>GAPTeyl</i>	-0.885*** (0.001)	-0.889*** (0.001)	-0.881*** (0.003)	-1.630*** (0.003)
<i>GAPTeyl-1</i>	-2.096*** (0.001)	-2.018*** (0.001)	-2.014*** (0.006)	-0.852*** (0.005)
<i>GAPTeyl-2</i>	1.635*** (0.001)	6.276*** (0.006)	6.163*** (0.060)	2.949*** (0.053)
<i>Δ KLR</i>	0.713*** (0.000)	0.652*** (0.001)	0.653*** (0.003)	0.204*** (0.002)
<i>Δ KLP-1</i>	0.005*** (0.000)	0.056*** (0.000)	0.055*** (0.002)	0.314*** (0.001)
<i>Δ KLP-2</i>	0.245*** (0.000)	0.241*** (0.000)	0.239*** (0.002)	0.327*** (0.002)
<i>Δ LogGDP</i>	-17.839*** (0.003)	-17.751*** (0.004)	-17.711*** (0.030)	-9.372*** (0.029)
<i>Δ LogGDP-1</i>	10.818*** (0.003)	10.260*** (0.006)	10.329*** (0.033)	10.401*** (0.032)
<i>Δ LogGDP-2</i>	5.320*** (0.003)	5.424*** (0.004)	5.393*** (0.021)	12.920*** (0.027)
<i>GAPLogA-2</i>		-0.302*** (0.000)	-0.304*** (0.003)	-0.227*** (0.003)
<i>GAPCAP-2</i>		0.016*** (0.000)	0.013*** (0.001)	0.033*** (0.001)
<i>GAPLongCred-2</i>			0.000*** (0.000)	0.000*** (0.000)
<i>GAPShortDep-2</i>			0.005*** (0.000)	0.002*** (0.000)
<i>HHI-2</i>				44.817*** (0.059)
Observations	26,381	26,381	26,381	26,381
Test AR(1)	0.000	0.000	0.000	0.000
Test AR(2)	0.568	0.596	0.570	0.828
Sargan test	0.843	0.846	0.930	0.939

Note: * p < 0.1; ** p < 0.05; *** p < 0.01.

Table 2. Risk-taking channel – share of non-performing loans

	Dependent variable: <i>LogNPL</i>			
	(1)	(2)	(3)	(4)
<i>LogNPL</i> (-1)	0.689*** (0.000)	0.686*** (0.001)	0.685*** (0.002)	0.687*** (0.002)
<i>Constant</i>	-0.016*** (0.000)	-0.017*** (0.000)	-0.015*** (0.000)	-0.016*** (0.000)
<i>GAPTeyl</i>	0.018*** (0.000)	0.018*** (0.000)	0.016*** (0.001)	0.019*** (0.001)
<i>GAPTeyl</i> -1	-0.021*** (0.000)	-0.025*** (0.001)	-0.022*** (0.002)	-0.023*** (0.002)
<i>GAPTeyl</i> -2	-0.081*** (0.001)	-0.234*** (0.001)	-0.220*** (0.012)	-0.212*** (0.012)
Δ <i>KLR</i>	-0.002*** (0.000)	0.000 (0.000)	-0.001*** (0.001)	0.000 (0.001)
Δ <i>KLP</i> -1	0.010*** (0.000)	0.008*** (0.000)	0.008*** (0.001)	0.007*** (0.000)
Δ <i>KLP</i> -2	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
Δ <i>LogGDP</i>	-0.100*** (0.001)	-0.103*** (0.003)	-0.098*** (0.010)	-0.120*** (0.011)
Δ <i>LogGDP</i> -1	-0.253*** (0.003)	-0.234*** (0.004)	-0.238*** (0.014)	-0.252*** (0.015)
Δ <i>LogGDP</i> -2	0.297*** (0.002)	0.292*** (0.003)	0.287*** 0.010	0.253*** 0.011
<i>GAPLogA</i> -2		0.010*** (0.000)	0.010*** (0.001)	0.010*** (0.001)
<i>GAPCAP</i> -2		-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
<i>GAPLongCred</i> -2			0.000 (0.000)	0.000 (0.000)
<i>GAPShortDep</i> -2			0.000 (0.000)	0.000 (0.000)
<i>HHI</i> -2				-0.170*** (0.028)
Observations	22,361	22,361	22,361	22,361
Test AR(1)	0.000	0.000	0.000	0.000
Test AR(2)	0.145	0.150	0.141	0.148
Sargan test	0.999	0.999	0.999	0.999

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3. Risk-taking channel (Z-score).
Use of the key rate only to reflect
the stance of monetary policy

	Dependent variable: Z-score	
	(1)	(2)
<i>Z</i> (-1)	0.702*** (0.000)	0.690*** (0.000)
<i>Constant</i>	0.086*** (0.000)	0.307*** (0.000)
Δ <i>KLR</i>	-0.044*** (0.003)	-0.059 (0.000)
Δ <i>KLP</i> -1	-0.053** (0.000)	-0.047*** (0.000)
Δ <i>KLP</i> -2	0.219*** (0.000)	0.280*** (0.000)
Δ <i>LogGDP</i>	-18.814*** (0.003)	-23.035*** (0.003)
Δ <i>LogGDP</i> -1	-1.074*** (0.003)	-1.741*** (0.004)
Δ <i>LogGDP</i> -2	-5.291*** (0.002)	-6.426*** (0.003)
<i>GAPLogA</i> -2		-0.007*** (0.000)
<i>GAPCAP</i> -2		0.003*** (0.000)
<i>Log_A</i>		0.209*** (0.001)
<i>CAP</i>		0.600*** (0.000)
Observations	26,381	26,381
Test AR(1)	0.000	0.000
Test AR(2)	0.738	0.561
Sargan test	0.784	0.796

Table 4. Risk-taking channel (Z-score),
2010–2019

	Dependent variable: Z-score	
	(1)	(2)
<i>Z</i> (-1)	0.759*** (0.001)	0.753*** (0.001)
<i>Constant</i>	-0.020*** (0.002)	0.060*** (0.002)
<i>GAPTeyl</i>	1.062 *** (0.017)	1.196*** (0.020)
<i>GAPTeyl</i> -1	-3.252*** (0.022)	-3.301*** (0.026)
<i>GAPTeyl</i> -2	1.813*** (0.016)	3.548*** (0.121)
Δ <i>KLR</i>	-0.014** (0.005)	-0.004 (0.006)
Δ <i>KLP</i> -1	-0.890*** (0.007)	-0.934*** (0.008)
Δ <i>KLP</i> -2	0.994*** (0.006)	0.976*** (0.007)
Δ <i>LogGDP</i>	-31.410*** (0.120)	-31.913*** (0.134)
Δ <i>LogGDP</i> -1	-1.186*** (0.111)	-1.884*** (0.120)
Δ <i>LogGDP</i> -2	-12.426*** (0.0638)	-12.777*** (0.076)
<i>GAPLogA</i> -2		-0.098*** (0.007)
<i>GAPCAP</i> -2		-0.006*** (0.001)
<i>HHI</i> -2		-8.955*** (0.230)
Observations	22,793	22,793
Test AR(1)	0.000	0.000
Test AR(2)	0.668	0.792

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 5. Research on the risk-taking channel

Efficiency factors	Impact	Loan application data	Financial statement data
Bank size	Larger in size – smaller change in risk appetite	Buch et al. (2014) – USA; Bonfim and Soares (2018) – Portugal; Jiménez et al. (2014) – Spain	Özşuca and Akbostancı (2016) – Turkey
	Reverse effect	Dell’Ariccia et al. (2017) – USA	
Liquidity	More liquidity – greater change	Bonfim and Soares (2018) – Portugal	Özşuca and Akbostancı (2016) – Turkey
Stage of the economic cycle	In anticipation of low rates and boom, efficiency is higher	Bonfim and Soares (2018) – Portugal; Fève et al. (2018) – USA	
Concentration in the banking sector	More concentrated – lower average risk level		Özşuca and Akbostancı (2016) – Turkey; Chen et al. (2017); Cubillas and González (2014)