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Bank Risk-Taking Behavior during a Prolonged Low Interest Rate Era: The Case of Thailand

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ABSTRACT

The objective of this study was to investigate the impact of prolonged expansionary monetary policy upon bank risks in Thailand. The data comprised balance sheets for 19 commercial banks from the first quarter of 2001 to the first quarter of 2019. The study hypothesized that prolonged low interest rates could impact the bank sources of liability-side funding, leading to leverage, and that different-sized banks may react differently. The results from a two-stage procedure showed that banks may borrow more to invest in risky projects if investment sensitivity to leverage has an inverse relationship with the prolonged low interest rate. This study used a fixed effects model to compare three risk proxies and justified the usage of leverage as a risk measure. These findings indicated that small- and medium-sized banks tended to take more risks than large banks. The final section used quantile regression to analyze the interest rate impact and other variables upon different levels of bank risks. The results indicated that different-sized banks responded differently to various variables under low-interest rate conditions.

Keywords: prolonged low interest rate, leverage, risk, two-stage procedure, quantile regression

Introduction

After the Great Recession in the United States (US) from December 2007 to June 2009, researchers argued that lower interest rates before economic crisis may increase the risk of economic problems, especially for banks which reduce the lending standard and invest money in high-return assets. Claudio Borio and Haibin Zhu (2012) refer to this impact as a risk-taking channel of monetary policy, influencing banking institution intent to search for revenue by taking

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more risk. Eventually the situation is aggravated when banking system risks translate into losses transmitted to the real sectors. Fundamentally, policy interest rates can impact risk-taking behavior of commercial banks in two ways. First, low-interest rates cause commercial banks to reduce lending standards, restarting an expanding number of low-quality loans that lead to an increase in non-performing loans. Second, as a low-interest rate policy continues, interest rates on deposits cause depositors to adjust their portfolios by switching from cash to other assets that yield higher return rates. Commercial banks facing lower deposits would then try to maintain revenue by raising leverage. These banks would create debt and invest in high-return assets. Basically, higher returns can be achieved by high-risk investing. This is the reason banks wind up taking more risk to face prolonged low interest rates in search of higher yields. Plotted data on small- and medium-sized bank, as well as large bank, during the studied period confirmed the original hypothesis. The purpose of this paper was to analyze commercial bank risk-taking channels in Thailand. Second, this paper also attempted to verify that small- and medium-sized bank risk-taking behavior differed from that of large-sized banks during times of prolonged low interest rates.

Literature Reviews

Considerable research examines bank risk-taking behavior during long-duration expansionary monetary policies. In the literature, determining factors of risk-taking behavior of commercial banks include non-performing loans (NPLs) to total loans, the ratio of NPLs to total loans, risk-weighted asset (RWA) to total assets, and capital adequacy ratio (CAR). Some balance sheet items are used as explanatory variables of risk, such as asset, deposit, loan, and liquidity. In addition, macroeconomic variables including gross domestic product (GDP) growth, inflation, and bank characteristics such as the Herfindahl-Hirschman Index (HHI) and bank size were also used as explanatory variables.

Ramayandi et al. (2014) studied annual panel data and quarterly data of publicly listed commercial banks in ten Asian countries from 2000 to 2011, finding that prolonged low interest rates may cause banks to take more risk. Ratanavararak and Ananchotikul (2018) studied the impact of prolonged low interest rates on bank profitability and bank risk-taking behavior by using panel regression analysis. They found that an easy money policy may tend to reduce bank profits, especially for small banks. The profit reduction was realized by decreasing net interest income. In addition, they found that low interest rates may also cause higher loan default risk and lower quality loans in small- and medium-sized banks. Andries et al. (2015) studied the

impact of prolonged easy money policy on bank risk-taking behavior. They found reversed relationships between interest rates and bank risk-taking behavior. Paligorova and Santos (2012) studied loan pricing of commercial banks in the US by using two decades of surveyed data. Loan pricing policy according to monetary policy changes, was hypothesized as a crucial factor in inducing bank risk-taking behavior. Chang and Tally (2017) used bank-level data such as net interest income (NII) growth rate, and net non-interest rate income (NNI) growth rate in US commercial banks and macroeconomic data. Results were that banks, especially large banks, tended to invest in risky projects with higher expected rates of return during times of low interest rates. Cecchetti et al. (2017) examined the impact of a prolonged easing monetary policy upon risk-taking behavior, concluding that a leverage ratio yielded identical consequences as other risk proxies and proxies of financial weaknesses. During times of prolonged low interest rates, both bank and non-bank leverage ratio increased.

These reviewed papers, mostly found evidence of reverse relationships between low interest rates and bank risk-taking behavior. This study hoped to identify further convincing empirical evidence from Thailand about the impact of prolonged low interest rates on bank risk-taking behavior. A fixed effects model was used to compare factors affecting risk, proxied by different measures, to justify leverage use as risk proxy. Later, the data was divided into two subperiods, precrisis and postcrisis, and a two-stage procedure was employed to determine the sensitivity of bank leverage during the precrisis and postcrisis, whether depending upon policy rate, uncovered interest rate parity (UIP), HHI or inflation. Finally, quantile regression (QR) was employed to analyze heteroscedasticity of banks in different quantiles.

Research Methodology

From 2011 to 2019, Thailand had sustained low interest rate. This low interest rate policy was used to accommodate capital inflow resulting from US, Japanese, and European Union (EU) national expansionary monetary policies. Low interest rate caused bank lending to rise at decreasing rates compared to traditional levels. This caused commercial bank interest income to decline. To maintain revenue, banks were obliged to borrow money to invest in high-yield risky assets or invest in risky projects. Was this line of reasoning correct under a prolonged low interest rate policy? This paper used three proxies of risk to examine relevant factors affecting risks. A fixed effects model was used to examine whether a prolonged low interest rate or extended easy money policy caused banks to take more, and different types of, risks. This paper

followed Andries et al. (2015), Ratanavararak and Ananchotikul (2018), and Cecchetti et al. (2017) in using the following three risk proxies:

Table 1 Different Risk Proxies

Variables used as financial risk proxies	**Definition**
Capital adequacy ratio	Total reserve to risk asset ratio: Increase in this ratio reflects declining bank risk and vice versa.
Leverage ratio	Liability without deposit to total asset ratio: Increase in leverage ratio induces banks to invest in risky asset or take on
Loan loss provision to total loan	Reserve for potential loss loan to total loan: Higher ratio of loan loss provision ratio reflects lower risk and vice versa.

This study used quarterly bank level data for 19 commercial banks in Thailand from 2001Q1 to 2019Q1. There were three measures of risk variable: capital adequacy ratio or total reserve funds to weighted asset risk; loan loss provision or loan loss reserve provision to total loan; and leverage ratio or bank liability. Nonperforming loans (NPLs) to total loan were not used as a measure of risk because during times of low interest rates, NPL value decline significantly and remain at low levels. After the 2009 US economic crisis, Thai commercial bank NPLs remained at a consistently low level. This study followed the work of Paligorova and Santos (2012) in identifying factors determining risk level. In equation (1),

$$Risk_{i,t} = \delta_t + \beta_1 Risk_{it-1} + \beta_2 Policyrate_{it} + \beta_3 Lowrate_{it} + \beta_4 BankChar_{it-1} + \beta_5 Macro_{it} + \eta_i + \varepsilon_{it} \quad (1)$$

$Risk_{it}$ is risk of bank i at time t. $Lowrate_{it}$ is a dummy variable equal to 1 when the effective policy rate at time t, the time when lending occurs, is less than the average rate during the study period. This average rate is the average rate from sample, with top and bottom 20 percent eliminated. Otherwise, the dummy variable low rate value equals 0. The low rate dummy variable serves the purpose of determining whether banks would take more or less risk during times of prolonged low interest rates. $BankChar_{it-1}$ is idiosyncratic characteristics of bank i at time t-1 that may impact risky behavior among small, medium, and large-sized banks.

Period t-1 is used to avoid collinearity problems from the fact that bank balance sheet variables may be collinear with one another. $Macro_{it}$ represents control variables from

macroeconomic data such as HHI, inflation. η_i is unobserved bank-specific effects. ε_{it} is the time varying error, $\varepsilon_{it} \sim iid(0, \sigma_\varepsilon^2)$ where δ_t is the time-specific effect.

Table 2 List of Variables

List of Variables	Description
Risk	Capital adequacy ratio, loan to deposit, and loan loss provision to gross
Asset	Log of total assets
Liquidity Ratio	Ratio of liquid assets to total assets
Equity Ratio	Ratio of total shareholder equity over total assets
Deposit	Ratio of deposits to total assets
Policy Rate	Policy rate
Low Rate	= 1 if policy rate is lower than average (eliminating the top and bottom 20%)
Gdp Growth	Growth rate of Quarterly GDP
Inflation	Consumer price index (CPI) growth
Hhi	The banking sector Herfindahl-Hirschman Index as calculated by the author.

1. Investment sensitivity under prolonged low interest rates

Chang and Tally (2017) found that during times of low interest rates, commercial banks have an incentive to invest more for higher expected returns. This section hypothesized that commercial banks intended to use leverage,[2] or risky sources of funds, to invest in assets that are atypical loans, with the aim of acquiring expected high returns during times of low interest rates. This section employed a two-stage procedure developed by Kashyap and Stein (2000), further refined by Cetorelli and Goldberg (2012a) and Cao and Dinger (2018).

The first stage began by estimating equation (2).

$$\Delta \text{investment}_{i,t} = \sum_{j=1}^{m} \alpha_{i,j} \Delta \text{investment}_{i,t-j} + \beta_t X_{i,t-1} + \gamma_t \text{Controls}_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

$\Delta \text{investment}_{i,j}$ represents investment growth of bank i at time t. One risk proxy was chosen from among three to represent bank risk. $X_{i,t-1}$ is a liability that is not a deposit of bank i at time t. $\text{Controls}_{i,t-1}$ is an idiosyncratic characteristic relating to bank i investment at time t, such as liquid assets to total asset ratio, equity to total asset ratio and log of total assets. ε_{it} is the time-varying error term for bank i at time t. For bank characteristics, a lag term is used to

[2] In this case, leverage is deposit liability.

avoid the endogeneity problem, as investment growth during period t may be collinear with some bank characteristics in period t.

The number of investment change lags, $\Delta investment_{i,t-j}$, is chosen by panel data structure optimal autoregressive distributed lag (ARDL). By setting m equal to 4 and estimating equation 1 with a cross-sectional model for each t, a series of β_t were obtained. Value of β_t represents bank investment sensitivity to bank leverage at different time t.

At the second stage, equation (3) is estimated.

$$\beta_t = \delta_0 + \sum_{j=1}^{n} \delta\, r_{t-j} + \sum_{j=1}^{n} \lambda\, UIP_{t-j} + \eta Controls_{i,t} + u_t \quad (3)$$

r_{t-j} is the variable representing monetary policy such as interest rates; UIP_{t-j} represents foreign factors, such as access to foreign funds. The number of lag j is chosen by the Akaike information criterion (AIC) from the total number of four lags.

The estimation of equation 3 adopted the method suggested by Cetorelli and Goldberg (2012a) in correcting the autocorrelation problem by using the Newey-West variance estimator with six lags.

If commercial banks used leverage (liabilities that are not deposits) to invest in other assets expected to have higher returns, then banks took higher risks in search for higher yields to compensate for lower interest revenue or revenue from loans resulting from low interest rates. The coefficient β_t, representing risk-taking behavior, could be evaluated for sensitivity to policy interest rates and its lags, foreign factors, and other macro variables. The reverse relationship between β_t and policy rate with lags suggests that during times of low interest rate, β_t is rising, meaning that banks would take more risks as they put more leverage into investment.

The UIP variable representing uncovered interest parity is introduced in this study to capture foreign factors hypothesized to significantly impact monetary policy of a state-owned enterprise (SOE), as in Thailand. If a UIP is realized by investors and banks, the interest rate spread will not affect bank borrowing cost, as interest rate difference will be covered by exchange rate movement. If a UIP is unrealized or there is UIP deviation, investors and banks may still earn revenue from differences in interest rates. Thus, UIP may be used to measure the influence of foreign factors upon bank investment behavior. Increased UIP deviation suggests that banks may earn more profits from overseas, resulting in liquidity that translates to more investment. Since UIP deviation may be caused by the result of investment decisions and

respond to monetary policy, UIP movement is proxied by instrumental variables such as the Chicago Board Options Exchange (CBOE) Volatility Index (VIX), commonly referred to as the fear index or fear gauge, exogenous to the studied system.[3] The proxy is adapted from Rey (2015).

2. Quantile Regression

From Table 2, it is seen that typically, some level of heterogeneity exists among different sized commercial banks. This study employed quantile regression as developed by Koenker and Bassett (1978) and Buchinsky (1994) to investigate the impact of different important factors on different percentiles of risk variable (leverage). Parameters obtained were then compare to those from Ordinary Least Squares (OLS). QR chooses parameter values that have the least absolute deviation or error,

$$\text{Min}\left[(1\text{-}p)\cdot\sum_{\hat{y}_i<\hat{y}_i^p}\left|y\text{-}\hat{y}^p\right| + (p)\cdot\sum_{\hat{y}_i\geq\hat{y}_i^p}\left|y\text{-}\hat{y}^p\right|\right],\ 0<p<1$$

while OLS chooses parameter values that minimize the squared deviation from the mean regression line. Thus, the equation to be estimated is as follows:

$$\begin{aligned} Q(risk) \;=\; & \partial_0(p)risk_{t-1} + \partial_1(p)Policyrate_t + \partial_2(p)Lowrate_t + \partial_3(p)BankChar_{i,t-1} \\ & + \partial_4(p)Lowrate_{t-1}{*}BankChar_{i,t-1} + \partial_5(p)Macro_t \end{aligned} \qquad (4)$$

for all $p \in (0,1)$, where $Risk_{it}$ is the risk proxy of bank i at t. $Policyrate_{it}$ is policy interest rate. $Lowrate_{it}$ is the dummy variable with value 1 when the effective policy rate at the time of bank investment is lower than the average sample interest rate, after eliminating the top 20 and bottom 20 percent. $BankChar_{i,t-1}$ is bank characteristics. $\log(asset)_{i,t-1}$ is bank total assets in a natural log. $Lowrate_{t-1}\cdot BankChar_{i,t-1}$ is the interaction term for low interest rate and bank characteristics at time t-1. This variable is used to measure the impact of variables during low interest rate times at different quantile levels. The term t-1 is used to avoid the endogeneity problem.

[3] Tested by over-identifying restrictions.

Results

1. Fixed effect model

First, for equation 1 with a capital adequacy ratio, loan loss provision to gross loan, and leverage ratio, each variable was used as the dependent variable. Each equation was estimated using the fixed effects model and random effect model and then tested using the Hausman specification test. Results as shown in Table 3 are that each P-value was 0.000, suggesting that a fixed effect was more prevalent than a random effect.

Table 3 Hausman Test

Hypothesis	**Ho: difference in coefficients not systematic**	
Loan loss provision to gross loan	Chi-square (12)	65.45
	P-value	0.000
Capital adequacy ratio	Chi-square (12)	61.90
	P-value	0.000
Leverage ratio	Chi-square (12)	199.46
	P-value	0.000

Table 4 reports the results of the fixed effects model upon three variables. Different risk proxies appear to have different determinants.

Model 1: When capital adequacy ratio was used as risk proxy, policy rate had a positive coefficient and statistical significance of 0.1. That is, when the interest rate rose, the capital adequacy ratio increased, reflecting declining risk. The opposite would be inferred if the interest rate decreased. However, the low rate variable was not statistically significant. Other variables, such as the HHI variable, measuring less competition, and deposits may have impacted the capital adequacy ratio.

Model 2: When loan loss provision was used as risk proxy, low rate environment coefficient was negative with a statistical significance of 0.05. This reflects that during low interest rate, loan loss provisions to gross loan decreased, as compared to normal interest rate levels. It could be concluded that commercial bank risk was higher during a low interest rate environment. HHI and deposits may positively impact loan loss provision.

Model 3: When leverage ratio was used, the interest rate variable coefficient was negative with a statistical significance of 0.05. This indicates that when the interest rate declined, banks had more liability, meaning that banks had higher risk. HHI coefficient was negative with a statistical significance of 0.01, meaning that with less competition, commercial banks would take

more risk and vice versa. For bank assets during prolonged times of low interest rates (Low rate·log (asset)), banks with more assets tended to take more risks. Three models shared certain aspects of conclusions that prolonged interest rates positively impacted risk-taking behavior. During times of prolonged low interest rates, small-sized banks had less reserves for loan loss than large-sized banks. Given that there was no change in interest rate, small-sized banks had more loan loss provision than larger banks. Overall, extended expansionary monetary policy tended to impact commercial bank risk-taking behavior. However, different sized banks tended to respond differently to prolonged low interest rates. Evaluating each proxy of risk, a capital adequacy ratio was more suitable for large-sized banks, while leverage was more appropriate for small-sized banks. This is because different-sized banks have diverse sources of funding. Large-sized banks have more branches, including foreign branches. As a result, they were able to raise more deposit than small-sized banks. Competing for profit, small-sized banks were obliged to raise funds by borrowing and bond selling, creating higher risk on the liability side. If this line of reasoning is correct, the result that the log deposit was less influential on the leverage ratio than the loan loss provision ratio and capital adequacy ratio would suggest that the log deposit had less impact upon small-sized banks. Thus, the choice of risk proxy depends upon what type of risk is most suitable.

Table 4 Risk determinants for commercial banks in Thailand

Variables	**Model 1**	**Model 2**	**Model 3**
Dependent variable	Capital adequacy ratio	Loan loss provision	Leverage
Independent variables			
Lagged dependent variable	.8925953*** (.0139935)	.8994832*** (.011623)	.7094197*** (.0233852)
Policy rate$_t$	.1070583* (.0587537)	.0134081 (.0113507)	-.0060749** (.0030604)
Liquidity ratio$_{t-1}$	3.027535 (3.078418)	.1834116 (.4238149)	-.0423301***
Low rate*log (asset)	.0062674 (.0267352)	.0113823** (.005179)	.0042507** (.0018302)
R^2	0.7881	0.8742	0.5080
No. of Observations	1184	1195	1367

Note: *, **, *** are significance level at 0.1,0.05 and 0.01.

2. Investment sensitivity during times of prolonged low interest rate

This section analyzed bank investment behavior from 2001Q1 to 2019Q1. A two-stage procedure was employed to capture the impact of prolonged low interest rates upon investment sensitivity to leverage (β) during entire periods. β was calculated for entire periods, then the analysis of determinants of β was divided into two subperiods, precrisis and postcrisis. Results are shown in Table 5.

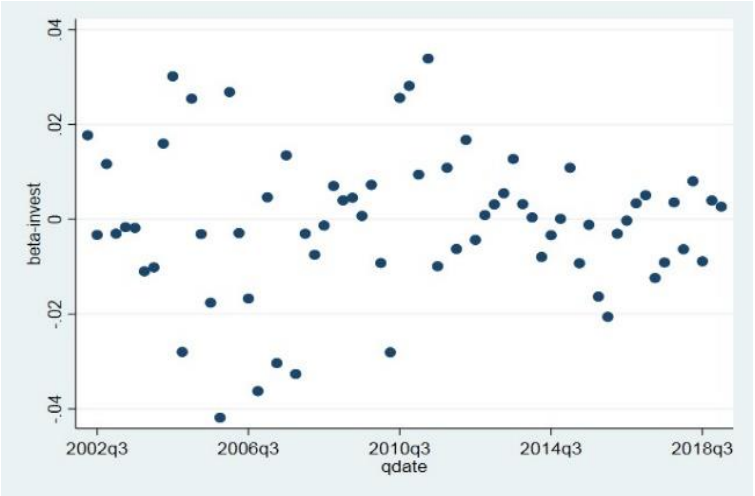

Figure 1 Time series of β

Table 5 Two-stage procedure, Pre- and Postcrisis

Variables	Precrisis β		Postcrisis β	
	Coefficient	P-value	Coefficient	P-value
ΣPolicy rate	.0016613	0.773	-.0078024	0.081
ΣUIP	.0006221	0.117	.0002794	0.006
Yield spread	-.0062177	0.073	.0001608	0.882
GDP growth	-.7106313	0.188	-.0519735	0.539
HHI index	.0027529	0.428	-.0031961	0.557
Cons	-.0093518	0.163	.0169037	0.647
R^2	0.3865		0.5659	
All Observations	665		684	

Policy rate was used as a proxy for the effective rate. The sum of policy rate was the sum of the lagged monetary policy rate. Its coefficient measured the impact of prolonged low interest rates upon β. During the precrisis noted in Table 5, the sums of policy rates and UIP did not impact β, as their coefficients were positive, but statistically insignificant (0.0016613, p-value=0.773 and 0.0006221, p-value=0.117). Inflation coefficient was negative and statistically significant (0.006177, p-value=0.073), suggesting that inflation caused investments to be less responsive to leverage. On the contrary, during the postcrisis, policy rate coefficient was negative, with a statistical significance of .01 (-0.0078024, p-value=0.081). This meant that prolonged low interest rates or continuous policy rate declines may cause β to increase, or may induce banks to increase investments for any increase in leverage. As a consequence, banks would assume even more active risk. The variable ΣUIP, representing the foreign factor, had a positive coefficient with statistical significance of .01 (0.0002794, p-value=0.006). The foreign factor caused investments to be more sensitive to leverage. That is, if banks had more access to foreign funds, they tended to move more of these funds into investment. Other macroeconomic variables did not influence the sensitivity of investment to leverage ratio. Results of the postcrisis suggested that prolonged low interest rates caused commercial banks to change their behavior, by simultaneously taking more leverage and putting a portion of it into investments. Plotted data during the postcrisis demonstrated that the average loan stayed above investments during the times of low interest rates.

3. Quantile Regression

A modified Wald test for groupwise heteroskedasticity was conducted for the fixed effects model in Section 1 on the leverage ratio. Results are shown in Table 6.

Table 6 Heteroskedasticity test

Hypothesis	**H_0: Homoskedasticity**	
leverage ratio	Chi-square (19)	28752.42
	P-value	0.000

The test result accepted the alternative hypothesis of a heteroskedasticity problem for the leverage ratio equation. Thus, the quantile regression was appropriate for analyzing the problem of leverage equation from Section 1. The quantile regression was estimated for large-sized banks as well as small- and medium-sized banks (following Bank of Thailand (BOT) criteria) during the postcrisis. Results are presented in a series of graphs in Figures 2 and 3.

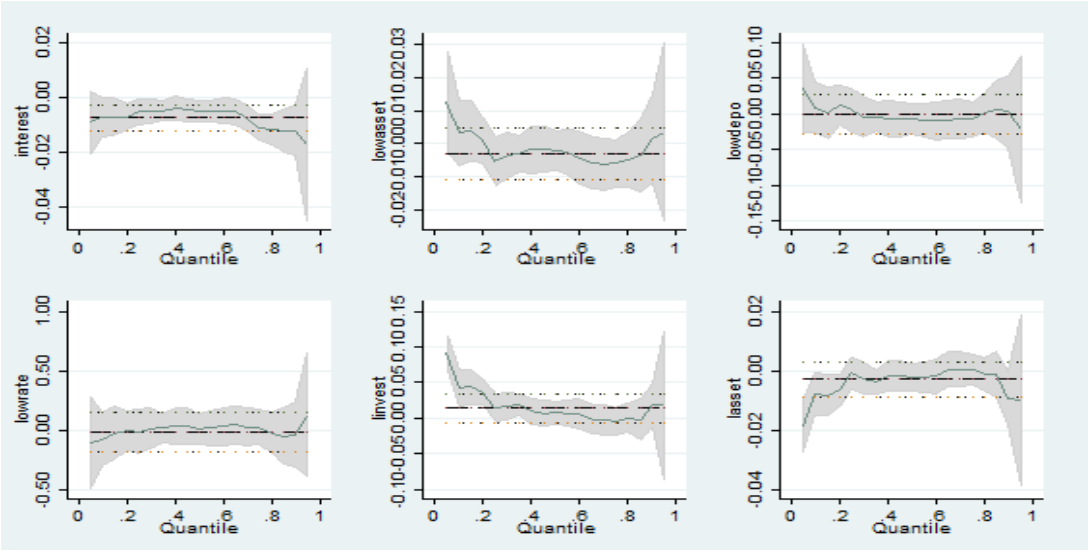

Figure 2 Large banks

For large banks, QR coefficients were mostly within the 95% confidence band of OLS coefficient, suggesting that QR coefficients did not statistically differ from OLS coefficients. With a low rate variable, zero was within the 95% confidence band, suggesting that large banks did not respond to the low rate.

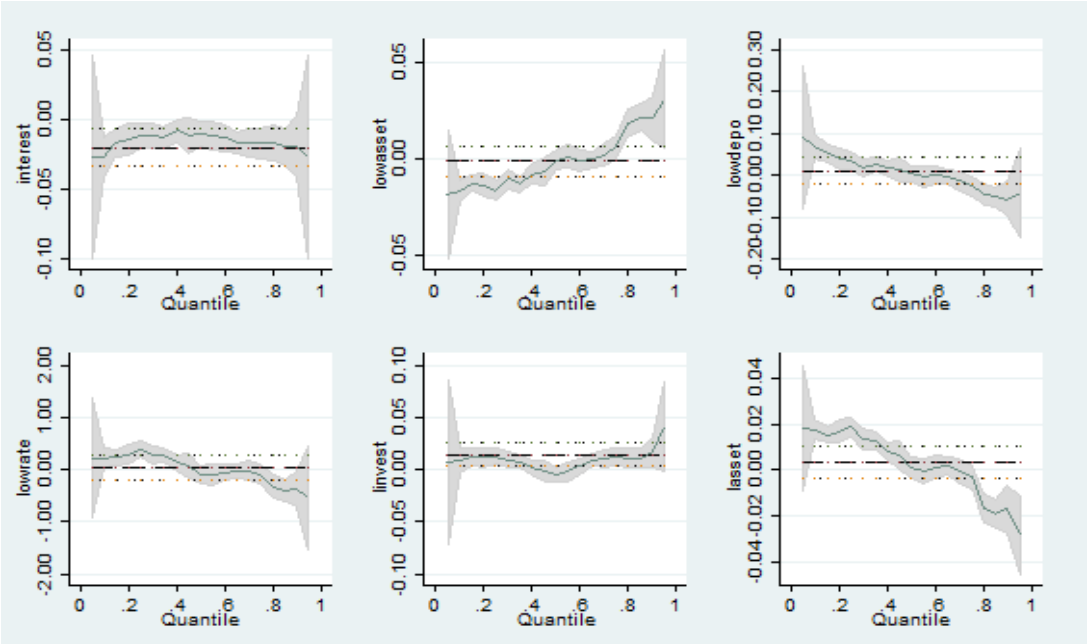

Figure 3 Small- and medium-sized banks

However, for small- and medium-sized banks, QR coefficients of lowrate (low interest rate) and lowdepo (interaction variable for low rate and log(depo)) were not within the 95% confidence band of OLS coefficients. Lowrate had a higher coefficient or greater impact (compared to OLS coefficient) on banks with lower risk (lower quantile) and a lower impact upon banks with higher risk. This suggested that small-sized banks with lower risk were more responsive to low interest rates, and therefore tended to borrow more during such times. The graph of lowasset (interaction variable for low rate and log(asset)) shows that small-sized banks with low leverage ratio were less responsive to lowasset. However, the graph of lowdepo (low rate and log(depo)) showed that small-sized banks with lower leverage ratios were more responsive to lowdepo. Or given an increase in deposit, small- and medium-sized banks may tend to expand their leverage more. In consequence, the result on low rates was consistent with this study's hypothesis that, small- and medium-sized banks may be more aggressive in searching for yield activities by expanding leverage more than large-sized banks during a time of low rates.

4. Policy Implication

In terms of policy implications, this paper found that banks might take risks on the liability side of balance sheets under prolonged low interest rate. Controlling bank lending may not be the complete solution for stabilizing the banking sector, especially during economic downturns. When bank lending is monitored tightly during times of low interest rate, the search for yield competition might force banks to take on risky projects, perhaps outside the balance sheet. Risk from the liability side should be specially scrutinized, as small- and medium-sized as well as large-sized banks have different levels of appropriate risk, especially in short-term and long-term liabilities. It would be disastrous if banks sought to assume more risk and diversified it, expanding and complicating their networks to create a too big to fail situation. Appropriate risk measures should be chosen for different sized banks according to bank specialty as well as size. In addition, to prevent hazardous chain reactions between banks and customers, monetary authorities must avoid placing new restrictive measures upon banks at times of potential economic downturn.

Conclusion

This paper hypothesized that prolonged low interest rates could impel commercial banks to more aggressive searching for yield activities and therefore assuming more risk. By examining the risk-taking behavior of banks from 2001 to 2018, this study first compared a fixed effects model of the capital adequacy ratio, loan loss provision, and leverage ratio. The concept of leverage was chosen as proxy to be further investigated in a two-stage procedure. Secondly, investment sensitivity to leverage was tested for precrisis and postcrisis periods. Results were that sensitivity during postcrises was determined by a prolonged low interest rate and the foreign factor. However, bank response to prolonged low interest rates was expected to vary according to bank size. Hence in the third section, quantile regressions were estimated for large-sized banks, compared to small-and medium-sized ones. Results demonstrated that small- and medium-sized banks may respond to prolonged low interest rates by taking on more leverage and, therefore, more risk, while the same response by large-sized banks was not statistically significant. In terms of policy implications, controlling bank lending may not be the complete solution for stabilizing the banking sector during economic downturns. It would be significantly dangerous for banks to assume more risk and diversifying it by expanding and complicating networks to create a too big to fail situation. Insofar as bank specialties are determined according to bank size, risk measures appropriate for different sized banks could be helpful. Secondly, curbing restrictive measures during potential economic downturns would be necessary for controlling the efficiency loss of expansionary monetary policies.

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