The Impact of Household Financial Asset Allocation on Regional Bank Risk Spillovers

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Abstract. The regional commercial bank is an important part of the Chinese multi-level financial market. In recent years, the risks of regional commercial banks have been gradually exposed, which can easily lead to the accumulation of systemic risks. This paper takes the impact of household financial management on the scale of systemic risk overflow of regional commercial banks as the research object, takes the data of China's household financial survey as the data source of household financial asset allocation, and uses market volatility, liquidity spread, term spread and credit spread are used as state variables to measure the level of the overflow of systemic risk of regional banks by the method of CoVaR, and on this basis, we established a fixed-effect model to test the significance of the effect. The research shows that the model constructed in this paper is significant and robust. The higher the proportion of risky assets held by households, the higher the risk overflow of regional commercial banks operating in the region to the banking system. For regional commercial banks, risk control capabilities should be improved; at the same time, government departments should also strengthen monitoring and early warning mechanisms for the dynamic impact of systemic risks.

Keywords: CoVaR, Banking, Regional bank, Risk of the banking system, Household finance

1 Introduction

Since the 1990s, the pace of market reform in my country's banking system has accelerated. By encouraging the development of small and medium-sized commercial banks, the banking system that meets the multi-level financing needs has been gradually improved. Regional commercial banks are positioned to serve the local economy and are an important part of my country's multi-level financial market, accounting for approximately 1/4 of the total assets of China's banking industry. Regional banks have played a financial intermediary role in inclusive development of inclusive finance, improved regional financial development, and improved resource allocation efficiency, which is of great significance.

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In recent years, with the development of financial technology, the types of financial management services and investment types in the household sector have diversified, and consumption and investment at the micro-level have been affected.

Small and medium-sized banks often have common problems such as homogeneous competition and lack of information technology capabilities. The "Monetary Policy Report for the Fourth Quarter of 2020" released by the central bank shows that some local corporate banks have achieved rapid expansion by absorbing deposits from other places, deviating from the positioning of "serving local" and attracting the attention of the regulatory authorities. Financing channels for small and medium-sized banks are subject to further policy restrictions.

From April 2022, the three rural banks in Henan experienced abnormal situation such as difficulty in withdrawing cash, which further exposed the problems existing in the risk management of small and medium-sized banks. 2008 financial crisis. It reminds us that the correlation of financial institutions will lead to the accumulation of systemic risks, and the negative externalities of financial risks are obvious, which will cause risk contagion and a decline in market confidence. Poor operation and management of small and medium-sized banks may also lead to serious financial crises. The report of the 19th National Congress of the Communist Party of China listed the prevention and resolution of major risks as one of the three tough battles. The absence of systemic financial risks is the bottom-line principle of macro-prudential policies. Therefore, establishing and improving the systemic risk prevention and governance system of banks is an urgent problem to be solved.

In this context, the risk sources of small and medium-sized banks have become an important research topic. Does the financial management of households in the region affect the scale of systemic risk overflow of banks in the region? This is the main content of this study. This paper mainly uses CoVaR to measure the level of systemic risk spillovers of regional banks. On this basis, a fixed-effect model is established for empirical analysis. The main contribution of this paper is that it innovatively integrates household finance and bank risk research, and explores the spillover effect of external factors on bank systemic risk from the outside of the financial system.

2 Literature Review and Theoretical Analysis

The global financial crisis triggered by the subprime mortgage crisis in 2008 has refreshed people's understanding of financial shocks and heightened the emphasis on the fragility of financial institutions.

The spillover of banks to systemic risk is affected by many factors. According to the assessment criteria of the Basel Committee for systemically important banks, the higher the bank's asset scale, the higher the importance of the bank's systemic risk. The research of Brunnermeier and Sannikov (2016) shows that the decline of capital will lead to the reduction of the internal liquidity of the bank [1].

Under the background of financial technology development, interest rate liberalization, and financial disintermediation, the proportion of the non-interest income of banks has increased from 17.5% in 2010 to 24.89%. The research of Jonghe (2010) shows that the increase in the proportion of the non-interest income of banks can help reduce the risk of banking system [2].

There are various measurement methods for systemic risk. At the overall level of the system, Greenwood (2015) established a network model, and by calculating the ratio of the cumulative contagion loss of the banking system to the total equity to display the SR indicator, which reflects the banking system risk in the time dimension [3].

In the field of risk management, VaR is the basic indicator to measure the risk level. The VaR of the banking system represents the maximum loss that may occur in the banking system within a certain time interval in the future under a certain confidence level. The disadvantage of this indicator is that it cannot reflect the loss exceeding VaR. ES (Expected Shortfall) is the expected value of the loss over VaR, which makes up for some of the shortcomings of VAR. The focus of this paper is on the spillover of a single bank to the system, so it pays more attention to the measurement of systemic risk at the bank level. MES id an indicator to calculate the marginal contribution of a single financial institution to systemic risk. The indicator calculation is as follows:

$$ES_{\alpha}=-\sum -\omega_i E[r_i|R\leq -VaR_{\alpha}] \quad (1)$$

$$MES_{\alpha}^{i}=\frac{\partial ES_{\alpha}}{\partial \omega_i} \quad (2)$$

Among them, 1- α is the confidence level, and i is each one of the financial institutionw, and ω_i represents the weight of the financial institution and R is the rate of return of the bank. MES is only suitable for post-event research, and cannot reflect the functions of prediction and early warning. Brownlees & Engle (2017) constructed an indicator, dynamic observation risk index SRISK, which can measure the capital gap of financial institutions during a crisis [4]. Adrian & Brunnermeier (2009) proposed the CoVaR (Conditional Value-at-Risk) method, which is used to measure the spillover level of systemic risk in the case of a commercial bank crisis [5].

The choice of assets between risk-free assets and risky assets is the main manifestation of household financial asset allocation. Many countries have established micro-databases on household finance, such as the Consumer Finance Survey (SCF) in the United States and the National Survey in Japan. data (JNSD) etc., Several studies have established links between the household sector and macroeconomic and financial risks. About the impact of household finance on the macroeconomy, Zhang (2019) established a DSGE model with household debt and concluded that changes in housing demand and negative shocks to risk perceptions in the real estate industry would lead to lower bank net worth, higher deposit and loan spreads, lower investment, and economic downturn [6]. Research by Ekinci (2020) shows that household credit leads to a decline in current account balances, proving the macroeconomic impact of household financial behavior [7].

Regional banks are an important part of the multi-level, extensive, and healthy competition banking system. They play an important role in solving the financing difficulties of small and medium-sized enterprises and stimulating regional economic vitality. However, restricted to Chinese policies, regional banks are restricted from taking deposits. In theory, it will be constrained by more micro-sectoral economic conditions.

In the early days, the influence of micro-sectors on the banking system remained at the theoretical stage. The current empirical research on external factors affecting the banking

systemic risk is mainly based on macroeconomic factors. This asset is used as the research object, and the core variable of this study is household risk asset allocation. The contribution of this paper is to empirically test the impact of the household sector on regional bank risk.

3 Research design

3.1 Sample and Data Source

Household financial asset allocation data comes from the China Household Finance Survey (CHFS), which is a nationwide sample survey led by the Southwestern University of Finance and Economics of China, including demographic characteristics, household assets, and liabilities. As for micro-financial data, there is data such as income, consumption, social security, and insurance, the original data is in the form of a questionnaire structure. This paper calculates the average value of the proportion of household risk assets on a province-by-province basis to reflect the allocation of household financial assets.

The bond yield data comes from the China Bond Information Network, and the rest of the data comes from the Wind database. Since the frequency of the household finance survey is biennial, the sample interval is the odd-numbered years from 2011 to 2019, and the data are annual. This paper selects 25 regional commercial banks from 12 provinces and cities to study their systemic risk spillover levels.

3.2 Variable Selection

Explained Variable: Since the focus of this study is the sensitivity of regional banks' systemic risk spillover level to the asset allocation of operating households, the metric $\Delta CoVaR_t^i$ is more in line with research needs. The definition formula is as follows:

$$P\left(R^{system} \leq CoVaR_q^{system|i} \middle| R = VaR_q^i\right) = q \tag{3}$$

$$P\left(R^{system} \leq CoVaR_{0.5}^{system|i,median} \middle| R = median^i\right) = q \tag{4}$$

$$\Delta CoVaR_t^i = CoVaR_q^{system|i} - CoVaR_{0.5}^{system|i,median} \tag{5}$$

q represents the confidence level (the value is uniformly 5% in the empirical research process of this paper), the probability that the rate of return of $bank_i$ is lower than VaR_q^i is q, and $median^i$ is the median of the rate of $bank_i$, representing its level of earnings under normal operating conditions.

$CoVaR_q^{system|i}$ represents the maximum loss suffered by the banking industry at a certain level of significance when $Bank_i$ is in crisis, while $CoVaR_{0.5}^{system|i,median}$ represents that $Bank_i$ is in a normal state ($median^i$), the maximum loss suffered by the banking industry at a certain level of significance.

$\Delta CoVaR_t^i$ is the difference between $CoVaR_q^{system|i}$ and $CoVaR_{0.5}^{system|i,median}$, representing the risk spillovers of $bank_i$ cause to banking system. $CoVaR_q^{system|i}$ and $CoVaR_{0.5}^{system|i,median}$ are calculated by quantile regression using historical data.

Select market volatility, liquidity spread, term spread, and credit spread as state variables respectively, adjust them to a value lagging one period, and record it as V_{t-1} as state variables, and use quantile regression, the regression equation is:

$$R_t^i=\alpha_i+\gamma^i V_{t-1}^i+\varepsilon^i \tag{6}$$

$$R_t^i=\ln\frac{P_t^i}{P_{t-1}^i} \tag{7}$$

$$R_t^{system}=\ln\frac{P_t^{system}}{P_{t-1}^{system}} \tag{8}$$

R_t^i and R_t^{system} represent $bank_i$ and the return of banking industry respectively, and use the CSI Bankindex data to represent the overall rate of return of the banking industry. The returns used in the regressions are scaled by a factor of 100 for ease of viewing the results.

Set the value of q to 0.5 to predict the return of the $bank_i$ under normal conditions $Median_t^i$; set the value of q to 0.05 to predict the rate of return of the commercial bank under the state of crisis VaR_t^i.

Next, calculate $\Delta CoVaR_t^i$. First, a quantile regression model is established for the China Securities Bank index return R_t^{system}. The regression equation is as follows:

$$R_t^{system}=\alpha^{system|i}+\beta^{system|i}R_t^i+\gamma^{system|i}V_{t-1}^i+\varepsilon^{system|i} \tag{9}$$

When performing quantile regression, the value of q is 0.05, which represents the rate of return when the banking system is in crisis.

The calculation method of the variable is shown in Table 1:

Table 1. Definition of the state variable.

Short Name	Variable	Calculation Method
V1	Volatility	Calculating the volatility of the CSI 300 Index represents market risk. Since the mean value of the rate of return Rm is about 0, Vol = Rm^2 can be used to calculate the market volatility
V2	Liq_spread	Shibor_6M (6-Month Shanghai Interbank Offered Rate) - R_Nation_6M (6-Month Treasury Bond Yield)
V3	Term_spread	R_Nation_10Y (10-Year Treasury Bond Yield) – R_Nation_1Y (1-Year Treasury Bond Yield)
V4	Credit_spread	R_Com_1Y (1-year commercial bank bond yield) - R_Nation_1Y (1-year treasury bond yield)

Put the estimated coefficients obtained after regression into the following formula:

$$CoVaR_t^{system|i} = \hat{\alpha}^{system|i} + \beta^{system|i} VaR_t^i + \gamma^{system|i} V_{t-1}^i \quad (10)$$

$$CoVaR_t^{system|i,median} = \hat{\alpha}^{system|i} + \beta^{system|i} Median_t^i + \gamma^{system|i} V_{t-1}^i \quad (11)$$

The subtraction is obtained $\Delta CoVaR_t^i$, which reflects the risk spillover level of the bank to the system. $\Delta CoVaR_t^i < 0$ indicates a positive effect on risk spillover.

Figure1 visually displays the systemic risk spillover levels of different regional banks. Most of the absolute values of regional banks' impact on the systemic rate of return are between [-2,0]. The CoVaR level of Bank of Ningbo (002142.XSHE), Bank of Nanjing (601009.XSHG) and Bank of Beijing (601169.XSHG) fluctuated greatly, whose CoVaR value was in the range of [-4, 2].

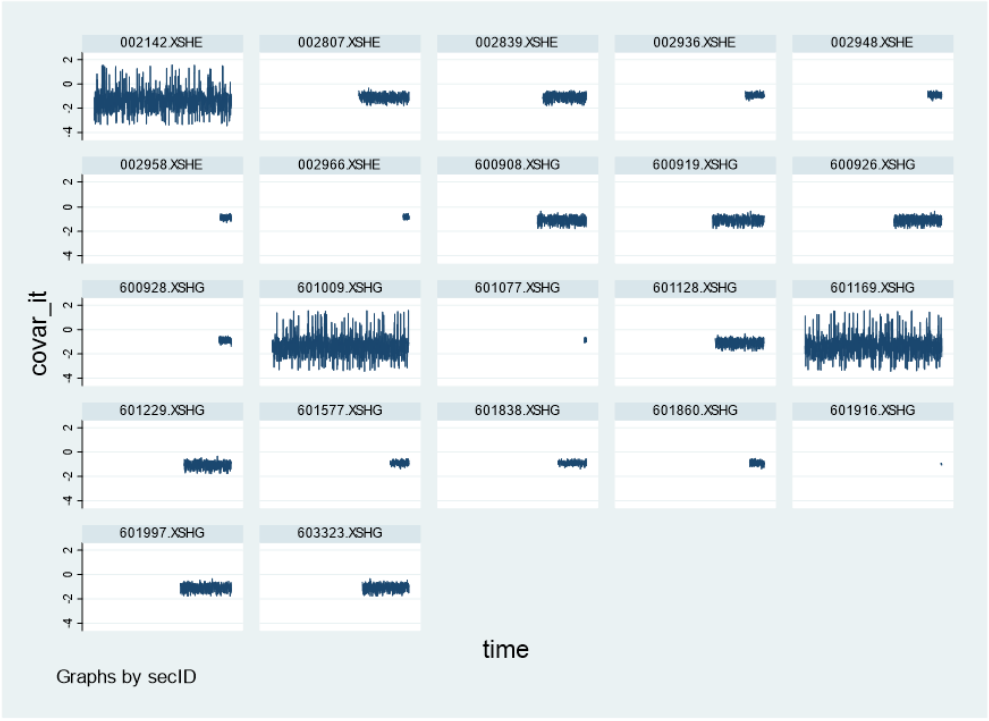

Fig. 1. CoVaR of different banks.

Core Explanatory Variable: Resident risk asset allocation ratio (Risk_Asset_Ratio) is our core explanatory variable. Risk assets include stocks, funds, bonds, financial derivatives, wealth management products, non-RMB assets, and gold. Since the original data comes from the CHFS questionnaire, the questions involved in the questionnaire include the range of the amount of the relevant assets held. When processing the data, if the sample selects 2,000~4,000 yuan in the relevant questions, the median value is 3,000 yuan, will be regarded as the number of assets of this type held by the sample, and summed up as the number of risk assets held as the numerator, the denominator is the number of total household assets in the year, and the final value used for model regression is the provincial average.

The resident samples selected in this paper are from 12 provinces. From the perspective of the full sample. The average holding ratio of risky assets is 7.72%, the maximum value is 21.15%, and the minimum value is 1%. It can be seen in figure2, that among the sample provinces, the proportion of risk assets held by Shanghai residents is the highest, reaching 17.38%, and the lowest in Guizhou and Chongqing, which is about 3.8%.

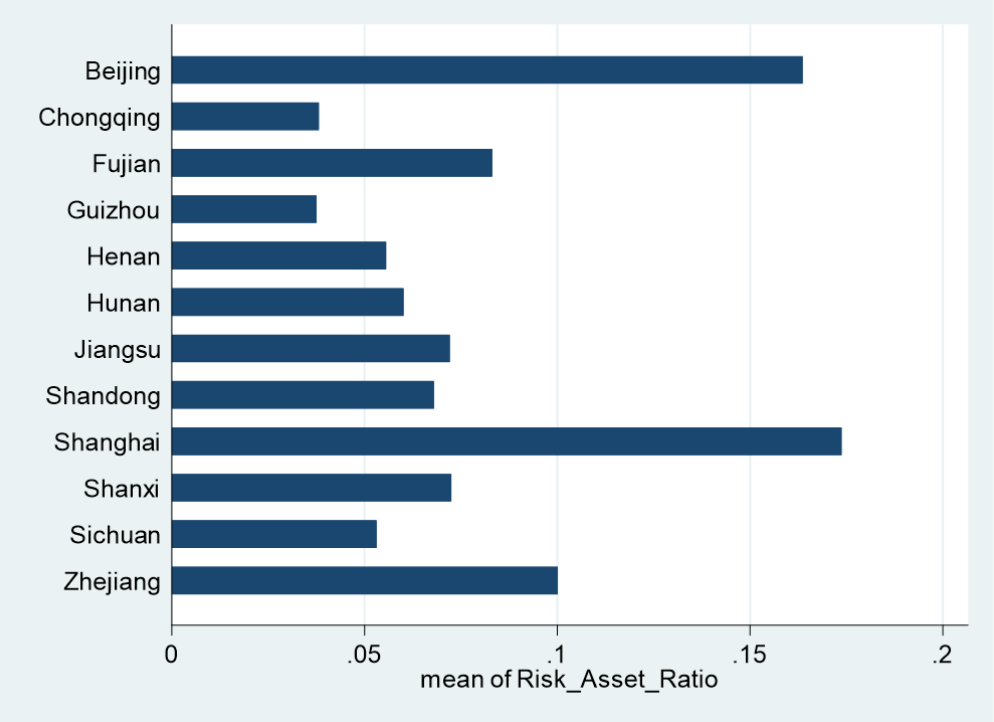

Fig. 2. Risk_Asset_Ratio of different provinces.

Control Variable: Control variables mainly include macroeconomic factors that may affect bank systemic risk spillover effects and microdata from commercial banks. The calculation methods are shown in Table 2.

Table 2. Calculation methods of the control variable.

VARIABLES	CALCULATION METHOD
Profit	Total bank profit
ROE	Roe
DG	The growth rate of deposits
TD	Total deposit
NIP	The proportion of non-interest income
CAR	Capital adequacy ratio
GDP	China's GDP growth rate
R	The average annualized yield of 1 -year treasury bonds

4 EMPIRICAL ANALYSIS

4.1 Model building

This paper builds a model based on panel data. To determine whether to use a mixed-effects model or a fixed-effects model, an F test is performed. The formula for calculating the value of the statistic F is:

$$F = \frac{(SSE_m - SSE_f)/(N-1)}{SSE_f/(NT-N-K)} \tag{12}$$

Among them, SSE_m represents the residual sum of squares of the mixed model, SSE_f represents the residual sum of squares of the fixed effects, N represents the number of individuals, T represents time, and K represents the number of explanatory variables.

$$F(20, 9) = 13.59 \ (Pro > b > F = 0.0002) \tag{13}$$

Therefore, a fixed effect model should be used. The regression model constructed in this paper is as follows:

$$\Delta CoVaR_{it} = \alpha_0 + \alpha_1 Risk\_Asset\_Ritio_{it} + \sum_{j=2}^{9} \alpha_j Control_{j,it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{14}$$

Among them, $\Delta CoVaR_{it}$ is the explained variable, that is, the level of systemic risk spillover of regional banks, and $Risk\_Asset\_Ritio_{it}$ is the core explanatory variable, indicating the allocation of household financial risk assets. $Control_{j,it}$ is the control variable, which μ_i controls the individual fixed effect and the λ_t time fixed effect, and ε_{it} is a random error term.

4.2 Result analysis

The results of the fixed effects regression model are shown in Table 3:

Table 3. Model regression results.

VARIABLES	Same Period y	Lag 1 Period y
Risk_Asset_Ratio	0.591**	-1.024*
	(2.81)	(-1.84)
R	0.087**	0.234***
	(2.79)	(3.75)
GDP	1.553	-2.834
	(0.54)	(-1.31)
NIP	-0.000	0.003*
	(-0.04)	(1.78)
DG	-0.004**	-0.001
	(-2.14)	(-0.71)
ROE	-0.005	0.009
	(-0.53)	(0.68)
profit	-0.003**	-0.000
	(-2.49)	(-0.15)
TD	0.000*	0.000

	(1.97)	(0.00)
CAR	0.032**	0.066***
	(2.30)	(3.06)
Constant	-1.918***	-2.618***
	(-4.98)	(-4.61)
R-squared	0.659	0.677
Company FE	YES	YES
Year FE	YES	YES

Note: ***, **, and * indicate significance at the statistical level of 1%, 5%, and 10%, respectively; t values are in brackets.

Robust standard errors were used for this regression. When the explanatory variable selects the data of the same period, the coefficient of the influence of the proportion of household risk assets on the systemic risk spillover level of regional banks is significant at the level of 5%. When the explanatory variable selects the data with a lag of one period, the coefficient of the proportion of household risk assets is 10 %, and the coefficient is significant in the economic sense, indicating that when the proportion of household risk assets increases by 1 unit, the systemic risk spillover of regional banks increases by 1.024 units on average.

After replacing explanatory variables and replacing the time of sample selection, the robustness of the model constructed in this paper is verified.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This paper conducts an empirical analysis of the impact of residents' risk asset allocation on the level of systemic risk spillovers in regional banks and selects household finance survey data from 2011 to 2019, macroeconomic data, and microeconomic data from 25 regional banks in 12 provinces. The empirical results show that the higher the proportion of households holding risky assets, the higher the risk spillover to the banking system by regional banks operating in the region. As a non-financial micro-subject, the investment behavior of households also affects the risk of the banking system.

5.2 Recommendations

Only by effectively preventing and controlling systemic risks can the stable development of the financial system be ensured. This paper puts forward corresponding suggestions for the two main bodies of regional banks and the government, aiming at the response of household finance to the spillover effects of banking systemic risks. For regional banks, due to regulatory requirements and the positioning of "serving local", online customer acquisition channels are subject to strict restrictions, and some regional banks have to further sink into the market. Faced with problems such as lack of customer credit data and increased credit risk, not only the operating costs of regional banks have increased, but also the risk control ability has been challenged. Diversified and differentiated business strategies and improved risk control capabilities are the prerequisites for the innovative development of banks. Carrying out open banking cooperation is an important exploration direction to enhance the credit of small and medium-sized banks and improve the efficiency of resource transformation in the banking

system. In addition to cooperating with other banking financial institutions in terms of information and other resources, it can also leverage the advantages of financial technology in risk control and other aspects, and cooperate with credit reporting platforms in the form of loan assistance and joint loans to enhance management capabilities on the liability side.

For government departments, first of all, while controlling the accumulation of internal risks in the financial system, it is necessary to pay attention to the possible impact of the structure of household assets on the financial system and to pay attention to the trend of diversification of the allocation of household financial assets. At the social level, strengthen residents' awareness of risks, and strengthen publicity and education on rational allocation of assets and improvement of families' ability to resist risks. At the regulatory level, it is necessary to establish and improve the monitoring and early warning mechanism for the dynamic impact of microfinance on systemic risks, while paying attention to the operational risks of small and medium-sized banks, strengthening the ability of financial institutions to resist risks, adhering to the “serving local” positioning of regional banks, and preventing cross-space contagion of risks, to improve risk management and emergency response capabilities.

There are still some shortcomings in this paper. Due to the insufficient amount of household financial data in my country, this paper fails to examine the sensitivity of banks of different nature to household financial asset allocation from the perspective of heterogeneity. It fails to examine the dynamic of household financial asset allocation to bank systemic risk. In the future, from the perspectives of heterogeneity analysis, dynamic analysis and network analysis, we can conduct in-depth research on the impact mechanism of micro-subjects on systemic risk accumulation.

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