

ANALYSIS OF FINANCIAL SYSTEM STABILITY IN INDONESIA: A PRINCIPAL COMPONENT ANALYSIS APPROACH

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ABSTRACT

This study uses Principal Component Analysis (PCA) to analyze the stability of Indonesia's financial system using 15 indicators from banking financial institutions and financial markets. The PCA technique is applied to each variable included in the components of bank financial institutions or non-bank financial institutions into several main factors that have the same variant value. The first principal component (PC1) successfully captured around 38 percent of the total variability and became the dominant indicator for financial system stability in Indonesia. In addition, from the banking financial institution indicators, NIM and LDR became factors that had quite an influence on PC1, indicating that profitability and banking intermediation activities still played a role in the dynamics of financial system. Furthermore, the interplay between Credit Default Swaps (CDS), exchange rates, and stock market indicators like the IHGS could provide deeper insights into how these elements influence investor sentiment and overall financial stability. Therefore, more comprehensive policy steps are needed to strengthen the resilience of the financial system, including stabilizing the bond market, managing exchange rate risk, and strengthening monetary and macroprudential policies to face future economic uncertainty.

INTRODUCTION

The financial system is an important part of a country's economy. In macroeconomic terms, this includes banking financial institutions, non-bank financial institutions, financial markets, and financial system infrastructure (Carmichael & Pomerleano, 2002). The financial system helps money flow through the economy when and where it is needed. For this important function to work well, a country needs a stable financial system. When financial institutions and markets work well, monetary policy works better (Kidwell et al., 2016). But when financial conditions are unstable, it becomes more difficult for the market to maintain price stability. Price stability is good for the community and the business world will be better able to plan and invest knowing that prices will not change much over time (Crockett, 2020).

Prudent monetary policy is an important approach in maintaining financial system stability. Especially in facing a global crisis, such as the one in 2008, monetary and macroprudential policies must be well coordinated to reduce financial risks and promote economic stability. According to research by Agung & Juhro (2016), the integration of monetary and macroprudential policies has proven effective in overcoming the impact of the 2008 global financial crisis in Indonesia. These policies include the regulation of loan-to-value ratios, reserve requirements, and capital buffers that

have successfully mitigated systemic risk and supported monetary policy in achieving price stability. Bank Indonesia, as the central bank of the Republic of Indonesia, has a constitutional mandate to maintain the stability of the financial system as mandated in Law No. 23 of 1999 concerning Bank Indonesia (as amended by Law No. 6/2009). The law emphasizes that BI is tasked with regulating and maintaining the smooth running of the payment system, regulating and supervising banks, and implementing monetary policy. Furthermore, Bank Indonesia Regulation No. 16/11/PBI/2014 strengthens BI's macroprudential framework in identifying and mitigating systemic risk in the financial sector. This mandate is the legal basis for BI to act as a guardian of financial stability, including intervention in the financial market during turmoil (Warjiyo, 2017).

Indonesia's experience shows that a flexible and responsive monetary policy to external and internal conditions can provide sufficient room to absorb the negative impacts of the crisis and maintain economic growth. Warjiyo (2017) stated that since 2010, the mixed policy approach implemented in Indonesia has shown advantages compared to the standard inflation targeting framework. This emphasizes the importance of coordination between Bank Indonesia and the government in encouraging structural reforms for sustainable long-term growth. The mixed policy adopted by Bank Indonesia consists of a combination of monetary and macroprudential policies to maintain financial system stability and support sustainable economic growth. In monetary policy, BI manages policy interest rates and open market operations to control inflation, ensure price stability, and maintain the rupiah exchange rate. Adjustments to policy interest rates aim to stimulate or slow economic growth, while open market operations are carried out by buying or selling government securities to control liquidity in the money market and influence interest rates. In addition, BI also applies a minimum reserve requirement for commercial banks to control the amount of money circulating in the market, and provides the Bank Indonesia Liquidity Facility as additional funds for banks that need liquidity under certain conditions. Currency intervention policies are also implemented to maintain the stability of the rupiah exchange rate against foreign currencies (Idris, 2023).

Within the macroprudential policy framework, BI collaborates with the government and the Financial System Stability Committee as regulated in Presidential Regulation No. 82 of 2016 to maintain financial system stability through regulating basic credit interest rates and adjusting other policies. Through the Financial System Stability Committee, BI coordinates with the Financial Services Authority and the Ministry of Finance to design systemic stress tests and crisis scenarios. BI also strengthens policy coordination with the central and regional governments to support economic growth, such as the National Movement to Control Food Inflation and the Acceleration and Expansion of Digitalization of Government Transactions (Simanjuntak, 2024). These policies are an integral part of a synergistic approach between monetary and macroprudential policies to ensure Indonesia's economic stability amidst global and domestic challenges.

These policy elements include interest rates to control inflation and manage credit, as well as exchange rate interventions through the foreign exchange market to reduce currency volatility and its impact on economic stability. Capital flow management is also carried out to prevent the impact of sudden changes in capital flows. In macroprudential policy, instruments such as the loan-to-value ratio (LTV) and the Countercyclical Capital Buffer (CCB) are used to mitigate systemic risks that could damage financial stability (Warjiyo, 2017). As a monetary authority, BI not only manages inflation but also actively stabilizes financial markets through liquidity and exchange rate control mechanisms. For example, BI has the authority to intervene in the foreign exchange (forex) market based on PBI No. 23/13/PBI/2021 to prevent excessive volatility in the Rupiah. Bank Indonesia data shows that BI's intervention in the spot and derivative markets succeeded in reducing exchange rate

fluctuations by up to 15 percent during the 2022 geopolitical crisis. In addition, BI regulates foreign transactions of commercial banks through a maximum net open position (NOP) policy of 20 percent to limit foreign exchange risk exposure.

Microprudential and macroprudential policies are equally important in maintaining financial system stability. Microprudential policies focus on the performance and health of individual financial institutions, particularly in the banking sector. BI supervises and regulates these institutions, including through credit risk monitoring and ensuring compliance with applicable regulations. This is important because the failure of individual financial institutions can lead to financial instability that impacts the national economy (Wakidah, 2021). Microprudential policies began to develop in response to the global financial crisis in 2008. At that time, many financial institutions failed because they took too much risk and were not properly supervised, triggering a systemic crisis. The crisis exposed weaknesses in the supervision and regulation of individual financial institutions that had a major impact on overall financial stability. The 2008 global financial crisis demonstrated the need for stronger microprudential policies to maintain financial system stability. Research by Fajriani & Sudarmawan (2022) shows how liquidity risk (Loan to Deposit Ratio), market risk (Net Interest Margin), and operational risk (Operating Expenses-Operating Income) can affect bank stability in Indonesia, underlining the importance of microprudential policies that focus on assessing individual banking risks in order to maintain financial system stability.

As an effort to prevent the risk of a similar crisis, BI was once the main authority in supervising the health of individual financial institutions (microprudential policy) before the establishment of the Financial Services Authority (FSA) in 2011. However, since the enactment of Law No. 21 of 2011 concerning the Financial Services Authority, the authority for microprudential supervision of banks and non-bank financial institutions has shifted to the FSA. Before the establishment of the FSA, banking supervision was under the responsibility of Bank Indonesia, while the non-bank financial services sector and capital markets were supervised by the Ministry of Finance and the Capital Market & Financial Institutions Supervisory Agency (Bapepam-LK) (Idris, 2023). However, BI still has a limited role in microprudential aspects that are directly related to monetary stability and the payment system. This policy aims to ensure that financial institutions have sufficient capital and liquidity and have good risk management practices. One of the microprudential policies implemented by BI is the regulation of the Loan-to-Value and Financing-to-Value ratios. This policy limits the proportion of financing that can be provided by banks to the value of collateral assets to prevent the risk of default which can trigger financial instability (Prasaja, 2023).

In addition, the role of FSA in microprudential policies that work together with BI. The formation of FSA affects the distribution of responsibilities between macroprudential and microprudential policies to ensure the stability of the financial system. Microprudential policies must be directed to complement macroprudential policies in order to maintain overall economic stability (Christiani & Lisai, 2019). FSA's integrated approach allows for more comprehensive supervision of financial conglomerates and all financial services sectors. That way, FSA is able to identify and mitigate systemic risks that may arise. This integrated supervision plays a key role in maintaining the stability of the financial system by combining the principle of prudence in banking and other financial institutions (Wiratmini, 2020). Microprudential policies issued by OJK play an important role in managing intermediation, pressure, and banking efficiency in Indonesia. In maintaining intermediation, FSA has issued instruments such as the Loan-to-Deposit Ratio and Countercyclical Capital Buffer to ensure that banks have sufficient liquidity and maintain the stability of the financial system. These instruments support banks in meeting their credit obligations and ensuring the health of the financial system as a whole (Susilowati & Purnama, 2022).

Banking pressure during the Covid-19 pandemic triggered credit restructuring through FSA Regulation Number 48/POJK.03/2020. Research by (Wahyudi & Arbay, 2021) shows that this policy has been effective in maintaining credit quality and bank stability by maintaining Non-Performing Loans below 5 percent while directing banks to manage credit risk carefully during the ongoing economic crisis. In the Indonesian banking industry, cost efficiency is one of the important aspects that affects bank profitability and sustainability. This efficiency is often measured by the ratio of operating costs to operating income, which reflects how effectively a bank manages costs relative to its income. Low efficiency, characterized by high Operational Cost-Operational Income, indicates that the bank has large operating costs compared to the income generated, which can be caused by various factors such as personnel costs, technology costs, and non-performing loan costs. Widiarti et al. (2015) found that the efficiency ratio of banks in Indonesia tends to be low, with Operational Cost-Operational Income ranging from 66-83 percent. Variables such as Non-Performing Loan, Loan to Deposit Ratio, and Capital Adequacy Ratio have a significant influence on bank efficiency. This finding suggests that poor risk management and inadequate capital adequacy can contribute to low cost efficiency.

Microprudential policies regulated by the Financial Services Authority and Bank Indonesia in maintaining the stability of financial markets in Indonesia, including the money market, capital market, and derivatives market. This policy involves regulations such as reserve requirements, Loan-to-Value, and restrictions on open foreign exchange positions to control risk exposure and ensure the stability of the financial sector. In the money market, macroprudential policies such as the Minimum Reserve Requirement affect interbank interest rates and open market operations. Sugandi (2022) found that instruments such as Minimum Reserve Requirement had a significant impact on the level of liquidity in the money market before and during the Covid-19 pandemic. Minimum Reserve Requirement controls the amount of money circulating in the interbank market and affects money market interest rates and rupiah stability. In the capital market, microprudential policies regulate capital and the loan-to-collateral ratio to minimize excessive credit risk and ensure financial institutions have sufficient buffers. According to Indrawan et al. (2020) Financing to Value (FTV) restrictions in the property sector have a significant impact on property prices and the stability of the Indonesia Stock Exchange (IDX), ensuring that financial institutions have sufficient buffers and avoid excessive credit risk. In addition, in the capital market, the Indonesian government bond market plays an important role in financing development projects and regulating fiscal policy. In providing stable and diverse investment alternatives for investors. The bond market provides an opportunity for companies and governments to obtain long-term funds by issuing bonds, while investors can obtain fixed income from the interest paid by the bond issuer. According to data from the Asian Development Bank (2021), Indonesia has experienced significant growth in bond issuance, both conventional and sukuk. This growth is part of the government's strategy to finance the budget deficit and support sustainable development through more diverse financial market instruments. Bank Indonesia's monetary and macroprudential policies also play an important role in regulating bond market liquidity, with the aim of maintaining price stability and preventing excessive inflation.

In the derivatives market, microprudential policies such as limits on open foreign exchange positions can reduce the risk of losses from sharp exchange rate fluctuations. This policy aims to ensure that financial institutions are not too exposed to the risk of volatile price changes in the derivatives market, especially in instruments such as Credit Default Swaps (CDS). According to Simarmata (2013) the relationship between exchange rates and stock prices and to understand how cross-asset risk can affect financial stability. Microprudential policies limit foreign exchange and other derivative exposures to ensure that financial institutions are not too exposed to risks that can

affect overall financial stability. This supervision helps avoid potential crises that arise from the high correlation between exchange rates and capital markets. There are many obstacles that must be overcome in order to face financial balance in the banking sector. The role of financial system stability is very important in supporting economic growth and sustainability in the development of a country. A stable financial system will be able to allocate funds and withstand disruptions and maintain real sector activities and the financial system (Basci & Kara, 2011).

This study uses Principal Component Analysis to analyze the stability of the financial system in Indonesia using 15 indicators from banking financial institutions and financial markets. The current research on the stability of Indonesia's financial system using Principal Component Analysis (PCA) offers several novelties compared to existing studies. It uniquely integrates 15 indicators from both banking financial institutions and financial markets, providing a comprehensive view of financial stability (Gunadi et al., 2014). The findings emphasize the significant influence of financial market indicators, such as Government Bonds and Credit Default Swaps, highlighting their pivotal roles in stability, which may not have been sufficiently addressed in prior research (Murphy, 2008; Ratner & Chiu, 2013). Additionally, the study tracks changes in stability over time (2015-2023), revealing increasing systemic pressures since 2020, thus adding depth to the analysis (Idris, 2023). By identifying specific indicators contributing to systemic pressure, it sheds light on vulnerabilities within the financial system. Furthermore, it advocates for stronger synergy among monetary, macroprudential, and microprudential policies to enhance risk management, providing actionable insights for policymakers (Warjiyo, 2017). Hence, this research advances the understanding of Indonesia's financial system stability through its integrative approach and focus on market dynamics.

METHODS

The PCA technique reduces the number of exogenous variables into several principal components that identify a linear combination of variables with the largest variance, grouping them into components that are easier to analyze. This process simplifies the analysis model and provides a clearer understanding of the main factors influencing the stability of the financial system. The PCA technique is applied to each variable included in the components of bank financial institutions and non-bank financial institutions into several main factors that have the same variant value. The PCA method assesses components through the results of loading factor values, score plots, and loadings plots. Mathematically, the Principal Component model matrix is as follows.

$$Z = \begin{bmatrix} z_{11} & z_{12} & \dots & z_{1n} \\ z_{21} & z_{22} & \dots & z_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ z_{m1} & z_{m2} & \dots & z_{mn} \end{bmatrix} \quad (1)$$

The analysis on the original data involves a data matrix, the data matrix Z contains all the original observations and variables used in the analysis. This matrix has dimensions of $m \times n$, where m represents the number of observations or samples in the dataset, and n denotes the number of variables or features being analyzed. Each row in matrix Z corresponds to a single observation, while each column represents a single variable. This matrix serves as the foundation for performing dimensionality reduction and transformation in PCA.

The selection of these variables is based on the financial system stability framework formulated by Gunadi et al. (2013), the pillars of banking financial institutions consist of three sub-pillars, namely banking pressure, banking intermediation, and banking efficiency. Banking pressure is measured

through the indicators of Non-Performing Loan (NPL), Capital Adequacy Ratio (CAR), Return on Assets (ROA), and Bank Liquidity. Banking intermediation includes interest rate spread, Loan-to-Deposit Ratio (LDR), and credit ratio to Gross Domestic Product (Credit/GDP). Banking efficiency is assessed through Net Interest Margin (NIM), Operating Costs to Operating Income (OCOI), and Cost-to-Income Ratio (CIR). In addition, this study also considers the pillars of the financial market which include five indicators: Interbank Money Market (IMM) to Deposit Facility (DF) Rate, Composite Stock Price Index (CSPI), Government Bonds, exchange rates (exchange rates), and Credit Default Swaps (CDS). Data for all variables were obtained from Bank Indonesia (BI) through official reports, periodic publications, and relevant databases. To analyze the data, this study used the Principal Component Analysis (PCA) approach on monthly data. The PCA method is used to reduce the dimensionality of data by maintaining the maximum variance explained by a number of principal components. After PCA is performed, the value of PC1 is normalized using the min-max scaling method to be in the range of 0 to 1, which aims to facilitate interpretation and further analysis of financial system stability.

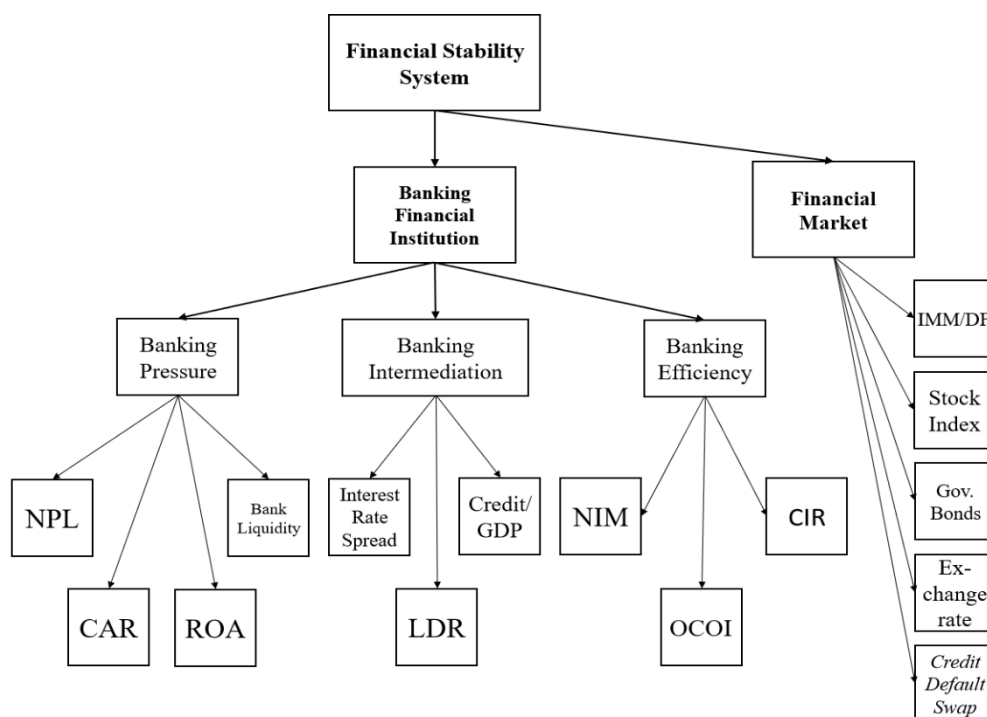


Figure 1. Research Framework

Based on Figure 1 shows the structure of the financial system stability indicator which is formed from two pillars, namely the banking financial institution index and the financial market index. Each indicator contains several pillars that measure specific aspects of financial system stability. PCA is used to reduce the dimension of this data by combining these indicators into several main components that still maintain the maximum variance of the original data. By using the PCA technique, by reducing the number of exogenous variables into several main components that will identify a linear combination of variables that have the largest variance and group these variables into several main components that are easier to analyze. This process helps simplify the analysis model and provides a clearer understanding of the main factors that affect financial system stability.

RESULTS

Screen Plot of Eigenvalues

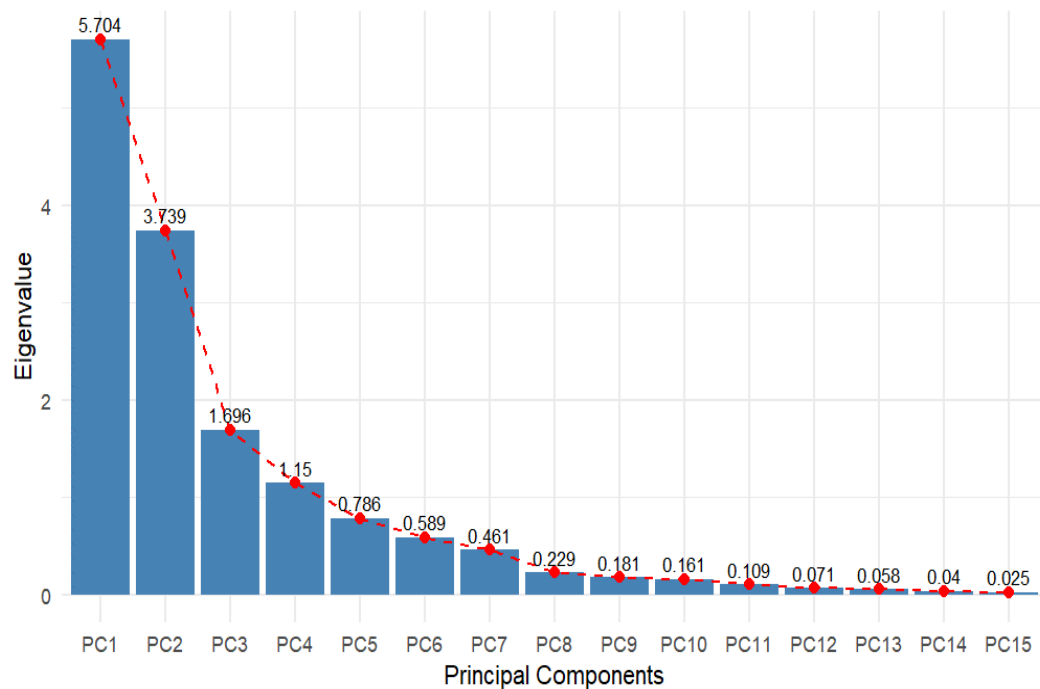


Figure 2. Screen Plot of Eigenvalues

Based on Figure 2, it can be seen that the first component (PC1) has the highest eigenvalue with an eigenvalue of 5.704, indicating that this component explains the most variance in the data. After PC1, the eigenvalues decrease significantly, indicating that the following components have a smaller contribution to the total variance. Therefore, PC1 is chosen as the main component in this analysis because of its dominant contribution in explaining data variance.

Principal Component Biplot Result

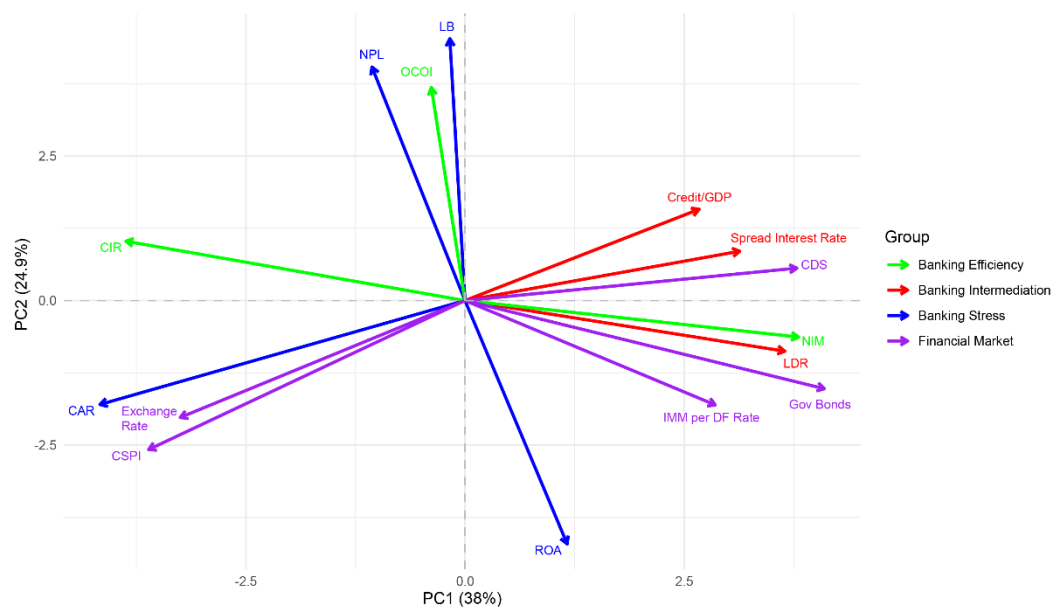


Figure 3. Principal Component Biplot PC1 dan PC2

In Figure 3, the first principal component in this study explains 38 percent of the variability in the data, while the second principal component explains 24.9 percent. With a total contribution of both principal components of 62.9 percent. The variables forming financial system stability in this study are grouped according to several groups, namely banking efficiency, banking intermediation, banking pressure, and financial markets. Each group reflects a certain pillar or dimension of financial system stability. By looking at the direction of the vector in the biplot shows the direction and strength of the correlation of the variable to each principal component. The longer the vector/arrow on the graph explains the greater the contribution of the variable to the principal component. Through biplot, several correlated variables can be projected into a two-dimensional space, namely first main component (PC1) and second main component (PC2), while maintaining most of the information or variation that exists. The direction of the arrow illustrates how a variable is positively or negatively associated with the PC axis.

In the biplot described in Figure 3, the right side of PC1 (positive PC1 value) is dominated by variables closely related to the banking intermediation function and the use of certain financial market instruments. LDR and NIM, which are indicators of the banking intermediation pillar, are on the positive side of PC1. A high LDR indicates that banks are able to channel savings into productive credit, which ultimately drives economic growth and consumption, as emphasized by Buchory (2023), regarding the importance of the intermediation function in supporting economic recovery. A high NIM, on the other hand, indicates that banks have succeeded in optimizing the difference between credit and deposit interest rates, thereby maintaining healthy profitability under normal conditions, a view that is in line with the findings of Angori (2013), regarding NIM as an indicator of bank efficiency and stable performance during normal times.

In addition to LDR and NIM, on the right side of PC1 there is the Interest Rate Spread. A large spread indicates high intermediation costs, which sometimes reflect market risks that have not been fully managed or efficiency that needs to be improved. The findings of Agapova & McNulty (2016) state that a high spread indicates high intermediation costs, so banks need to manage risks and operational costs better so that the efficiency of the banking system increases. In addition to the intermediation variables, the right side of PC1 is also colored by the presence of CDS and Government Bonds, which represent financial market instruments. CDS, according to Ratner & Chiu (2013), allows financial institutions to transfer credit risk, create a more liquid risk protection market, and increase capital allocation efficiency. Gov Bonds, on the other hand, reflect investor preferences for low-risk instruments, which act as a safe-haven asset, especially when economic uncertainty increases. Both, CDS and Gov Bonds, play a role in creating dimensions related to risk management and the provision of safe instruments in the financial market (Koroleva & Kopeykin, 2022). The right side of PC1 reflects not only strong banking intermediation, but also the ability of financial markets to provide risk mitigation instruments, which overall contributes to the stability of the financial system.

On the left side of PC1, there are CAR, LB, IHGS, and Exchange Rate which are in the opposite direction from the intermediation variable. CAR and bank liquidity that are heading towards the negative side can be interpreted that increasing capital and liquidity are not necessarily in line with high intermediation activity. This is consistent with the findings of Gharaibeh (2023), that an increase in CAR can be associated with a decrease in stability if not balanced by good risk management, and high liquidity in uncertain conditions can actually trigger the potential for fund withdrawals and liquidity crises. IHSG and Exchange Rate which are also heading towards the negative side on PC1 indicate that this dimension not only reflects banking intermediation alone, but also includes sensitivity to financial markets. A weakening stock market and exchange rate or volatility can reduce

investor confidence, thus affecting the stability of the financial system as a whole. In other words, the left side of PC1 can be interpreted as a dimension that reflects the stability of capital, liquidity, and more conservative market sentiment, where the emphasis is not on aggressive fund distribution, but rather on capital retention and market volatility that need to be managed.

Overall, PC1 illustrates a range of conditions that span the two poles of financial system management. On the right side, there are banks and financial markets that are active in channeling credit, generating interest margins, and utilizing market instruments (CDS, Gov Bonds) to manage risk. This condition can drive economic growth through strong intermediation, but it is necessary to be vigilant so that hidden risks such as dependence on certain instruments or increasing spreads can be managed properly. On the other hand, the left side shows a tendency to focus on capital stability and strong liquidity, while facing the risks of stock market and exchange rate volatility. Although this side is more conservative, the emphasis on long-term stability and prudence can limit the aggressiveness of intermediation and the ability of banks to generate significant interest margins. Gharaibeh (2023) and Paccès (2013) emphasize the importance of proper risk management in maintaining stability despite high CAR and LB, while Agapova & McNulty (2016) convey the importance of efficiency in managing interest rate spreads. Ratner & Chiu (2013) and Koroleva & Kopeykin (2022) focus on the role of CDS and Gov Bonds in mitigating risk and maintaining market confidence. Xie et al. (2020) emphasize the impact of the stock market and exchange rates on investor confidence and financial system stability. PC1 reflects the dimensions of real dynamics in the banking and financial world, which involve a balance between the aggressiveness of intermediation and the prudence of market risk management. Thus, PC1 can be viewed as an axis that describes the trade-off between the intermediation function and short-term profitability with capital stability, liquidity, and sensitivity to the broader financial market. While the right side promotes growth through dynamic intermediation and diversified risk management, the left side reminds us of the importance of a strong capital foundation, liquidity resilience, and awareness of the impact of stock market and exchange rate volatility. These two sides complement each other in forming a holistic picture of financial system stability.

Principal Component Result

The results of the PCA, then the value of the first principal component used is then normalized to allow a clearer understanding of changes in stability throughout the observation period, seen through the up-down trend in Figure 4, depicting fluctuations in the stability of the financial system.



Figure 4. Financial System Stability Formed from Indicators of Banking Financial Institutions and Financial Markets in Indonesia

Based on the results of the first principal component of PCA from 2015 to 2023, there is a striking phenomenon related to the decline in the SSK indicator over time. At the beginning of the period (2015–2016), the SSK value was in the range of 1 to 2.5 points, indicating that the financial system was relatively stable and able to manage risks and internal imbalances well. However, starting in 2017, the SSK value showed a consistent downward trend, approaching zero and finally changing to a negative value since 2020. The peak of the decline occurred in 2021, where the SSK value reached around -1.5 points, indicating an increase in pressure and instability in the financial system.

The phenomenon of the decline in the SSK value can be interpreted as an indication that the financial system is facing serious challenges, such as increasing market uncertainty and liquidity risk, which may be caused by external shocks or unfavorable domestic market dynamics. This decline indicates that the internal mechanisms of the financial system, which were previously able to absorb shocks through self-correction, are now starting to weaken in balancing the sudden changes that occur. Thus, this phenomenon emphasizes the need for policies to strengthen risk management and structural reforms to maintain financial stability in a sustainable manner.

CONCLUSION

Future research should focus on exploring the underlying factors contributing to the volatility of government bonds and their impact on the stability of Indonesia's financial system, as indicated by the significant contribution of Gov Bonds in the Principal Component Analysis (PCA) results. Additionally, investigating the interplay between Credit Default Swaps (CDS), exchange rates, and stock market indicators like the IHGS could provide deeper insights into how these elements influence investor sentiment and overall financial stability. Given the downward trend in financial system stability from 2015 to 2023, it is essential to assess the effectiveness of current monetary and macroprudential policies while considering the role of banking operational efficiency, as suggested by the minor contribution of BOPO. Future studies could also analyze the implications of integrating microprudential measures into the broader policy framework to enhance risk management and resilience against systemic pressures, ensuring a comprehensive approach to maintaining financial stability in the face of economic uncertainties.

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