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The Impact Of Size And Other Income On Systemic Risk In Indonesia

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Abstract: This research aims to measure systemic risk, especially in the banking system, between 2018 and 2022. In this research, the measurement method used is SRISK, which aims to measure the potential capital shortage of a bank when there is pressure on the market. The lack of capital from a bank, which is an individual risk for a bank, also poses the potential for a contagious threat which could end up becoming a systemic risk in the banking system in Indonesia. This research shows that several banks, through SRISK calculations, have the potential for capital shortages when market pressure occurs, especially from 2019 to 2022. In this research, bank size and non-interest income are essential factors in systemic risk in the banking system. Meanwhile, business complexity does not affect systemic risk in Indonesia.
Keywords: Systemic Risk; Banking, Financial Crisis; Capital Shortfall; SRISK.

Abstrak: Penelitian ini bertujuan untuk mengukur tingkat risiko sistemik khususnya pada sistem perbankan di Indonesia yang terjadi antara waktu 2018 sampai 2022. Dalam penelitian ini, metode pengukuran yang digunakan adalah SRISK hal ini bertujuan untuk mengukur potensi kekurangan modal dari suatu bank ketika terjadi tekanan pada pasar. Dengan adanya kekurangan modal dari suatu bank yang merupakan risiko individu suatu bank tentunya juga memberikan potensi ancaman yang menular yang dapat berakhir menjadi risiko sistemik di system perbankan di Indonesia. Dalam hasil penelitian ini, menunjukan bahwa beberapa bank melalui perhitungan SRISK memiliki potensi kekurangan modal ketika terjadi tekanan pasar khususnya di tahun 2019 sampai 2022. Dalam penelitian ini ukuran bank dan pendapatan non bunga menjadi faktor penting dalam terjadinya risiko sistemik di sistem perbankan di Indonesia. Sedangkan kompleksitas usahanya tidak berpengaruh terhadap risiko sistemik di Indonesia.
Kata Kunci: Risiko Sistemik; Perbankan; Krisis Keuangan; *Capital Shortfall;* SRISK.

INTRODUCTION

Financial system stability is needed in the economy to run optimally and create sustainable economic growth. (Otoritas Jasa Keuangan, 2023) If monetary stability is not accompanied by financial system stability, there will be no support for creating sustainable growth. From the external side, developing countries such as Indonesia are still very much impacted by economic factors from developed countries such as America, Japan and other developed countries. This shows that every event and policy that occurs in developed countries or countries with a sizeable economic impact can affect developing countries' economies. Research conducted by (Bhattarai et al., 2021) showed that economic policies carried out by developed countries such as the United States impact developing countries; Indonesia is also included in the research as one of the research objects. Meanwhile, from

the internal or domestic side, a country's economy must be connected to the banking industry because banking has quite a big task as a driver of a country's economy.

Of course, many factors can influence a country's internal and external economy. From the external side, developing countries such as Indonesia still significantly impact economic factors from developed countries such as America, Japan and other developed countries. This shows that every event and policy that occurs in developed countries or countries with a sizeable economic impact can affect developing countries' economies. As in research conducted by (Bhattarai et al., 2021), economic policies carried out by developed countries such as the United States impact developing countries; where in their research, Indonesia is also one of the research objects.

U.U Tahun 1998, it was stated that a bank is a business entity whose function is to collect funds from the public and channel the funds in the form of credit to improve the standard of living of humans or people. It can be stated in the same legislation in a broader sense that banking is everything that includes banks from an institutional perspective and also the process of carrying out bank business activities. Apart from that, banking is an intermediary or intermediary institution whose job is to collect public funds and provide financing for consumer and production needs. (Acharya et al., 2020), it was stated that the financial sector and banks also have a crucial role in reducing shocks by distributing the required funds. In Indonesia itself, in the financial industry, the banking sector is still the financial sector that dominates the most compared to other sectors. From 2018 to 2022, the banking industry had an asset proportion of more than 70 per cent compared to the total assets in the Indonesian financial industry. With the high proportion of banking assets in Indonesia with a proportion above 70 per cent of the financial system in Indonesia, assuming Too Big Too Fail, banks can be said to be the sector with the most significant influence and is considered the most important systemically. Especially for banks with relatively large assets in the banking industry, they are also systemically important (Systemically Important Financial Institutions / SIFI). Eighty per cent of the banking sector's total assets in Indonesia are owned by 36 banks, which are financial conglomerates.

The existence of this conglomeration can increase the potential for risks, both idiosyncratic and systemic because financial conglomerates can transmit failures that occur in one financial institution to other financial institutions. The risk that arises from systemic bank failure gives rise to a risk called systemic risk. Systemic risk can cause contagion or contagion effects, which can disrupt the financial system's stability and have a fatal impact on a country's economy. In research conducted by (Fan et al., 2024), it is stated that systemic risk occurs because assets held generally by banks become a channel for significant spread, thereby causing the spread of risk. Previously, research stated that diversifying is one way to overcome the threat of systemic risk. Diversification provides benefits for banks by increasing bank resilience from economic shocks that may occur. Research (Maghyereh et al., 2022) examines the effect of income diversification from banking on systemic risk using banking data from 2008 to 2020. This research found that diversification can reduce systemic risk in the banking system. This effect is more robust in the Islamic banking system than in the non-Sharia banking system, like research conducted by (Yang et al., 2020), where this research examines the effect of diversification carried out by banks in the United States from 2000 to 2013 on systemic risk. In this research, it was found that diversification increases systemic risk. In addition, the impact of diversification on systemic risk will be more significant for medium to large banks.

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Table 1. Table of Bank Income in Indonesia for the 2018 to 2022 period
Expressed in IDR and Billions of Rupiah

Bank	2018	2019	2020	2021	2022
Interest Income	742,327	828,197	794,091	773,902	811,458
Non-Interest Income	261,214	318,252	407,621	460,019	522,998
Total	1,003,541	1,146,449	1,201,712	1,233,921	1,334,456
Common Size					
Interest Income	74 Per cent	72 Per cent	66 Per cent	63 Per cent	61 Per cent
Non-Interest Income	26 Per cent	28 Per cent	34 Per cent	37 Per cent	39 Per cent
Total	100 Per cent	100 Per cent	100 Per cent	100 Per cent	100 Per cent

Source: OJK, Processed by Author

Table 1 shows, It can be seen that from 2018 to 2022, there has been a continuous increase in non-interest income, which shows that bank income diversification is starting to occur in Indonesia. Non-interest income from all banks in Indonesia moved from 26 per cent in 2018 to 39 per cent in 2022. This increase can also be seen in terms of nominal non-interest income itself. The many debates from existing research have raised researchers' interest in looking at the impact of diversification depicted by non-interest income in Indonesia on systemic risk. This was done to see whether the diversification carried out in Indonesia impacted the systemic risks that occurred in Indonesia. Moreover, Indonesia's non-interest income used for income diversification differs from developed countries.

The banks' systemic impact in Indonesia is determined in the U.U. NO. 9 tahun 2016. This law discusses the prevention and handling of financial system crises. U.U. NO. 9 Tahun 2016 states that the Financial System Stability Committee will hold regular meetings every three months to discuss financial system stability, and the results of this report include handling the financial system crisis, handling systemic bank problems and implementing the banking restructuring program by Lembaga Penjamin Simpanan. From the results of this meeting, banks will be determined to have a systemic impact on the financial system in Indonesia. However, there is information that needs to be, and Bank Indonesia does not publish information regarding systemic banks. This is done to avoid the public perception that systemic banks are banks that fail and create panic in society. In determining systemic banks, OJK uses bank size, business complexity, and linkages between financial institutions, as determined in POJK No. 2 /POJK.03/2018. Based on what has been explained in the previous paragraph, with information that is not open to the public regarding banks that are classified as systemic banks, researchers are interested in examining which banks experience capital shortages or are said to be systemic banks when faced with crisis conditions using the SRISK method. SRISK, in this research, aims to measure the capital shortage of each bank when an economic shock occurs. The greater the SRISK value of each bank indicates the greater the need for additional capital from that bank when an economic shock occurs. It shows that the bank has the potential to experience capital shortage problems, which can lead to the emergence of systemic risk in Indonesia's banking system. The selection of SRISK as a measure of systemic risk refers to POJK No. 2 of 2018, which, in determining systemic banks, also uses Capital Surcharge calculations or additional capital needed to reduce the negative impact on the stability of the financial system and economy when a bank failure occurs with the hope that the additional capital can absorb losses that occur to the bank.

Jurnal Manajemen
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Apart from that, by the method used by the OJK, which uses size and complexity in determining systemic banks, researchers are interested in seeing the impact of bank size and business complexity on systemic risk in Indonesia. With the shifting pattern that is occurring in the banking industry in Indonesia, which is currently starting to shift with the development of digital banks, researchers see a shift in income concentration, which was initially focused on interest income, starting to shift to non-interest income and this can be considered as diversification of income from the bank. So, the researchers tried banking diversification, which was described as non-interest income against systemic risk in Indonesia, especially from 2018 to 2022.

By conducting this research, the author also aims to see whether the policies currently being implemented by the OJK by increasing the size of banks and creating income diversification have a positive impact on the sustainability of the banking system in Indonesia or increase systemic risk in the banking system in Indonesia. Apart from that, current research on systemic risk in banking systems in developing countries, especially in Indonesia, using SRISK as an indicator of systemic risk is still quite limited and is mainly carried out in banking systems in developed countries such as the United States and European countries. Hence, researchers are interested in researching systemic risk in developing countries, especially in Indonesia and between developed and developing countries there are differences in banking policies from each country, especially for developed and developing countries, which have the potential to provide different results due to differences in policies that apply between the banking industry in developed and developing countries. In terms of period, the researcher used 2018 to 2022, where this research tried to look at banking conditions when the health crisis occurred (caused by the COVID-19 pandemic), which was quite different from the economic crisis that previously occurred in 1998 and 2008. This research will use data from banks registered on the Indonesian Stock Exchange.

THEORETICAL REVIEW

Definition of Systemic Risk Systemic risk, according to (Das et al., 2022), is a risk that can affect many market participants simultaneously and is described by significant losses that spread through the system. Rapid illiquidity changes and the risk of insolvency and financial losses in the financial system accompany Systemic Risk. It influences relationships and interactions between financial stakeholders, especially during financial stress. In the same research, it was also written that systemic risk can be caused by four sources: banking panic, increased risk in banking caused by falling asset values, contagion of effects and mismatches in exchange rates in the banking system. (Brunnermeier et al., 2020) It was said that the Subprime Mortgage that occurred in 2007-2009 was an example where there was a significant spillover effect from one bank to another, which caused an increase in risk in the banking system as a whole; in other words, caused a transmission or contagion that causes systemic risk.

According to (Berger et al., 2022), systemic risk is the widespread distribution of failures and losses that significantly negatively impact external parties in the economy. Also, the same research stated that in the banking sector, systemic risk is generally considered to originate from the linkages and dependencies between institutions, which produce correlated risks. Quoted by (Bank Indonesia et al., 2021), systemic risk is the

Jurnal Manajemen
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potential for instability that occurs from disturbances that are contagious in part or the entire financial system due to the relationship between size, business complexity and connectivity between financial institutions and also behavioural tendencies—excesses from financial actors or institutions in carrying out the economic cycle.

Too Big Too Fail Too Big To Fail is a concept where companies are deemed to be able to mitigate the impact of unacceptable disruptions to the financial system (Labonte, 2018). This emerged again when the Subprime Mortgage crisis occurred in the United States. During the 2008 crisis, the United States government bailed out USD 700 billion to save several companies in America. Companies that the United States government rescues are considered to be able to have a disruptive impact that causes the collapse of the financial system in the United States. If we use the Too Big To Fail assumption, then by looking at the market concentration of Indonesian financial institutions, more than 70 per cent of which are concentrated in the banking industry; in other words, Banking is an industry that falls under the Too Big To Fail concept.

Apart from that, banks are also a payment system in a country. Banks are vulnerable institutions due to the high concentration of deposits held by banks and short-term funding sources where these funding sources are easier and quicker to withdraw. In addition, because banks have a relatively high level of connectedness through deposits, loans, and derivatives between banks, problems can spread from one bank to another very quickly, thereby encouraging the concept of Too Big To Fail.

There is research conducted by (Kamani, 2019), who tries to measure the impact of non-traditional banking activities on systemic risk and whether bank size influences systemic risk in the banking system. This research uses data from 2002 to 2016 from 82 banks in Europe. This research uses SRIKS to measure systemic risk and uses the Generalized Method of Moment (GMM). This research also tries to measure the interaction between bank size and the bank's non-traditional activities as measured by the bank's non-interest income. This research found that non-interest income and the interaction between non-interest income and bank size significantly influenced systemic risk at a significance level of 1 per cent. This shows that the influence of non-interest income on systemic risk varies depending on the size of the bank. Apart from that, non-interest income is considered to have a positive effect on systemic risk, which means that the greater the non-interest income from a bank, the greater the impact on systemic risk at a bank. The results of this research support the Too Complex to Manage concept because higher non-interest income indicates multiple and more complex bank activities. Hence, the bank is more difficult to manage.

The following research is conducted by (Rizwan et al., 2020), which aims to see the impact of the spread of COVID-19 on systemic risk. This research uses daily stock prices from the largest banks and financial institutions in Canada, China, France, Germany, Italy, Spain, England and America. All daily stock prices are denominated in USD. The data period used is between 2006 and 2020. This research uses the CATFIN method and is estimated using three different methodologies: Generalized Pareto Distribution (GPD), Skewed Generalized Error Distribution (SGED), and Non- Parametric Estimation. This research shows that all countries in the 2015 to 2016 period experienced increased systemic risk, especially China and the U.K. This was due to shocks in the Chinese capital market. At the same time, Canada experienced systemic risk in 2016 due to the oil sector experiencing shocks due to the fire in Fort McMurray, which caused a decline in exports of

Jurnal Manajemen
e-JM
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4.5 per cent and also experienced the most significant decline in GDP since 2016. 2009. Meanwhile, during the COVID-19 period, there was the highest increase in systemic risk except for China, England and the United States. In general, the spread of COVID-19 has caused an increase in systemic risks in all countries, but regulations from regulators play a vital role in suppressing systemic risks.

(Cincinelli et al., 2022) We researched changes in financial connectedness using Granger causality at the company level (Leverage, Market to Book Value and Return) and systemic risk measured using Covar, MES, and SRISK. This research used 161 financial institutions in China consisting of 14 banks, 16 financial services companies and 131 real estate financing companies. This research period uses data from 2007 to 2021. In this research, it was found that during the financial crisis in stocks. Apart from that, during the spread of COVID-19, there was pressure on China's financial system. From this research, looking from the banking side, it was found that from 2007 to 2009, there was a one-way relationship between book value and COVAR, while from 2010 to 2014, there was a one-way relationship between Return and MES. From 2015 to 2019, which saw the second stock crisis in China, there was a one-way relationship between Leverage to COVAR and Market to Book Value to COVAR. However, in this research, during the spread of COVID-19, there was no causal relationship between leverage, market-to-book value and return on COVAR and MES. This research found that banks are the main factor in increasing systemic risk in China due to the high level of leverage and market-to-book value in the banking industry.

Systemic Risk Calculation using the SRISK method SRISK used by (Brownlees et al., 2017) is a development of the MES or Marginal Expected Shortfall method. As previously mentioned, SRISK is considered to be related to expected shortfall conditions during times of crisis that affect the financial system. In the SRISK approach, companies that have the largest Capital Shortfall are considered to have the most significant contribution to crisis risk and are also considered institutions that have the most significant systemic risk. In calculating SRISK, SRISK considers the linkage of one institution to another through the Long Marginal Expected Shortfall (LRMES)system.

$$LRMES_{it} = 1 - \exp(Log(1-d)x\ beta \quad \text{..... (1)}$$

LRMES is considered to have a relationship with an institution's expected decline in equity value if the market experiences a decline that exceeds a predetermined threshold or limit for six months. In research conducted (Kamani, 2019), the limit used was a market decline exceeding 40 per cent within six months. LRMES is estimated using the GARCH-DCC standard, which can balance the prediction accuracy of the complexity of a model well. Apart from that, LRMES is also considered capable of monitoring system risks in volatile market conditions. d is the crisis threshold within six months; the reference value is 40 per cent, while for beta, it is the company's beta coefficient. Determination of the six-month crisis threshold of 40 per cent based on research is also used in research (Kamani, 2019)

$$SRISK = k(\text{Debt}) - (1-k)(1-LRMES)MV \quad \text{..... (2)}$$

k is the capital requirements ratio, and the k value used in research (Brownlees et al., 2017) is 8 per cent (The capital requirement ratio used in this research is 8 per cent based

on research (Brownlees et al., 2017). Debt is the total liabilities of each bank, and MV is the market value of bank equity. This SRISK calculation will obtain a nominal amount, which is used to illustrate each bank's capital shortage. From the results of this calculation, the order of banks that are said to have contributed to systemic risk in Indonesia can be determined. This is, of course, in line with research conducted by (Brownlees et al., 2017), which states that SRISK can be used to identify and also provide ratings on companies that are considered Systemically Important Financial Institutions (SIFI) and can indicate banks that can be given bailout in crisis finance. Researchers use SRISK as a proxy to measure systemic risk because the approach is the same as the systemic risk calculation carried out by the OJK, where the OJK states that banks designated as systemic banks must form a Capital Surcharge and SRISK is a calculation of additional capital requirements when an economic shock occurs.

Research conducted by (Brunnermeier et al., 2019; Kamani, 2019; and Varotto et al., 2018) stated that bank size influences the systemic risk that occurs in a country. Departing from previous research, the author builds a hypothesis, but there are different results from other research conducted by (Bank Indonesia et al., 2021). In this research, increasing each bank's structure and size would strengthen the bank's resilience in facing economic shocks. In research conducted by (Varotto et al., 2018), it is stated that banks with a larger size have better capital, so they have a lower risk of becoming systemic. Of course, with the issuance of POJK No. 12/POJK.03/2020 and POJK no. 12/POJK.03/2021 related to the consolidation of minimum core capital for banks, researchers want to see whether the issuance of this regulation will impact systemic risk in the banking financial system in Indonesia. Given the different views regarding the influence of bank size on systemic risk in the banking system, the author develops the following hypothesis:

H1: Bank size influences systemic risk in Indonesia.

Research conducted by (Kamani, 2019; Cai et al., 2018; Maghyereh et al., 2022; Wang et al., 2022; Yang et al., 2020) tries to measure the impact of diversification on systemic risk. In this research, the researcher refers to research conducted by (Kamani, 2019), which uses non-interest income, which is written as non-traditional bank income and describes business diversification in banking. In this research, it was found that non-interest income had an impact on systemic risk. Likewise, research conducted by (Yang et al., 2020) stated that according to his research at Bank America from 2000 to 2013, income diversification in banks increased systemic risk. Researchers are trying to see whether the effect of income diversification on banks in Indonesia differs from that of existing research. This is because income diversification in Indonesia has different types of products compared to previous research, where banks in Indonesia are still more focused on non-interest income originating from Spot and Derivative trading activities for hedging purposes. Based on this research, a hypothesis was developed in this research as follows:

H2: Non-interest income from a bank influences systemic risk in Indonesia.

Research conducted by (Kamani, 2019) tried to measure the influence of bank complexity on banking systemic risk. This departs from the Too Complex To Manage hypothesis, which, in research (Kamani, 2019), assumes that the more complex the activities

Jurnal Manajemen
e-JM
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of a bank are, the more difficult it will be to manage and increase a bank's risk. It is feared that this will increase the bank's risk of systemic risks occurring with the shift in banking business trends, which have been focused on intermediary functions, namely fundraising activities (Funding) and also channelling funds in the form of credit (Lending) to become financial services businesses which can be seen from the start of the establishment of digital banks. The existence of this digital bank will undoubtedly increase the complexity of the bank's business itself. So, in this research, a hypothesis is:

H3: The complexity of bank activities influences systemic risk in Indonesia

METHODS

This research uses sample data from 32 banks operating in Indonesia and listed on the Indonesia Stock Exchange with 640 observations. The panel data method is used, and this research uses the Random Effect Model (REM). This research aims to look at the impact of bank size, as well as the diversification of bank income, which is described by non-interest income and the complexity of its business on systemic risk, which SRISK describes. This research uses a previous research model that was carried out by (Kamani, 2019) with the following research model:

$$SRISK_{i,t} = \beta_0 + \beta_1 Size_{i,t} + \beta_2 NII_{i,t} + \beta_3 NII_{i,t} * Size_{i,t} + \beta_4 ROE_{i,t} + \beta_5 Inflation_{i,t} + \beta_6 GDPG_{i,t} + \beta_7 Creditrisk_{i,t} + \beta_8 Liquidity_{i,t} + \alpha + u_{i,t} \quad \text{..... (3)}$$

Where **SRISK** is a measure of calculating the capital shortage of a bank when an economic market shock occurs, **SIZE** is a measure of the natural logarithm of bank assets, **NII** is non-interest income, complexity is described by multiplying the size by non-interest income (**NII*Size)**. For the control variables in this research, **ROE** is the Return on Equity from each Bank; **Inflation** is the Inflation rate in Indonesia; **GDP growth** is the Gross Domestic Product growth rate in Indonesia; and **Credit Risk** is used, which is described. The provision for credit loss ratio is described by the provision for losses with the total credit disbursed by the bank**, as well as liquidity**, which is the level of bank liquidity described by the ratio between deposits and the bank's total current assets.

In this research, to carry out data regression, it is necessary to select the most appropriate model to produce research results that are BLUE (Best Linear Unbiased Estimator), so it is necessary to test whether the model used will use the Common Effect Model, Fixed Effect Model or Random Effect Model. In the test, it is necessary to carry out the Chow Test, where the Chow Test is to determine whether the Common Effect Model or Fixed Effect Model is better to use and the Hausman Test to determine whether the Fixed Effect Model or Random Effect Model is better to use in research.

RESULTS

In this research, researchers used the Chow Test and the Hausman Test to determine the best model to use in this research. The Chow test is a testing method for choosing a model between Pooled Least Square (PLS) or Fixed Effect Model (FEM). In the Chow Test, there are hypotheses including:

Jurnal Manajemen
e-JM
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$H_0: \beta_0 = \beta_1 \rightarrow Pooled\ Least\ Square$ ..... (4)

$H_0: \beta_0 \neq \beta_1 \rightarrow Fixed\ Effect\ Model$ ..... (5)

Following are the results of the Chow test carried out by researchers using the EViews application :

Table 2. Chow Test Result

Test	P-Value (Cross Section Chi-Square)	Result
Chow Test	0.000	Fixed Effect Model is selected

Source: Author, Processed Data, 2023

From the results of the Chow test in **Table 2**, the author uses 5 per cent as the level of significance; if the results of the Chow test are smaller than 5 per cent, H0 can be rejected and vice versa. From the results of the Chow test above, H0 is rejected, and the research model is better using the Fixed Effect Model or FEM.

After the Chow Test is carried out, the next test carried out is the Hausman Test. The Hausman test is carried out to determine whether the Fixed Effect Model (FEM) or Random Effect Model (REM) is used to get a better research model. The following is the hypothesis used in the Hausman test :

$H_0: \beta_0 = 0 \rightarrow Random\ Effect\ Model$ ..... (6)

$H_0: \beta_0 \neq 0 \rightarrow Fixed\ Effect\ Model$ ..... (7)

Table 3. Hausman Test Result

Test	P-Value (Cross Section Random)	Result
Hausman Test	0.211	Random Effect Model is selected

Source: Author, Processed Data, 2023

Table 3 shows the results of the Hausman test; researchers used a significance level of 5 per cent in the Hausman test. If the Hausman Test value is smaller than 5 per cent, then the Fixed Effect Model is chosen for this research. On the contrary, if the Hausman Test value is greater than 5 per cent, then the Random Effect Model is used in the research. From the results of the Hausman Test that was carried out, it can be seen that the P-value value is greater than 5 per cent, so the model chosen in this research is the Random Effect Model (REM).

A classical assumption test is carried out after determining the model used in the research. The first test is the normality test, which aims to see whether the residual values from the research used are normally distributed.

Table 4. Normalilty Test Result (SRISK)

Test	P-Value (Jarque Bera)	Result
Normality Test	0.0000	Not normally distributed

Source: Author, Processed Data, 2023

Jurnal Manajemen
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In this study, researchers used a significance level of 5 per cent. If the probability value from Jarque Bera is greater than 5 per cent, then the research model used is normally distributed. In contrast, if the probability from Jarque Bera is smaller than 5 per cent, then the research model is not normally distributed. The results of the tests in **Table 4** show that the model used still needs to be distributed, as seen from the Jarque Bera p-value, which is smaller than 5 per cent. Therefore, changes to the data must be made using the natural logarithm or LOG method. Researchers perform natural logarithms on the dependent variable so that SRISK becomes LOGSRISK.

Table 5. Normalilty Test Result (LOGSRISK)

Test	P-Value (Jarque Bera)	Result
Normality Test	0.238	Normally distributed

Source: Author, Processed Data, 2023

The results in **Table 5** show that the probability value is 0.2381 or greater than 5 per cent, so the research model is normally distributed.

After the data is normally distributed, the multicollinearity test continues. The multicollinearity test is a test that aims to see whether there is a high correlation between independent variables. The high correlation between independent variables will ensure the research model meets the requirements for a good model or BLUE (Best Linear Unbiased Estimator). In this study, researchers used the VIF test to test multicollinearity. Following are the results of the VIF Test:

Table 6. VIF Test

Variable	VIF	Result
SIZE	5.853	
NII	502.025	There is Multicollinearity
NII*S	539.541	There is Multicollinearity
ROE	2.383	
GDPG	1.003	
INFLATION	1.102	
LIQUIDITY	1.319	
CREDIT RISK	2.716	

Source: Author, Processed Data, 2023

The VIF test produces the VIF value of each variable. If the VIF value is greater than 10, it is indicated that there is a multicollinearity violation. The test results in **Table 6** show that the variables NII and NII*S have violations of multicollinearity or a reasonably high correlation between the two variables. So, it is necessary to transform the data using the natural logarithm method to eliminate multicollinearity. So, after carrying out the natural logarithm method on the NII*S variable, the results were obtained :

Table 7. VIF Test (After Natural Logarithm on NII*S & NII)

Variable	VIF	Result
SIZE	2.203	No Multicollinearity
NII	8.030	No Multicollinearity

Jurnal Manajemen
e-JM
E-ISSN: 2549-8797
ISSN: 1410-3583

NII*S	8.428	No Multicollinearity
ROE	2.845	No Multicollinearity
GDPG	1.010	No Multicollinearity
INFLATION	1.084	No Multicollinearity
LIQUIDITY	1.517	No Multicollinearity
CREDIT RISK	2.868	No Multicollinearity

Source: Author, Processed Data, 2023

Table 7 shows that after using the natural logarithm on the NII*S variable, it can be seen that there is no multicollinearity in all the test variables in this study. After carrying out the multicollinearity test, the research continued with SRISK measurements, which obtained the following results:

Table 8. SRISK calculation table from Sample Bank
(Measured in USD in Millions)

Bank	Average	Max	Min	Std Dev.
AGRO	7.013	35.063	0.000	14.390
AGES	0.000	0.000	0.000	0.000
BABP	0.000	0.000	0.000	0.000
BACA	5.137	25.683	0.000	10.540
BBC	0.000	0.000	0.000	0.000
BBKP	204.703	418.684	0.000	183.990
BBMD	0.000	0.000	0.000	0.000
BBNI	1,351.202	1,999.995	514.208	571.285
BBRI	0.000	0.000	0.000	0.000
BBTN	1,358.355	1,722.414	992.087	277.170
BBYB	0.000	0.000	0.000	0.000
BDMN	38.372	138.844	-	55.680
BEKS	0.000	0.000	0.000	0.000
BGTG	0.000	0.000	0.000	0.000
BINA	0.000	0.000	0.000	0.000
BJBR	0.000	0.000	0.000	0.000
BJTM	50.156	119.548	0.000	48.269
BKSW	0.000	0.000	0.000	0.000
BMAS	0.000	0.000	0.000	0.000
BMRI	361.259	1,309.485	0.000	524.962
BNGA	562.697	707.645	509.905	75.195
BNII	134.480	297.667	0.000	125.713
BALI	0.000	0.000	0.000	0.000
BTPN	6.263	31.313	0.000	12.851
BVIC	73.400	116.810	32.235	29.895
MAYA	106.477	350.287	0.000	144.495
MCOR	2.830	14.149	0.000	5.807
MEGA	0.000	0.000	0.000	0.000
NISP	86.237	230.980	0.000	108.822
NOBU	0.000	0.000	0.000	0.000
PNBS	0.000	0.000	0.000	0.000
SDRA	0.000	0.000	0.000	0.000

Source: Author, Processed data, 2023

Jurnal Manajemen
e-JM
E-ISSN: 2549-8797
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Table 8 shows explains the average, highest and lowest values of SRISK. As previously explained, SRISK is used as a proxy to measure a bank's systemic risk level in the form of an estimated value of additional capital that must be added to a bank during market pressure or a crisis. Because the SRISK value is the value of the estimated capital that must be added when market pressure occurs, the SRISK calculation's negative value is not considered. From the results of this processing, it can be interpreted that the bank with the highest average SRISK value is the bank that has the most systemic risk and vice versa; the bank with the lowest SRISK value can be considered a bank that does not have systemic risk when market pressure occurs or during a crisis. The following table shows that Bank Tabungan Negara has the highest systemic risk, as seen from the highest average SRISK compared to other banks, followed by Bank Negara Indonesia. Meanwhile, Bank Central Asia, Bank IBK, Bank MNC, Bank Ganesha, Bank Permata (and other banks that do not have an SRISK value) are considered to have no systemic risk when market pressure occurs or during a crisis.

Table 9. Descriptive Statistic
(Measured in USD in Millions)

Bank	Mean	Maximum	Minimum	Std. Dev.
SRISK	143.701	1,999.995	-	369.663
SIZE	24.824	28.314	22.071	1.683
NII	11.412	32.530	0.780	7.687
NII_S	291.251	916.389	19.703	211.633
CREDIT_RISK	1.785	33.470	- 2.590	3.419
GDP	183.769	199.976	167.193	8.402
INFLATION	2.784	5.550	1.430	1.129
LIQUIDITY	72.508	85.760	44.250	8.814
ROE	3.128	21.460	- 90.310	14.050

Source: Author, Processed data, 2023

Table 9 shows is descriptive statistics for the variables used in this research. From the data used for the research period, the bank with the largest assets is Bank Mandiri, with an asset value of 1.980 trillion Rupiah in 2022, and the bank with the lowest assets is Bank Ina Perdana, with an asset value of 3.850 trillion in 2018. The increase in assets from Bank Mandiri is sufficient. This is significant due to the merger activity between BRI Syariah Bank, Bank Syariah Mandiri and Bank BNI Syariah, a subsidiary of Bank Mandiri. The second largest bank in terms of assets is Bank BRI with the code BBRI, where assets in 2022 will reach 1.847 trillion, followed by Bank BCA with assets of 1.307 trillion in 2022.

The non-interest income ratio averages 11.412 per cent, with the highest value being 32.530 per cent owned by Bank Mandiri. This shows that Bank Mandiri relies on a non-interest income of 32.530 per cent for its income. This can also mean that most banks in Indonesia still rely heavily on interest income; however, the bank will encourage the digitization of transactions from Mobile Banking and Business Banking. This is expected to increase fee-based income, which will also increase non-interest income from the bank. Currently, non-interest or fee-based income from banks still relies on income from the digitization of mobile banking and business banking. Quoted from the same source,

Jurnal Manajemen
e-JM
E-ISSN: 2549-8797
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according to the President Director of BCA, as of March 2022, transactions from BCA Mobile Banking grew by 45 per cent YoY.

For credit risk, which is described by the level of provisions for credit losses compared to the total credit disbursed, Bank Raya Indonesia had a ratio of 33.470 per cent in 2022. This provision level ratio can describe the health condition of the bank's credit. The higher the reserve ratio, the higher the credit with non-performing credit status.

For ROE, the bank with the largest ROE is Bank Mega. In 2021, Bank Mega's ROE will reach 21.460 per cent. Bank Mega's high ROE is consistent in 2022, reaching 20.380 per cent. This shows that Bank Mega will gain high profits in 2021 and 2022 for its shareholders. This cannot be separated from Bank Mega's efforts to make its operational activities more efficient, which continues to reduce the BOPO ratio (Operating Costs to operational income).

Table 11. Panel Regression Result
(Measured in USD in Millions)

Independent Variable	**Random Effect Model**	
	Coefficient	**Prob.**
SIZE***	2.076	0.000
NII***	-0.087	0.001
LOGNIIS	0.251	0.327
Control Variable		
LIQUIDITY***	0.075	0.000
GDPG	0.004	0.526
CREDIT_RISK	-0.026	0.619
ROE***	-0.039	0.001
INFLATION	-0.001	0.971
R-Squared	0.436	
Adjusted R-Squared	0.410	
F-Statistic	16.352	
Prob(F-Statistic)	0.000	

Notes: The best-selected model is the Random Fixed Model
*Significant at 10 percent, ** Significant at 5 percent, ***Significant at 1 percent
Source: Author, Processed Data, 2023

Table 11 shows is the result of panel regression using the Random Fixed Model. The regression results show that SIZE and NII significantly impact systemic risk as measured using SRISK, with a significance level of 1 per cent. LIQUIDITY and ROE, control variables, also significantly impact systemic risk, with a significance level of 1 per cent.

DISCUSSION

The spread of COVID-19 occurred, and it cannot be denied that the Indonesian capital market was also affected by the spread of COVID-19. This can be seen from the correction of the Indonesian stock exchange, which is illustrated by the movement of the IHSG during the 2020 period. There was quite a drastic decline in the IHSG in March 2020, when it was first announced that COVID-19 had begun to enter Indonesia and finally started to spread in Indonesia. This is by research conducted by (Li et al., 2023), which stated that in 2020,

Jurnal Manajemen
e-JM
E-ISSN: 2549-8797
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the JCI recorded an abnormal negative return, which was the impact of the spread of COVID-19, and the abnormal negative return had more impact on the financial, real estate and construction.

The JCI movement in 2020 meets the LRMES conditions where there are 6-month cumulative returns that are below -40 per cent. The low number of days with six-month returns below -40 per cent cannot be separated from the regulations issued by the regulator during the COVID-19 emergency period issued by the IDX through Directors' Decree No. Kep-00023/BEI/03-2020 and Kep-00024/BEI/03-2020. This Board of Directors' decision regulates the position of the Lower Auto Reject on the capital market during the COVID-19 emergency period, better known as the Asymmetric Lower Auto Reject regulation, which stipulates that during the COVID-19 emergency period, the Lower Auto Reject value of each share is limited to a maximum decrease of 7 per cent and the Upper Auto Reject value remains around 20 percent-35 per cent depending on the share price.

Apart from that, it is also regulated that if there is a decline in the JCI, if there is a decline of up to 5 per cent, a Trading Halt will occur for 30 minutes. If the decline continues to 10 per cent, the Trading Halt will be enforced again for 30 minutes. Moreover, the JCI continues its decline of up to 15 per cent in 1 trading day. In that case, a Trading suspension will be implemented until the end of the trading session or more than one trading session after obtaining approval or orders from the OJK. This regulation has been in effect since March 10, 2020, hoping to maintain the decline in share prices and IHSG within reasonable limits during emergency conditions caused by the spread of COVID-19.

The banking sector also experienced a decline in the first quarter of 2020, as seen from the daily stock price sampling above. There is a similar pattern where banking shares experienced a significant decline in March 2020, and this is the impact of the entry of the COVID-19 virus into Indonesia. BBCA shares, for example, experienced a decline of 1,920 points from the previous price of 6,200 to 4,430 per share price in a relatively short time, namely 18 days. Meanwhile, Bank Mandiri shares experienced a decline of 1,865 points from March 5 2020 to March 24 2020. Bank BNI also experienced a decline of 1,915 points in the same period. This was also followed by CIMB Niaga Bank, which experienced a decline of 295 points for 18 days from March 5 2020. Bank OCBC NISP experienced the lowest decline of 155 points from the previous price on March 5 2020, but this share experienced the longest downward trend compared to other banks. That is, for 75 days. In processing the data, the author used data from 32 banks listed on the Indonesia Stock Exchange from 2018 to 2022.

In this research, the variable used is SRISK as a proxy for Systemic Risk in Indonesia. Then there are other variables such as Bank Size (SIZE), which is described from the natural logarithm of total bank assets, non-interest income (NII) and credit risk (CREDIT_RISK), which is described from the level of bank reserves. Provision for losses compared to the total loans disbursed by the bank, Liquidity (LIQUIDITY), which is described by total deposits compared to total bank assets and Bank Complexity (NIIS), which is a multiple of SIZE and also NII, ROE, Inflation and also GDP Growth.

From the regression results shown in **Table 11**, we can see that in terms of bank size, as measured by the natural logarithm of bank assets, it shows a positive and significant coefficient at a significance level of 1 per cent. This shows that bank size, as measured by bank assets, has a positive effect on the SRISK of a bank, which can be interpreted as the more significant the bank size, the greater the potential for systemic risk to occur. Research

conducted by (Bank Indonesia et al., 2021) shows that carrying out banking consolidation will increase banking capital, increasing banking resilience in terms of shocks that occur, thereby reducing the risk of each bank. However, it should be noted that banking consolidation will increase banking concentration and the Contagion effect so that if a bank fails, the impact of the contagion will also be more significant. Otoritas Jasa Keuangan, in its duty to organize a regulatory and supervisory system in the financial services sector, issued POJK No. 12/POJK.03/2020, which discusses bank consolidation. This regulation regulates the minimum core banking capital of IDR 3 trillion. POJK No. 12/POJK.03/2020 aims to strengthen the structure of banking resilience and competitiveness to encourage national stability and growth. With this regulation, it encourages banks in Indonesia to increase core capital. By carrying out this consolidation, it is hoped that the bank will gain an increase in business scale and more robust capital due to increased capital and assets from the bank (its structure will become more extensive). With this consolidation, banks are also expected to become more innovative in providing services. This can be seen from the trend that larger banks are considered healthier in acquisitions of smaller banks and then building digital banks. With the trend of increasing digital banking in Indonesia, there is a visible shift in the trend from previous banks being intermediaries, namely financial institutions whose business activities were collecting funds and distributing credit funds so that their income came from interest income, starting to become financial services companies that began serving debtor transactions digitally and their income. Comes from transaction fees. This certainly diversifies income for banks in Indonesia.

This research shows in **Table 11** that non-interest income from a bank impacts systemic risk as measured through SRISK. The results of this research are in line with research conducted by (Kamani, 2019; Cai et al., 2018; Maghyereh et al., 2022; C. Wang et al., 2022;) which shows that diversifying bank income, namely with non-interest income, will have an impact on systemic risk. This research shows that diversifying income will reduce systemic risk, indicated by non-interest income. This research has different results from those conducted by (Yang et al., 2020); the research results stated that diversification of bank income would increase systemic risk in banking. This might happen because the research conducted in the United States, which has a diversification nature, is more focused on trading CDO and CDS derivative portfolios, which increases the linkage between banking portfolios. In contrast, Indonesia is more focused on SPOT and derivatives for hedging purposes, which do not increase the linkage between banking portfolios.

However, different results are shown from the NIIS variable, which describes the level of complexity of banking activities in Indonesia, where the level of complexity of banking activities does not significantly influence systemic risk. (Due to heteroscedasticity problems, the NII*S data was transformed using the LOG method). There is a possibility that banks in Indonesia are more dependent on interest income (Shown in **Table 1**), causing their activities to be less complex and thus not having a significant impact on systemic risk in Indonesia. This supports the Too Complex Too Manage hypothesis theory, which states that banks consisting of many activities will be more complex and more difficult to manage.

(Martynova et al., 2022) Who, in their research, tried to examine bank complexity and said that more complex bank activities would increase the risk to the bank. This research tries to divide complexity into two aspects: geographic complexity and business complexity. Business complexity refers to how banks' increasingly diverse business activities can increase difficulties in management and assessment. Table 5 shows that bank revenue

activities in Indonesia are still more focused on interest income than non-interest income. With the banking business in Indonesia still more focused on interest income, the level of complexity could be higher, so systemic risk in the banking system in Indonesia is not impacted. Research (Correa et al., 2022) states that banks with different business lines will increase the complexity of the bank's business efforts and increase each bank's systemic risk. For example, banks in Indonesia also offer products such as Bancassurance as a new business line from banks, but POJK No. 33/SEOJK.03/2016 states that banks may not bear the risk of selling insurance products, and if there are products integrated with the bank's product, the bank may only bear the risk of the bank's product. This reduces the impact of risks from the complexity of the bank's business and divides the risks so that the impact of business complexity can be reduced.

The control variables used in this research show that all significantly affect systemic risk in Indonesia. Liquidity, described by comparing total deposits to a bank's total current assets, shows a positive coefficient and has a significant effect with a significance level of 1 per cent. This shows that an increase in deposits compared to total bank current assets will increase systemic risk in the banking system in Indonesia.

Research from (Zhang et al., 2021) states that excessive liquidity creation from a bank will increase systemic risk for that bank. This is because banks in the intermediary process need funds from depositors as funds that will be distributed to debtors. Funds deposited by depositors are current liabilities for the bank because the bank promises easy withdrawal of funds, which can be done at any time by depositors even though the funds are channelled as credit, which is a non-current asset for the bank. This causes excessive liquidity to cause systemic risk for banks (Zhang et al., 2021).

Likewise, ROE shows a negative coefficient with a significance level of 1 per cent, which means that a better or higher ROE for a bank will negatively impact or reduce systemic risk in banking in Indonesia. This is because ROE is a ratio used to measure a company's net rate of return compared to its capital. The higher the ROE, the better the company can manage its capital to gain profits. This is useful for improving its reputation among players in the capital market and the public. In other words, if a bank gets a higher ROE, this will positively impact public trust in the bank and reduce the possibility of systemic risks. (Moussu et al., 2017) They have tried to examine the role of ROE as an indicator or measuring tool of bank profitability before and during the crisis. The results of this research found that ROE can be used as an excellent proxy to measure the level of risk exposure of a bank and the bank's vulnerability to crises. (Xu et al., 2019) Their research stated that a bank's profitability is negatively related to systemic risk. This is, of course, in line with the findings from this research, where ROE, which is used as a measure of a bank's profitability, is negatively related to systemic risk. This study shows that inflation does not significantly affect systemic risk in Indonesia. Research from (Sánchez et al., 2023) tries to examine the relationship between inflation and systemic risk in 12 European countries. This research shows that inflation increases the systemic risk of 12 European countries. Apart from that, there are findings that inflation has more influence on increasing systemic risk than increasing interest rates because the central bank increases interest rates due to the impact of increasing inflation. Research from (García et al., 2023) also states that targeting low inflation is the optimal macroeconomic policy to reduce financial pressure. If seen from the Indonesian context, Indonesia has an inflation target of 3 ± 1 per cent. Judging from the history of inflation in Indonesia, inflation in Indonesia during the 2018 to 2022 period was

relatively low and maintained according to the target, so inflation in Indonesia did not impact the systemic risk of banking in Indonesia.

Meanwhile, GDP growth in this study also did not significantly affect systemic risk in Indonesia. The results of this research align with those of (Kamani, 2019), which shows that GDP growth does not influence systemic risk.

CONCLUSION

From this research, Bank size as measured by assets has a significant favourable influence on systemic risk. This can be interpreted as the larger the size of a bank, the higher the bank's contribution to systemic risk in the banking system in Indonesia and vice versa. This is because the more significant the bank, the stronger it is at dealing with shocks that occur, and it also increases its ability to absorb losses when shocks occur. However, increasing the size of the bank will increase the contagion effect that occurs, and if a bank fails, it will have a more significant systemic effect.

Non-interest income in banking in Indonesia significantly negatively affects systemic risk in Indonesia. This shows that the existence of non-interest income will reduce systemic risk. This is because the non-interest income obtained by banks in Indonesia is mainly obtained from SPOT and derivative trading activities for hedging purposes and not from trading CDO and CDS derivative portfolios as in the United States and Europe, so it does not increase portfolio linkages between banks. However, banks in Indonesia still rely more on interest than non-interest income. Non-interest income is obtained from Spot and Derivative transactions with a concentration that tends to be lower than interest income. With banks in Indonesia still focusing on interest income rather than non-interest income, the level of business complexity described by the interaction between size and non-interest income also does not significantly affect systemic risk in Indonesia. Apart from that, even though banks in Indonesia have various product lines and businesses, clear regulations state that banks can only bear the risks of the banking products themselves.

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