

The Interaction Between Monetary and Macroprudential Policy to Achieve Price and Financial Stability: An Evidence from Indonesia

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Abstract

The 1998 Asian Financial Crisis was a milestone in the existence of structural policy reforms in the Indonesian financial sector. Most of the empirical results show that the financial crisis was caused by the lack of soundness and instability of the financial sector. This problem changed the perspective of Bank Indonesia, the central bank in Indonesia, that financial stability is as important as price stability. This highlights the need for the central bank to also ensure financial stability, while monetary policy focuses on price stability and economic growth. However, achieving these goals does not always ensure financial stability. To address systemic risk, Indonesia has begun adopting macroprudential policies. Thus, monetary policy cannot secure both price and financial stability, and a policy mix with macroprudential measures is needed to achieve both price and financial stability. This research examines the relationship between monetary and macroprudential policies and their effects on stability. Monetary policy was measured by the BI Rate and macroprudential policy was measured by Loan to Value (LTV). Price stability was proxied by inflation, and financial stability by credit growth. We analyzed the causality between the variables using the Vector Autoregression Model (VAR) and Granger Causality Test, using quarterly time series data from 2005:Q1 to 2018:Q3. The findings indicate that monetary and macroprudential policies significantly affect price and financial stability. Empirical findings show that tightening the BI rate and LTV significantly reduces inflation and credit growth. This paper highlights the need for a policy mix to ensure price and financial stability.

Kata kunci:

Stabilitas finansial;
Kebijakan makroprudensial;
Kebijakan moneter;
Stabilitas harga.

Abstrak

Krisis Keuangan Asia 1998 merupakan tonggak penting dalam sejarah reformasi kebijakan struktural di sektor keuangan Indonesia. Sebagian besar hasil empiris menunjukkan bahwa krisis keuangan tersebut disebabkan oleh kurangnya ketahanan dan stabilitas sektor keuangan. Masalah ini mengubah perspektif Bank Indonesia bahwa stabilitas keuangan sama pentingnya dengan stabilitas harga. Hal ini menyoroti kebutuhan bagi bank sentral untuk memastikan stabilitas keuangan mengingat kebijakan moneter berfokus pada stabilitas harga dan pertumbuhan ekonomi. Namun, pencapaian tujuan-tujuan ini tidak selalu menjamin stabilitas keuangan. Untuk mengatasi risiko sistemik, Indonesia mulai mengadopsi kebijakan makroprudensial. Kebijakan moneter tidak dapat menjamin stabilitas harga dan keuangan secara bersamaan, dan memerlukan perpaduan kebijakan dengan pengukuran makroprudensial untuk mencapai keduanya. Penelitian ini menganalisis hubungan antara kebijakan moneter dan makroprudensial serta dampaknya terhadap stabilitas finansial. Kebijakan moneter diukur melalui BI Rate, sedangkan kebijakan makroprudensial diukur melalui Loan to Value (LTV). Stabilitas harga diproksikan oleh inflasi, dan stabilitas keuangan oleh pertumbuhan kredit. Kami menganalisis kausalitas antara variabel-variabel tersebut menggunakan Model Regresi Vektor Otoregresif (VAR) dan Uji Kausalitas Granger, dengan menggunakan data seri waktu

kuartalan dari 2005:Q1 hingga 2018:Q3. Hasil penelitian menunjukkan bahwa kebijakan moneter dan makroprudensial memiliki dampak signifikan terhadap stabilitas harga dan keuangan. Temuan empiris menunjukkan bahwa pengetatan suku bunga BI dan rasio LTV secara signifikan mengurangi inflasi dan pertumbuhan kredit. Artikel ini menyoroti perlunya kombinasi kebijakan untuk memastikan stabilitas harga dan keuangan.

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1. Introduction

The role of the central bank in achieving financial stability has become very important in recent years given the various crises and shocks that occurred in various countries are generally caused by instability in the financial sector (Warjiyo, 2016). The set of low interest or loosened rate in monetary policy could induce the risk-taking behaviour in the banking sector (Maddaloni & Peydro, 2013). Banks tend to take higher risks by channelling more credit, which can potentially trigger a crisis similar to the 2008 financial crisis in the United States of America. This phenomenon is reflected in the rise of bank housing loans which securitized and traded in the financial system. The correlation between macro finance and the economic boom in superpower countries increased the systemic risk which results in a terrible financial crisis and impacts all parts of the world (Warjiyo, 2016).

In a period of economic boom which supported by controlled price stability (inflation) and low interest rates as in the Great Moderation era in the United States of America, the inducement the level of investment returns and increasing in value of assets (financial and physical) will be higher than debt interest rates or capital costs. The perception of the expected investment returns will continue to be high during the period of the economic boom, which will encourage the rapidly trade of money and capital to financing those investments with will cause debt accumulation, whether from bank credit or foreign debt, to become increasingly out of control.

The distribution of credit to support economic growth is essential, but risky if not aligned with prudential principles. Monetary and microprudential policies alone cannot fully address systemic risks arising from the interaction between the financial system and macroeconomic conditions. While microprudential focuses on the soundness of individual banks or financial institutions, monetary policy focuses to achieve the price stability and support the maintenance of financial stability (Warjiyo, 2016). Financial crises that have occurred in various parts of the world have changed the perspective of central banks in the world that is not sufficient just

to maintain the price stability. On the other hand, maintaining the financial stability is also important for the economic condition (Pecaric & Viskovic, 2013). Therefore, it is necessary to have policies that could support the financial stability by mitigating systemic risks which will arise from the interaction between macroeconomics and the financial sector.

2. Literature Review

Monetary Policy and Macroprudential Policy

When Indonesia was hit by a crisis in 1997 and 2008, many parties especially policymakers realized the importance of maintaining financial stability. Achieving price stability through monetary policy alone is insufficient if it is only accompanied by maintaining overall economic stability. Therefore, there is a need for other policies that can complement monetary policy in achieving the price stability and financial stability. Macroprudential policy is a policy which has the main objective to maintain financial stability through limiting systemic risk (International Monetary Fund, 2017). Gerlach et al. (2009) explained the relationship between monetary policy and macroprudential policy depends on the subsequent effects of each policy on the objectives and how these policies could take the place in order to achieve the main objectives respectively.

The financial system has a tendency to be procyclical, so that would be induced the excessive of economic fluctuations. According to Agung et al. (2016) the role of "leaning" macroprudential policy can support the objectives of monetary policy by maintaining price and output stability. Monetary policy and macroprudential policy would collaborate with the same paradigm, namely countercyclical, the two policies are interrelated to one another. As a consequence of these dynamics, the condition of economic slowdown can directly impact the performance of bank lending and quality (Bank Indonesia, 2016).

Within the broader academic literature, Claessens et al. (2013) asserted that macroprudential policies are most effective when they are specifically tailored to address the unique vulnerabilities of a country and coordinated with the monetary policy. They illustrate how certain instruments are more effective in mitigating credit booms, asset bubbles, and systemic risks. Additionally, Bruno and Shin (2015) note that global liquidity and capital flows significantly interact with domestic financial conditions, indicating that macroprudential tools like the Loan-to-Value (LTV) ratio must be carefully calibrated to ensure both internal and external stability.

These insights underscore the analytical importance of examining the policy mix in Indonesia. The inflation targeting framework in monetary policy is

complemented by macroprudential policies in order to achieve price stability and financial stability (Warjiyo, 2016). Therefore, according to Warjiyo (2016), monetary policy and macroprudential policy can be transmitted together into the financial system. As a result, the two policies are transmitted to the final target by considering macroeconomic analysis and forecasts as well as microfinance to achieve the ultimate goals of Bank Indonesia, which is the price stability and financial stability.

Price Stability and Financial Stability

The relationship between financial stability and price stability is very close and can even be mutually reinforcing. The policies can impact financial stability through interest rates, exchange rates, liquidity and bank credit. This is supported by Warjiyo (2016) who argued that the stability of the financial system determines the effectiveness of monetary policy transmission in maintaining the economic condition.

The crisis that hit Indonesia in 1998 was conducted by an increase in market, credit and bank liquidity risks, which in turn would create the systemic risks that could disrupt the function of the financial system in monetary transmission, so the economic growth and the price stability would be disrupted (Simorangkir, 2014b). The pursuit of price stability through monetary instruments is essential to ensure broader financial stability. However, stability can lead to instability itself, such as the bad condition at the United States of America in 2008 which reflected the conditions of low inflation and low interest rates would induce the risk-taking behavior of banks in channelling loans, especially housing loans, so encouraging high levels of debt could trigger systemic risk. Borio and Shim (2007) argue that financial instability can persist even when inflation is contained. Therefore, low inflation and stable macroeconomic conditions are not sufficient to guarantee financial stability.

Table 1. Price Stability and Financial Stability Scenario

Probability of Financial Stability Risk		High	Low
		High	Quadrant II a. Monetary Policy: Tight b. Macroprudential: Tight
Low	Quadrant I a. Monetary Policy: Tight b. Macroprudential: Neutral/Leaning	Quadrant III a. Monetary Policy: Neutral/Leaning b. Macroprudential: Neutral/Leaning	

Source: (Warjiyo, 2016)

Based on the scenario in table 1, the interaction between price and financial stability is determined by the level of estimated risks in both forecasts of price stability risk and financial stability risk. When risks are low, as represented in Quadrant I, means that monetary policy can be loosen up or there is no need for any changes followed by neutral or also loose macroprudential policy. This condition is usually aimed to increase the economic growth.

In another scenario, the situation would differ if one of the stability objectives faced high-risk forecasts. For example, consider the interaction between price stability and financial stability in Quadrant II, where financial stability risk forecasts are high. In this case, macroprudential policy needs to be tightened. Under these economic conditions, monetary policy would be most effective if it plays a "leaning" role against the forecasts of further financial stability risks. Conversely, when conditions are in Quadrant IV, where financial stability risk forecasts are low while price stability risk forecasts are high, monetary policy clearly needs to be tightened. In this scenario, macroprudential policy should "lean" toward supporting price stability forecasts, thereby enhancing the effectiveness of monetary policy.

Monetary Policy and Price Stability

In achieving and maintaining the price stability, the central bank as a monetary authority makes efforts in the form of monetary policy determination. Monetary policy regulates money supply and interest rates to achieve ultimate goals such as inflation control, economic growth, and external balance. Monetary targeting is amount to control money supply in the form of base money (M0), demand deposits (M1), and quasi money (M2) (Simorangkir, 2014a).

The control of the money supply needs to be regulated and maintained in the economy because if the money supply is excessive, it will increase prices and would induce high inflation that could decrease people's purchasing power. However, if the money supply is too low, it will create a recession phase in the economy. Similarly, interest rates must be carefully managed because interest rates that are too low can fuel an increase in credit demand, potentially leading to inflation, while excessively high rates can suppress credit and investment, ultimately hindering economic growth. Therefore, the central bank's ultimate goal is to control these monetary magnitudes to achieve key macroeconomic targets, including price stability (inflation and exchange rates), economic growth, reduced unemployment, and a balanced payment.

The monetary policy framework experienced in several evolutions following changes in economic conditions in a country (Sethi et al., 2019). Initially, the central banks adopted monetary targeting, which emphasized money demand stability. However, in practice the monetary targeting policy framework increases the inflation rate. This is proven by Sethi et al. (2019) which shows that the monetary targeting framework through an increase in money supply makes the inflation rate increase and the output gap negative, but the monetary policy framework in the form of a multiple indicator approach and inflation targeting framework is effective in reducing the inflation rate especially in India. In that way, inflation targeting framework is more effective and generally applied in several countries in the world until now, including in Indonesia. This policy framework emphasizes that the central bank sets a medium-term inflation target to achieve price stability as a long-term goal and the inflation target is publicly announced transparently so that central bank accountability increases.

In Indonesia, the monetary policy framework can be divided into operational and strategic frameworks. The operational framework consists of monetary policy instruments such as open market operations, discount facilities, minimum reserves requirement, and the interest rates. Meanwhile, the strategic framework consists of intermediate targets, which are credit, money supply, and long-term interest rates and the final target, namely inflation and economic growth. Therefore, in a monetary policy framework consisting of monetary policy instruments, operational targets, intermediate targets and final targets are grouped into operational and strategic frameworks.

There are two approaches in the monetary policy framework in Indonesia, which are the quantitative approach and the price approach (Bank Indonesia, 2016). A monetary policy framework based on the quantitative approach, which controlled the money supply in order to achieve price stability. On another hand, a

monetary policy framework based on a price approach, which focuses on regulating and maintaining prices by controlling interest rates to achieve the ultimate goal of monetary policy. Therefore, within the framework of monetary policy, the central bank employs several channels, including interest rate, credit, asset price, expectations, and exchange rate channels.

Macroprudential Policy and Financial Stability

Macroprudential policy aims to maintain overall financial stability through limiting the increase in systemic risk (Lim et al., 2011). This can be achieved by preventing the boom-bust of credit supply and liquidity, which could induce economic instability (Warjiyo, 2016). Macroprudential policy also encourages a balanced and quality banking intermediary function that improves efficiency and access in the financial system. Furthermore, macroprudential policy also exists to complement monetary policy that is unable to maintain financial stability itself, because financial instability is not always related to the level of liquidity in the system that can be overcome by monetary policy (International Monetary Fund, 2013).

Pecaric and Viskovic (2013) found that the effectiveness of macroprudential policies can improve financial stability. In their research, macroprudential policy can reduce the level of Non-Performing Loans (NPL). The researcher also concluded that the policy could increase bank profitability and be able to influence the liquidity of the bank itself. The author used sample data in several Central and Southeast European (CSE) countries from 1998-2010 and used the LTV instrument as an indicator of macroprudential policy. Similarly, Dumovic (2018) examined macroprudential policies in Central and Eastern European countries and found that ten macroprudential policy instruments can reduce household credit growth, indicating their role in mitigating excessive credit expansion and systemic risk.

The financial stability and limiting systemic risk are the final targets to be achieved by macroprudential policy. Although financial stability is difficult to define, previous researchers have classified it into two perspectives: positive and negative. The positive definition, according to Schinasi (2004), defines financial stability as the soundness of financial institutions, financial market conditions, and the effectiveness of the various components of the financial infrastructure. The negative definition, according to Issing (2003), states that financial instability is related to bubbles and market volatility. Stability in the financial sector can be observed through market performance (volatility and deviation of share prices), financial institutions (capital adequacy ratios, profitability, NPL), and financial infrastructure. Financial stability will be achieved if the financial sector does not have the potential to create systemic risk. Systemic risk arises from the mutually

reinforcing interactions between shock and the vulnerability in financial sector (Lim et al., 2011).

There are researchers who use Financial Soundness Indicators (FSI) as indicators of financial stability which include capital adequacy ratio (CAR), asset quality, profitability, liquidity, and the level of sensitivity to market risk (International Monetary Fund, 2003). The European Central Bank (ECB) also identified other indicators, such as Macroprudential Indicators (MPIs), which try to identify and measure quite a large number of factors affecting the financial soundness of the European banking sector, one of that could be reflected by credit growth and aggregate lending.

There are two dimensions that can explain systemic risk including based on cross-section and time-series dimensions (Schwerter, 2011). Systemic risk which viewed from the cross-section dimension explain how risks are distributed in the financial system in a given period caused by the existence in similar exposure (concentration risk) and interlinks between institutions in the financial system (contagion risk). On the other hand, the time-series dimension describes that systemic risk arises due to the behavior of the entire financial system which tends to be procyclical. In addition, other risks such as credit, liquidity, market, and operational risks faced by individual banks can also trigger systemic risk. Financial stability can be maintained if financial institutions hold sufficient buffers and liquidity, which can be supported through macroprudential policy.

In the research regarding the effectiveness of macroprudential policies, Lim et al. (2011) identified a variety of instruments to mitigate systemic risk in 49 countries. Macroprudential instrument such as LTV, Debt to Income (DTI), reserve requirements, maximum credit restrictions, countercyclical capital requirements, and dynamic provisioning are effective instruments to reduce risks arising from the procyclical financial cycle (time-series dimension). Meanwhile, instruments like currency and maturity mismatch limits address risks from similar exposures (cross-sectional dimension). Policy approaches to systemic risk can be grouped into credit-related, liquidity-related, and capital-related measures. If the authorities would like to influence the amount of lending, the right policy instruments to use are the LTV, DTI, caps on foreign currency lending and ceilings on credit. In regulating the amount of liquidity, the match policy instrument limits net open currency positions (NOP). Net Open Position (NOP) limits measure the difference between banks' foreign currency assets and liabilities to control exchange rate exposure. Additional regulatory tools include maturity mismatch limits and reserve requirements for liquidity management, while capital adequacy is strengthened through

countercyclical requirements, dynamic provisioning, and profit distribution restrictions.

In Indonesia, the use of macroprudential policy instruments is not much different from the various instruments as discussed by Lim et al. (2011). The instruments can strengthen capital and prevent excessive leverage, manage the intermediation function and control credit risk, liquidity risk, exchange risk, interest rate risk and other risks that have to be potentially for systemic risk (Bank Indonesia, 2016). In addition, macroprudential policy instruments must be able to limit the similarity exposures among financial institutions, enhance financial system infrastructure, and improve overall efficiency and access. The macroprudential policy instruments implemented in Indonesia include LTV, Countercyclical Capital Buffer (CCB), Macroprudential Intermediation Ratio (RIM), and Macroprudential Liquidity Buffer (PLM).

LTV is a macroprudential policy formulated for risk management in banks that provide mortgages. The purpose of this policy is to reduce the systemic risk that might arise due to the growth of housing loans, which in historical stated in financial crisis due to the mortgage crisis. From the macroprudential side, too high mortgage growth can encourage an increase in property asset prices that do not reflect the actual price (bubble), thereby increasing credit risk for banks (Simorangkir, 2014b). LTV can hamper speculative motives for property purchases by utilizing bank credit and strengthening bank risk management. At the end of 2018, banks are required to ensure that there is no transfer of credit to other debtors for a minimum period of one year. The LTV easing is valid if the bank has a Net NPL ratio $< 5\%$ and a gross KPR NPL $< 5\%$.

CCB is an additional capital that serves as a buffer to anticipate losses in the event of excessive credit growth or bank financing that can disrupt financial stability. The aim of the CCB instrument is to prevent an increase in systemic risk arising from excessive credit growth. Therefore, this is related to procyclicality behavior in lending conducted by banks, when the economy in boom condition, credit growth increases and vice versa when the economy is in a recession, credit growth decreases. The amount of CCB will be increased when the economy in boom condition and vice versa when the economy is in a recession then the amount of CCB is reduced. The CCB rate is seen based on the credit to Gross Domestic Product (GDP) gap as the main buffer, but there are other indicators, such as the financial cycle, GDP growth, loan growth, NPL and CAR.

RIM is an instrument used to encourage the intermediation function and reduce credit risk. The purpose of this instrument is to expand the credit/ financing component by including securities purchased by banks. The component in the RIM

instrument is the ratio between total credit plus securities owned to total third-party funds or in Indonesia known as *dana pihak ketiga* (DPK) plus securities issued. The range of RIM is in the range of 80-92%, RIM in the range of 80% is the lower limit, which shows that banks raise more funds from deposits compared to lending. Conversely, when RIM banks are greater than 92% shows banks distribute too much credit compared to raising funds from the DPK. Therefore, banks with a lower or upper limit will be subject to additional reserves. RIM can be used to strengthen the intermediation function and encourage financial market deepening.

PLMs are instruments that are used to manage liquidity and improve financial system resilience to overcome banks' liquidity procyclical behavior. This policy instrument can be adapted to the state of the financial system. In addition, PLM can act to complement the CCB instrument. The main component in PLM is high-quality liquid assets divided by total assets. Another option is the ratio of high-quality liquid assets divided by short-term deposits. PLM can be increased to collect a liquidity buffer when banks' risk-taking behavior and economic liquidity are increasing. Meanwhile, PLM can be reduced to deactivation to the level of 0% if the bank starts experiencing liquidity distress, there are indications that liquidity hoarding by the bank's liquid assets becomes unavailable and liquidity distress continues until its peak during the crisis. Indicators that can also be used in PLM include Indonesia Digital Monetary Aggregates Index, Overnight Volatility Index Spreads, and financial cycles.

Conceptual Framework

Bank Indonesia's policy mix was formally applied starting in 2010. This policy was prepared to achieve Bank Indonesia's objectives stated in the law to maintain price stability and financial stability. In achieving this goal, Bank Indonesia has a monetary policy to achieve price stability and macroprudential policy to achieve financial stability. This study aims to examine the application of Bank Indonesia's monetary and macroprudential policy mix to the stability of the Rupiah and the financial stability. The instruments of each policy are analyzed for their impact on each policy objective.

Picture 1. Conceptual Framework

Source: Author(s)

This study is further motivated by Minsky's (1992) financial instability hypothesis, which posits that extended periods of economic and financial stability can lead to excessive risk-taking behavior within the financial sector, thereby increasing systemic vulnerability. In Indonesia, such patterns have been evident through rapid credit growth and rising asset prices during stable periods. Macroprudential instruments, such as the LTV ratio, are intended to mitigate these risks, aligning with Minsky's (1992) assertion that stability can be destabilizing in the absence of appropriate safeguards.

3. Methods

This study aims to determine the impact of monetary and macroprudential policies on price stability and financial stability. The variables used to reflect monetary and macroprudential policies are the Bank Indonesia Rate (BI Rate) and LTV policy instruments respectively, while price stability and financial stability are reflected by inflation and credit growth variables. This study uses a Vector Autoregression (VAR) analysis and the Granger Causality technique to see the effect between variables. In the VAR analysis technique, all variables act as endogenous variables for other variables. In this case, each variable is influenced by the past value of the variable contained in the model. The Granger Causality Test analysis is used to see the direction of the causality relationship between variables. This is an interesting discussion, because monetary policy and macroprudential policy variables are determined directly by the monetary authority so that the policy variables are basically exogenous, but the VAR test assumes all variables are

endogenous. According to Pang & Siklos (2016) policy variables are endogenous because historical past each variable can affect all other variables in the model with lag.

The data used in this study are secondary data that generally sourced from Bank Indonesia, Financial Service Authority (OJK), and Central Bureau of Statistics (BPS). The type of data used is time series started from 2005:Q1 until 2018:Q3. Although more recent macroeconomic data are accessible, several critical variables, particularly those about macroprudential policies such as the LTV ratio, lack consistent quarterly data beyond 2014. The inclusion of incomplete or inconsistent data would undermine the reliability of the model. Consequently, this research focuses on a period during which all four key variables; BI Rate, LTV, inflation, and credit growth that are fully available and correspond with the policy emphasis during the early implementation of Indonesia's macroprudential framework.

Table 2. Indicators of the Variable

No	Variable	Definition of Data	Units	Source
1.	BI Rate	BI Rate is the base rate (policy rate) which is used by the central bank of Indonesia to shape the monetary policy.	Percent	Bank Indonesia & Central Bureau of Statistics
2.	LTV	The ratio between the value of the credit that can be given by the Bank to the collateral value in the form of property at the time of loan.	Percent	Bank Indonesia Regulation
3.	Inflation	The tendency of rising prices for goods and services in general simultaneously.	Percent	Bank Indonesia
4.	Credit Growth	The growth of credit that given by conventional bank in Indonesia.	Percent	Financial Service Authority

Source: Author(s)

Vector Autoregression (VAR)

Referring to the understanding of VAR, Gujarati (2004) distinguishes between the terms autoregressive and vector. The term autoregressive refers to the lag value of the dependent variable while the term vector refers to the involvement of two or more variables. In the VAR analysis technique, all variables are treated as endogenous allowing the model to capture correlations without necessarily reflecting causality, since current values are explained by their own past values and other related variables (Diebold, 2018). This makes VAR a widely applied tool in

forecasting and economic analysis, since it can simultaneously model interactions among variables and test economic hypotheses (Luetkepohl, 2011). Although policy variables such as the Bank Indonesia Rate and LTV are determined exogenously by the central bank, following Pang and Siklos (2016), they can be considered endogenous within VAR because policy decisions respond to past macroeconomic conditions with delays. This feedback mechanism supports the application of VAR to model the dynamic interactions among these variables.

The VAR model requires stationary conditions so that it is closely related to the stochastic trend which is a probabilistic prediction in which the true value will be known if an event has occurred, so it would be to bring up the data. A model is considered not stationary if it has a stochastic trend, because the direction of its movement cannot be predicted. Meanwhile the stationary condition will show a direction of movement that will return to its long-term return. Luetkepohl (2011) explains some of the terminology and notation in understanding stochastic processes related to VAR. For example, the variable is referred to as integrated of order d or $I(d)$ if the stochastic trend or instability can be removed by making a difference d .

Univariate regression only involves one variable. In contrast to univariate, the VAR model is a multivariate regression so that it involves two or more variables to allow cross- variable dynamics in which each variable is not only related to its own past, but also all related variables (Diebold, 2018).

According to Gujarati (2004), the Vector Autoregression (VAR) method offers several significant advantages that make it particularly attractive for econometric analysis. First, VAR is a simple method that eliminates the need to determine which variables are exogenous and endogenous, as all variables in the model are treated as endogenous, thereby avoiding the complex theoretical considerations required in traditional simultaneous equation models. Second, the estimation process in VAR models is straightforward because the ordinary least squares (OLS) method can be applied to each equation separately, making the computational process more manageable and accessible. Third, in terms of forecasting applications, the VAR method consistently produces superior forecasting results compared to more complex simultaneous equation models, demonstrating its practical effectiveness despite its methodological simplicity.

The model that can be built from the VAR analysis method is as follows:

$$y_t = \theta_0 + \sum_{i=1}^p \theta_1 Z_{t-i} + \varepsilon_t$$

Where:

- y_t : vector (m x 1) is a variable in VAR model
- θ_0 : vector (m x 1) is an intercept in the model
- $\theta_1, \dots, \theta_i$: coefficient matrix (m x m) which describe the cross dependency between variable
- ε_t : error vector matrix

One of the requirements in the VAR model is a stationarity as it belongs to time-series models. As a method that has a relation to the stochastic process, the VAR model in the condition stationary if the mean and variance are constant over the time and the covariance value between two time periods depends on the lag between two time periods and not the actual covariance time calculated or often referred to as covariance-stationary (Gujarati, 2004). Empirically stationarity is achieved if the modulus in the characteristic polynomial is less than 1. Initially, in testing stationarity, the VAR model is applied to the level. If the results obtained do not indicate stationary conditions, it is necessary to retest the first difference. If the first difference is still not obtained stationary results, then the test will be repeated on the second difference. After the stationarity test is performed the optimum lag determination is done through sequential modified LR test statistics (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quinn Information Criterion (HQ). Determination the optimum lag is important, as too few lags lead to biased results, while too large will consume the data. The optimum lag is then used in the VAR model and in testing causality through the Granger Causality Test.

Granger Causality

The Granger Causality Test is used to see the direction of causality between pairs of variables. Unlike the one-way causality relationship as x affects y, a causal relationship consisting of two directions is reciprocal where x affects y and y can also affect x. In this case, the Granger Causality Test can test whether there is a causality relationship and how it is directed through the significance shown by the probability of the relationship between pairs of variables. The equation for the Granger Causality model which involves two variables (bivariate) is as follows:

$$x_t = \alpha_1 + \sum_{i=1}^p \theta_{11x_{t-i}} + \sum_{i=1}^p \theta_{12y_{t-i}} + \varepsilon_{1t}$$

$$y_t = \alpha_2 + \sum_{i=1}^p \theta_{21} x_{t-i} + \sum_{i=1}^p \theta_{22} y_{t-i} + \varepsilon_{2t}$$

More clearly, Gujarati (2004) describes several possible results of the Granger causality test, among others:

1. Unidirectional causality from variable y to x will be indicated if the coefficient estimated in the variable y lag is statistically different from zero and the coefficient estimated at the variable lag x is not statistically different from zero ($\sum_{i=1}^p \theta_{12} \neq 0$) and the coefficient estimated at the variable x lag is statistically no different from zero ($\sum_{i=1}^p \theta_{11} = 0$).
2. On the contrary, the Unidirectional causality relationship from variable x to y occurs if the set of coefficients on the lag variable y is not statistically different from zero ($\sum_{i=1}^p \theta_{22} = 0$) and the set of coefficients on the lag variable x is statistically different from zero ($\sum_{i=1}^p \theta_{21} \neq 0$).
3. Feedback or bidirectional causality occurs when the set of coefficients y and x are statistically significantly different from zero in both regression ($\sum_{i=1}^p \theta_{12} \neq 0$ and $\sum_{i=1}^p \theta_{21} \neq 0$).
4. Independence occurs when the coefficients of y and x are not statistically significant in both regressions.

In this study, the Granger Causality Test is used to look at the direction of causality between the BI rate, inflation, LTV, and credit growth variables. Thus, the Granger model used in the study is as follows.

$$\text{BI rate}_t = \alpha_1 + \sum_{i=1}^p \theta_{11} \text{BI rate}_{t-i} + \sum_{i=1}^p \theta_{12} \text{INF}_{t-i} + \sum_{i=1}^p \theta_{13} \text{LTV}_{t-i} + \sum_{i=1}^p \theta_{14} \text{CREDIT}_{t-i} + \varepsilon_{1t}$$

$$\text{INF}_t = \alpha_2 + \sum_{i=1}^p \theta_{21} \text{BI rate}_{t-i} + \sum_{i=1}^p \theta_{22} \text{INF}_{t-i} + \sum_{i=1}^p \theta_{23} \text{LTV}_{t-i} + \sum_{i=1}^p \theta_{24} \text{CREDIT}_{t-i} + \varepsilon_{2t}$$

$$\text{LTV}_t = \alpha_3 + \sum_{i=1}^p \theta_{31} \text{BI rate}_{t-i} + \sum_{i=1}^p \theta_{32} \text{INF}_{t-i} + \sum_{i=1}^p \theta_{33} \text{LTV}_{t-i} + \sum_{i=1}^p \theta_{34} \text{CREDIT}_{t-i} + \varepsilon_{3t}$$

$$\text{CREDIT}_t = \alpha_4 + \sum_{i=1}^p \theta_{41} \text{BI rate}_{t-i} + \sum_{i=1}^p \theta_{42} \text{INF}_{t-i} + \sum_{i=1}^p \theta_{43} \text{LTV}_{t-i} + \sum_{i=1}^p \theta_{44} \text{CREDIT}_{t-i} + \varepsilon_{4t}$$

Information:

BI rate : Policy rate of BI

INF : Inflation

LTV : Loan to Value

CREDIT : Credit Growth

ε_t : Error term

i : Lower limit

p : Lag value

α : Intercept

4. Result and Discussions

Stationary Test

The stationary test is the first step in processing a VAR model that requires stationary conditions because the data used are time series. Data stationarity was tested using a unit root test called the Roots of Characteristic Polynomial. In stationarity tests, variables are tested directly and together not individually for each variable used. The stationarity test results are shown in Table 3 below:

Table 3. Roots of Characteristic Polynomial Result

Modulus (level)
0.981489
0.812642
0.703182
0.541297
0.541297
0.520339
0.284920
0.044291

Source: Author(s)

Polynomial Roots of Characteristic estimation results will show modulus numbers that can show the stationarity of the data. The data used can be said to be stationary if the modulus numbers are less than one, which means that the VAR model has covariance-stationary and eigenvalues conditions inside the unit circle. When the stationarity test is applied at a level that raises more than one modulus number, it needs to be tested again on the first difference, and so on. Based on Table 3, the stationarity test that was applied at the level showed that modulus numbers are less than one. Thus, the data used in the model for both periods are stationary at the level, and no testing is needed in the first difference test.

Optimum Lag

Based on the VAR analysis, the second step is determining the optimum lag to ensure model accuracy. This requires considering criteria such as LR, FPE, AIC, SIC, HQ. The results of data processing, the optimal lag is 7, indicating that the impact of the influence of independent variables on the dependent will be felt in the 4th quarter of the 2nd year. This optimum lag then becomes an input in VAR data processing and the Granger Causality Test.

Vector Autoregression (VAR)

Based on several steps that have been carried out by entering the optimum lag, the data is finally processed using the VAR analysis techniques, which showed the following results:

Table 4. Vector Autoregression Result

VARIABLE	BI RATE	INFLATION	CREDIT	LTV
BI RATE (-1)	0.745189 [3.50663]*	0.308878 [0.87089]	0.009968 [0.73733]	1.770321 [0.68147]
BI RATE (-2)	-0.27156 [-1.00645]	-0.31047 [-0.68944]*	0.023835 [1.38859]*	-4.6968 [-1.42399]*
BI RATE (-3)	-0.23593 [-1.06927]*	0.101649 [0.27604]*	-0.00972 [-0.69221]	1.869988 [0.69330]
BI RATE (-4)	-0.05964 [-0.30665]	-1.14117 [-3.51567]*	-0.01299 [-1.04974]	-0.28057 [-0.11801]
BI RATE (-5)	-0.06655 [-0.31723]	0.059452 [0.16981]**	-0.01391 [-1.04205]	-0.158 [-0.06162]
BI RATE (-6)	0.187042 [0.91091]	0.0512 [0.14940]	-0.00192 [-0.14658]	0.60348 [0.24042]
BI RATE (-7)	-0.16562 [-1.00722]	0.640364 [2.33347]*	-0.01697 [-1.62255]***	1.821252 [0.90608]
INFLATION (-1)	0.197804 [1.94609]**	0.62905 [3.70823]*	0.008377 [1.29555]	-0.18666 [-0.15023]
INFLATION (-2)	-0.07541 [-0.63820]	-0.23727 [-1.20313]	-0.00668 [-0.88887]	0.159687 [-0.88887]
INFLATION (-3)	-0.01695 [-0.16079]	0.051756 [0.29426]	-0.00605 [-0.90219]	0.515649 [0.40026]
INFLATION (-4)	0.119152 [1.82405]**	-0.26264 [-2.40903]*	0.006747 [1.62353]***	-0.66182 [-0.82879]
INFLATION (-5)	-0.04235 [-0.66106]	0.187363 [1.75256]**	0.00183 [0.44900]	-0.55383 [-0.70727]
INFLATION (-6)	0.063808 [0.95331]	-0.18702 [-1.67416]***	-0.00427 [-1.00246]	-0.00427 [0.60733]
INFLATION (-7)	0.033703 [0.54401]	0.027931 [0.27013]	0.192941 [1.02980]	-3.27696 [-0.59102]
CREDIT (-1)	1.972801 [1.45433]***	3.777948 [1.66874]***	0.032357 [0.37496]	14.33616 [0.86455]
CREDIT (-2)	0.434945 [0.36236]	2.070168 [1.03338]	0.192941 [2.52670]*	-3.27696 [-0.22333]
CREDIT (-3)	-0.26026 [-0.23282]	3.660392 [1.96195]**	0.196846 [2.76798]*	6.498213 [0.47553]
CREDIT (-4)	-0.22048 [-0.19369]	2.112514 [1.11198]	0.156524 [2.16148]*	4.028734 [0.28953]
CREDIT (-5)	-2.68602 [-2.28279]*	-8.94713 [-4.55610]*	0.032634 [0.43597]	-4.90396 [-0.34094]
CREDIT (-6)	0.920529 [0.59059]	-0.20788 [-0.07991]	0.157107 [1.58442]***	3.287638 [0.17255]
CREDIT (-7)	-1.16442	-6.179	0.084265	-23.1329

	[-0.80684]	[-2.56535]*	[0.91780]	[-1.31124]***
LTV (-1)	0.011051	-0.01192	-0.00311	0.864999
	[0.63873]	[-0.41290]	[-2.82269]*	[4.08971]*
LTV (-2)	-0.00126	-0.01317	0.000706	-0.01598
	[-0.05688]	[-0.35674]	[0.50163]	[-0.05909]
LTV (-3)	-0.00477	0.040005	-0.00066	0.086166
	[-0.21477]	[1.07832]	[-0.46347]	[0.31709]
LTV (-4)	0.004194	-0.04095	0.002462	0.006125
	[0.18591]	[-1.08774]	[1.71519]**	[0.02221]
LTV (-5)	-0.01064	0.011235	0.001119	-0.04237
	[-0.45958]	[0.29077]	[0.75981]	[-0.14970]
LTV (-6)	-0.03925	-0.11219	0.011468	-0.05813
	[-1.68503]**	[-2.88598]*	[7.73900]*	[-0.20417]
LTV (-7)	0.01135	-0.01813	-0.0142	-0.19181
	[0.50447]	[-0.48282]	[-9.92241]*	[-0.69742]

- [prob.]* significant at the level $\alpha=5\%$
- [prob.]** significant at the level $\alpha=10\%$
- [prob.]*** significant at the level $\alpha=15\%$

Source: Author(s)

Based on the results of the VAR method used, there were various variables that significantly influenced other variables. The significance of the variable is seen from the t-statistics shown by the number in [] and the number one line above it is a regression coefficient. The figures are bold and red is significantly affected the variables. Based on the final result, it could be concluded that variable BI Rate have a negative effect on inflation and credit growth. In other side, the macroprudential policy which proxied by LTV is significantly has a negative effect on inflation and credit growth.

The multi-lag structure of the VAR model effectively captures the delayed effects of monetary and macroprudential policies. For example, an increase in the BI Rate leads to a gradual decrease in inflation, while adjustments to the LTV ratio impact credit growth over several quarters. These dynamics align with the insights typically illustrated by impulse response functions. Future research could enhance this analysis with graphical impulse response functions (IRFs) and variance decompositions; however, the regression outputs presented here already indicate the temporal effectiveness of the policies.

Granger Causality Test

Based on several steps that have been carried out by entering the optimum lag, finally the data is processed using VAR analysis techniques that show the following results:

Table 5. Granger Causality Test Result

Dependent Variable	Independent Variable	Probability
BI RATE	INFLATION	0.1289**
	CREDIT	0.2789
	LTV	0.4396
INFLATION	BI RATE	0.0000*
	CREDIT	0.0000*
	LTV	0.0015*
CREDIT	BI RATE	0.0001*
	INFLATION	0.5169
	LTV	0.0000*
LTV	BI RATE	0.7760
	INFLATION	0.9572
	CREDIT	0.9564

-[prob.]* significant at the level $\alpha=5\%$
-[prob.]** significant at the level $\alpha=10\%$

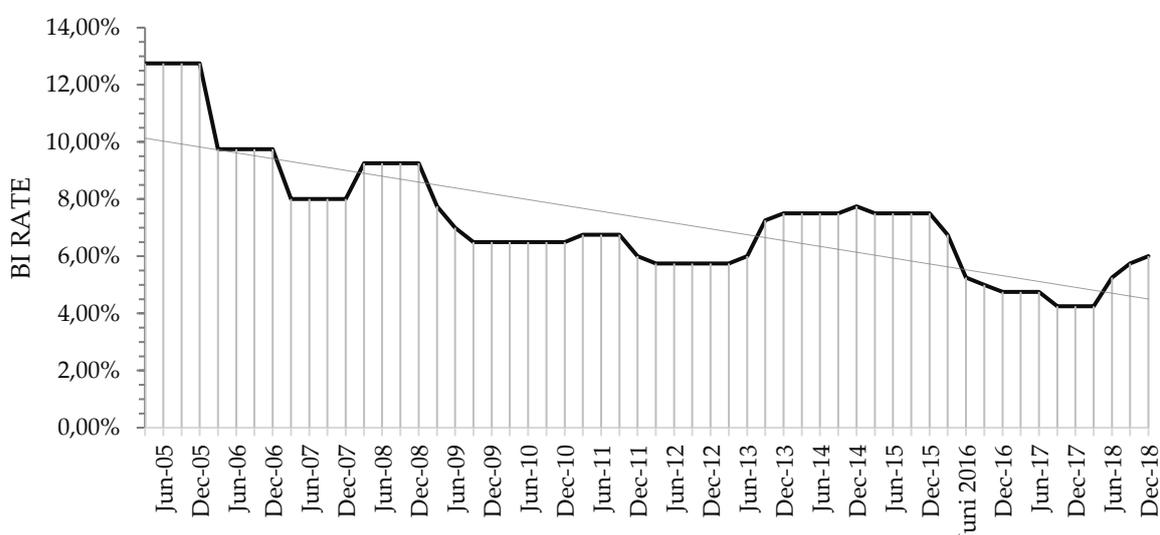
Source: Author(s)

Based on the result, to determine the direction of causality of each variable, a granger causality test was performed. Granger causality test results are shown in Table 5. The relationship between variables can be seen from the number of probabilities that arise. the probability numbers in bold and in red indicate that the independent variables listed significantly influence or have a relationship to the dependent variable. Thus, there are several results that can be concluded. First, monetary policy (BI Rate), macroprudential (LTV) and financial stability (credit growth) significantly influence the price stability (inflation). This result proves that macroprudential policy not only reaches the financial system, but it can also influence price stability. Second, it was found that macroprudential and monetary policies could affect financial stability. This indicates that monetary policy, besides impacting price stability, also affects financial stability. These results confirm the author's hypothesis that the policy instrument as an independent variable could affect the objective of achieving price and financial stability. However, this study does not show a bidirectional relationship between price and financial stability. It only shows that financial stability can affect price stability, indicating that in Indonesia, excessive credit growth is not influenced by inflation.

The interaction between monetary and macroprudential policy highlights distinct transmission channels. The BI Rate impacts inflation via the interest rate channel, which subsequently affects consumption and investment decisions. Conversely, the LTV ratio influences credit growth through the credit channel, particularly in the housing sector. However, there are inherent policy trade-offs. Tightening the LTV ratio enhances financial stability but may limit credit availability, potentially hindering economic growth. Similarly, increasing the BI Rate can reduce inflation but also raises borrowing costs. This underscores the necessity for coordinated policy efforts to minimize conflicts between price stability and financial stability objectives.

Evolution of Policy Rate in Indonesia

Graph 1. Evolution of BI-Rate 2005:Q1 – 2018:Q4



Source: (Bank Indonesia, 2025a; Central Bureau of Statistics, 2025)

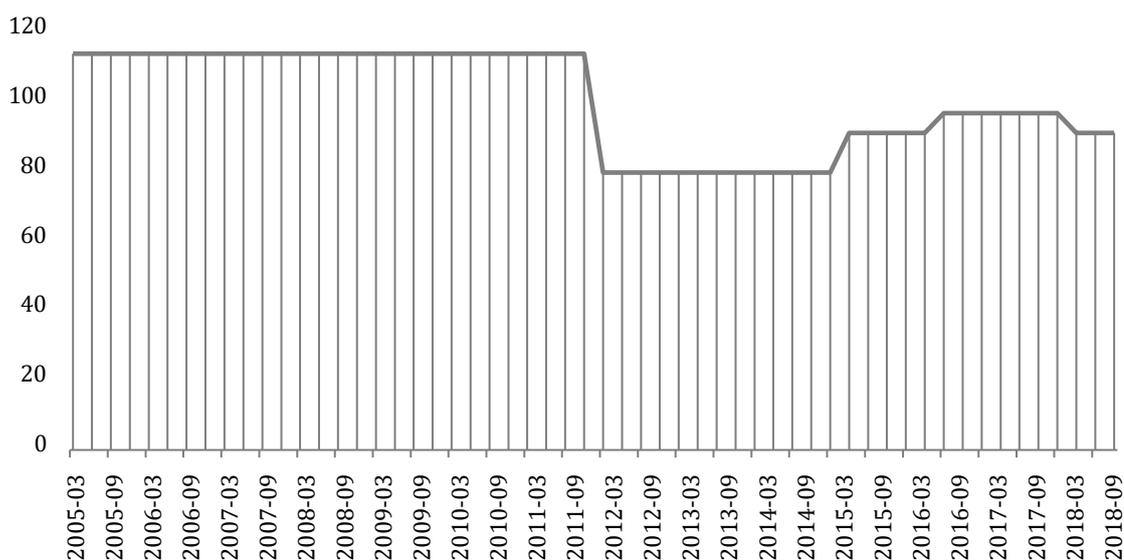
Since July 2015, Bank Indonesia has officially adopted the Inflation Targeting Framework as the monetary policy framework. Achieving the inflation target is the main objective of monetary policy to be achieved within this policy framework (Simorangkir, 2014a). Changes in the policy framework also indicate a shift in monetary policy operational targets from a quantity-based approach, which is base money (M0), to a price-based approach in the form of a policy rate, which is the BI Rate. The BI Rate becomes the reference rate for the formation of other interest rates in the economy, such as deposit rates and bank lending rates.

Based on graph 1, monetary policy through the BI Rate has experienced a downward trend, so it can be interpreted that the monetary policy trend is easing. In 2005, Bank Indonesia tightened its policy by setting a BI Rate of 12.75 percent. Then Bank Indonesia reduced its benchmark interest rate the following year, 2006-

2007, and increased it again in 2008 in response to the global crisis. The decrease and increase in the BI Rate had an impact on Bank Indonesia's goal of maintaining price stability (inflation) shown in graph 2. Loosened monetary policy aimed at boosting the economy but also increasing economic growth was followed by rising prices (inflation). In contrast, tightening monetary policy to maintain price stability is often accompanied by lower economic growth. However, sometimes monetary policy through interest rates is not always effective in maintaining price stability. In 2008, the BI Rate increased from the previous year to 9.25 percent did not cause the inflation to decline. It can be seen in graph 2 that inflation in 2008 increased from the previous one. This is due to external factors, such as the existence of Global Financial Crises originating from the crisis in the United States.

Evolution of Policy Rate in Indonesia

Graph 2. Evolution of LTV 2005:Q1 – 2018:Q3

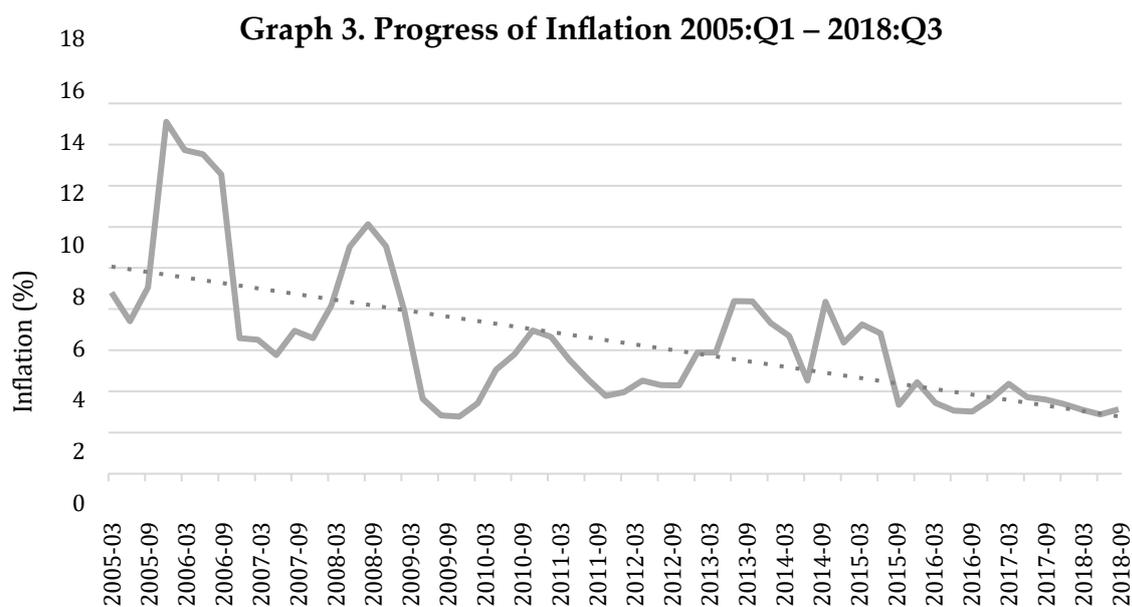


Source: Bank Indonesia (2019)

The LTV policy instruments in Indonesia all the time indicated a tightening policy movement. At the first time, the LTV policy was set in March 2012 in SE BI No. 14/10/DPNP show that mortgages are subject to LTV with a ceiling of 70% (Bank Indonesia, 2012). In June 2015 in SE BI No. 17/10/PBI/2015 show that mortgages for houses of >70 m² are subject to LTV up to 80%. In September 2016, Bank Indonesia (2016) adjusted its mortgage regulations, establishing that mortgages for houses exceeding 70 m² were subject to LTV ratios of up to 85%. Subsequently, the latest regulation issued by Bank Indonesia regarding LTV determination began to be relaxed in August 2018 in accordance with PP BI No. 20/8/PBI, which stipulated that housing loans (KPR) were subject to LTV ratios of

up to 80%. The easing of the LTV policy in 2018 was implemented as an effort to stimulate growth in the housing sector, considering that the property sector represents one of the main pillars of the Indonesian economy and would therefore provide a significant impact in encouraging overall economic growth. Consequently, the LTV policy can also support the achievement of monetary policy objectives, although LTV policy rules are generally designed to maintain financial stability.

The Evolution of Inflation in Indonesia



Source: Bank Indonesia (2025b)

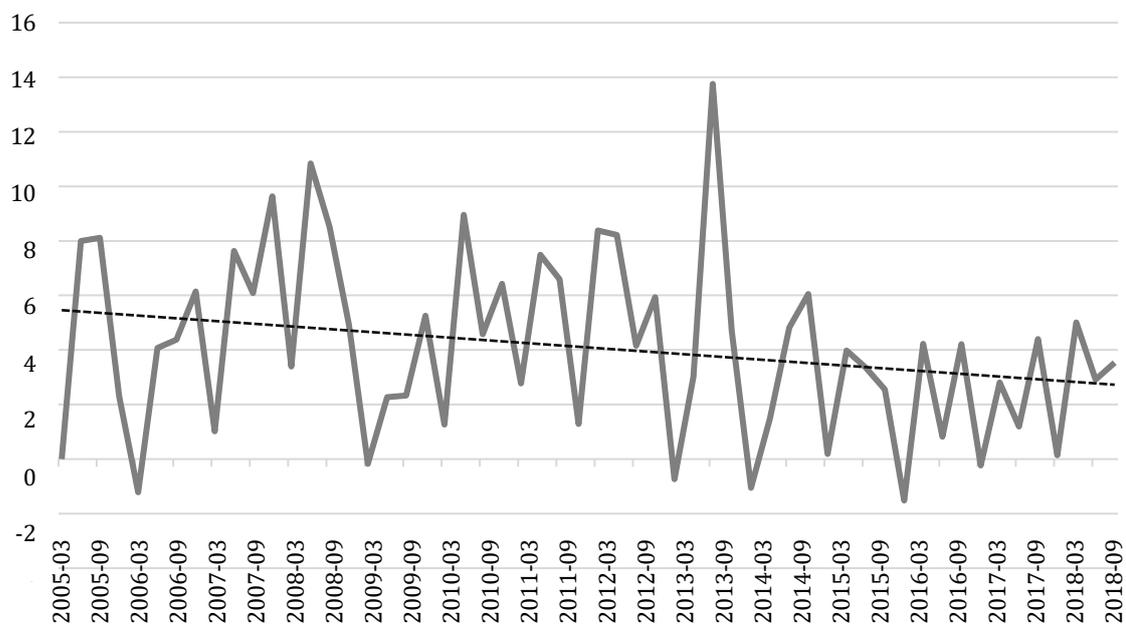
Based on graph 3, the development of Indonesia's inflation from 2005-2018 experienced a downward trend. The inflation rate experienced a sharp increase in 2006 in the first quarter of 17.03 percent and reached 17.92 percent in the second quarter. According to the Central Bureau of Statistics report (2006), the Indonesian economy was recovering, where economic growth increased by 5.5 percent with the highest growth in the transportation and communication sector of 13.6 percent. However, economic growth in 2006:Q4 decreased by 1.9 percent so that inflation in 2006:Q4 also decreased. Therefore, the increase and decrease in economic growth is followed by an increase and decrease in inflation.

Bank Indonesia responded to the macroeconomic situation by tightening monetary policy through an increase in the BI Rate to 9.75 percent. Thus, Bank Indonesia sees that economic growth in 2006 will face several challenges, namely the risk of macroeconomic instability that is marked by an increase in the price of fuel oil. Meanwhile, the financial sector also faces risks arising from economic financing with high interest rates. In addition, external factors may pose challenges to the Indonesian economy, particularly the monetary tightening in the United

States of America. The existence of the global crisis in 2008 made Indonesia's inflation increase from the previous year to 7.36 percent and even continued to increase until 2009:Q1 of 9.17 percent.

The Evolution of Credit Growth in Indonesia

Graph 4. Evolution of Credit Growth 2005:Q1 – 2018:Q3



Source: Indonesia Financial Service Authority (2018)

The evolution of credit growth is one of the indicators that can reflect financial stability. This is because in Indonesia, 80 percent of the roles in the financial sector are still dominated by the banking sector. Indonesia also found procyclical behavior in the financial sector. Bank lending from year to year has always experienced a significant increase. This indicates that there is procyclical behavior, so that systemic risk can be faced by the financial sector. Data shows that credit growth has fluctuated, where the highest growth was felt in 2013:Q3 this triggered by Indonesia's economic growth, which at that time reached 5.78%.

However, if we see from the trend, Indonesia's credit growth showed a declining trend since years 2005:Q1 to 2018:Q4. The declining trend can be caused by the LTV policy which is always experiencing in tightening period. This finding shows that the tightening of LTV can affect the decline in credit growth. Thus, it can be said that an effective LTV policy can able to encourage financial stability and limit systemic risk as demonstrated through credit growth.

5. Conclusion

Financial stability is one indicator that can reflect stable economic conditions. The economic financial crisis that hit various countries in the world is

generally caused by an unsound and unstable financial sector. Given its importance, financial authorities must take comprehensive measures to ensure stability. As Indonesia's monetary and financial authority, Bank Indonesia not only maintains price stability but also designs policies to safeguard financial system stability. This is because monetary and microprudential policies are not sufficient to limit the systemic risk imposed by the financial system. Therefore, macroprudential policy serves as an important instrument to address risks aligned with the economic cycle in the financial sector. Thus, the result of this study found that the mix between monetary and macroprudential policies was effectively achieving price stability and financial stability.

Based on the results of the VAR and the Granger Causality analysis, we conclude that policy tightening is able to increase both price stability and financial stability. Tightened monetary policy, in addition to being able to reduce inflation, can also reduce credit growth, even though the impact requires considerable time to materialise. Similarly, macroprudential policy reflected by the LTV ratio, in addition to being able to reduce credit growth, can also reduce the inflation rate over time. Thus, it can be concluded that monetary and macroprudential policies are complementary policies in achieving price and financial stability.

There is still very limited research on the policy mix, so it is hoped that this research can contribute to policymakers, especially Bank Indonesia, as a material for further policy decision-making. In addition, we anticipate that this research will serve as a catalyst for young researchers to engage more deeply with the topic of policy mix effectiveness in Indonesia, given the many policy channels and instruments that still require comprehensive exploration. The results of our analysis are expected to help monetary authorities formulate appropriate policies that will have a better impact on the economy and benefit the broader community.

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