Monetary and Macroprudential Mix under Financial Frictions Mechanism with DSGE Model: Lessons from Indonesian Experience

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The GFC has taught us that managing the inflation alone is insufficient to attain macroeconomic stability. Several crisis episodes have shown that the majority of macroeconomic instability stems from shocks in the financial sector.

Inherently, financial sector is procyclical in nature. This, in turn, would act as a financial accelerator to the real sector. Thus, to obtain macroeconomic stability, it is essential that monetary policy be supported by countercyclical macroprudential policy.

To analyze and understand these linkages better, it is imperative to develop a DSGE model with financial frictions in the banking sector.
The goal of this research is to develop a small open economy DSGE model with financial friction in the banking sector, such that it characterizes Indonesian economy, in order to accurately simulate monetary and macro-prudential policy.

To understand how financial frictions modifies the transmission mechanism of monetary policy shocks in a heterogenous economic agent model with borrowing constraints and financial accelerator.

To analyze how financial shocks are transmitted to the real economy by affecting households’ and entrepreneurs’ consumption and investment decisions and thus contribute to business cycle fluctuations.

To conduct some simulations to identify the transmission channels of each macro-prudential measures (LTV, RR) in affecting the financial system and macroeconomic condition as a whole.
### Some Macroprudential Measures in Indonesia

<table>
<thead>
<tr>
<th>Measures</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Minimum Holding Period (MHP) on BI bills</strong></td>
<td>To “put sand in the wheels” on short-term and speculative capital inflows, and mitigate risks of sudden reversals</td>
</tr>
<tr>
<td>- 1 month holding period July 2010</td>
<td></td>
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<tr>
<td>- Introduce Six Month Holding Period (MHP) May 2011</td>
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<tr>
<td><strong>2. Increase Primary Rupiah Reserve Requirement (RR) from 5% to 8% June 2011</strong></td>
<td>Helps absorb domestic liquidity</td>
</tr>
<tr>
<td><strong>3. Loan to value (LTV) ratio for property sector (max 70%); automobile (max 70%), for productive vehicle (max 80%), and for motor-cycle (max 75%) March 2012</strong></td>
<td>To control accelerating growth of credit to consumer sectors (especially property and automobile sectors)</td>
</tr>
</tbody>
</table>
Literature Review: Modeling of Pro-cyclicality on Financial System with Financial Frictions on DSGE Model

1. Collateral Constraint (Kiyotaki and Moore, 1997)

Basic assumption: asymmetric information between creditors and debtors (there is private information from debtor, which is repayment ability, proxied by the value of the asset owned)

→ The value of collateral owned by debtor give affect to the amount of loan that can be received (quantitative channel).

2. Financial Accelerator (Bernanke, Gertler and Gilchrist, 1999)

Basic Assumption: asymmetric information between creditors and debtors (there is private information from debtor, so that need monitoring cost to know repayment ability, which in the end will affect external finance premium)

→ produce external finance premium: differences between using loan compare with using own fund.

→ external finance premium determined by net worth (profit expectation) from debtors which in the end will determine the loan rate (price channel).
The Model Characteristics

- The model developed in this research is based on the banking sector DSGE model refined by Harmanta, et al (2012), which itself was based on the model of Gerali et al (2010).
- The model includes 2 types of financial frictions, namely collateral constraints on households and a financial accelerator mechanism on entrepreneurs.
- A financial accelerator mechanism is added to the model by following Bernanke et al (1999), which was subsequently modified by Zhang (2010).
- Following Zhang (2010), the model simulates default by entrepreneurs that prevents them repaying the loan to the bank.
  - Banks also bear risk due to the presence of asymmetric information concerning the repayment capacity of the entrepreneur, which in this model will affect the level of bank profit generated and, ultimately, bank capital.
  - Bank capital in this model also functions as a buffer stock against the unexpected realization risk of aggregate returns on capital from the entrepreneur, which subsequently influences the capital adequacy ratio and forces the bank to manage its asset portfolio.
- The model assumes a small open economy and includes the government to enrich the simulations of macroprudential policy.
- The standard features of the DSGE model, for instance habit persistence in terms of consumption, the adjustment cost related to adjusting investment, the modelling of sticky prices and sticky wages are also included in the model.
Model Interactions

- Capital/Housing/Intermediate/Final Goods Flow
- Financial Intermediation Process
- Labor
- Tax
Households: Collateral Constraint

There are 2 types of household. In general, both types supply labor, receive wage, consume, buy housing assets, and pay taxes. They differ in the discount factor and whether they are borrowing or saving funds. Patient household is a saver and has a bigger discount factor than impatient household ($\gamma > \rho$).

**Patient Households**

They are the owner of retailers and bank, receive profits, deposits funds, receive interest. Their optimization problem differs slightly from impatient households in that they are depositing funds instead of borrowing, and they receive profits and interest.

**Impatient Households**

As a borrower, impatient households borrow from bank and pay interest. The collateral constraint applies in this optimization problem in the form of Loan to Value (LTV) ratio, which will determine the amount of funds that can be borrowed.
Entrepreneur’s problem is to maximize expected gross return \( V \), subject to the Individual Rationality Constraint (IRC) / Participation Constraint from the bank (loan branch), i.e:

- Loan branch can only allocate the funds to either entrepreneur or impatient household or both.
- Loan branch will enter the contract if the expected return from allocating their funds is equal or greater than the rate of return determined by the wholesale branch.

This particular model has the capacity to simulate default that could occur when an entrepreneur fails to repay his/her debt to the bank, which involves the bank bearing the risk of asymmetric information regarding the repayment capacity of the entrepreneur.

- Such conditions affect the size of bank profit that will subsequently determine bank capital. Risk sharing by a bank is possible because the model has two threshold values, namely:
  - that is the ex-ante threshold based on bank expectations regarding the return on capital of the entrepreneur;
  - which is ex-post or the actual return on capital of the entrepreneur.
- The difference between the expected and realised return on capital of the entrepreneur will determine bank capital that functions as a buffer stock against the unexpected realisation of aggregate return on capital of the entrepreneur, which will subsequently affect the capital adequacy ratio of the bank and compel the bank to manage its asset portfolio.
Producers: Utility Functions

**Intermediate Goods Producer**

\[
\left\{ \left( \begin{array}{c}
                          \end{array} \right) \right\}
\]

*Production Function*

\[
\left( \begin{array}{c}
                          \end{array} \right) \left[ \left( \begin{array}{c}
                          \end{array} \right) \right] \left( \begin{array}{c}
                          \end{array} \right)
\]

**Final Goods Producer**

\[
\left( \begin{array}{c}
                          \end{array} \right)
\]

Price of Final Goods

Price of Domestic Goods

Price of Imported Goods

Domestic Goods

Imported Goods
Producers: Utility Functions

**Capital Goods Producer**

\[
\left( \begin{array}{c}
\end{array} \right) \left( \begin{array}{c}
\end{array} \right)\]

**Capital Goods Motion**

\[
\left( \begin{array}{c}
\end{array} \right) \left( \begin{array}{c}
\end{array} \right) - \left( \begin{array}{c}
\end{array} \right)
\]

**Housing Producer**

\[
\left( \begin{array}{c}
\end{array} \right) \left( \begin{array}{c}
\end{array} \right) \left( \begin{array}{c}
\end{array} \right)\]

**Housing Goods Motion**

\[
\left( \begin{array}{c}
\end{array} \right) \left( \begin{array}{c}
\end{array} \right) - \left( \begin{array}{c}
\end{array} \right)
\]
NKPC in terms of real marginal costs

\[
\begin{align*}
\text{Intermediate Goods Producers} & \rightarrow \text{Domestic Retailers} & \rightarrow \text{Final Good Producers} \\
\text{Exporting Retailers} & \rightarrow \text{ROW} & \rightarrow \text{Importing Retailers}
\end{align*}
\]
Banking Sector

- Patient households deposit their money in the deposit branch, with a markdown deposit rate determined by both the wholesale branch (due to the reserve requirement) and the deposit branch (due to the monopolistically competitive nature of this branch).
- The latter will then manage the allocation of these funds, namely to fulfil the reserve requirement, purchasing risk free assets, and loans for both impatient households and entrepreneurs.
- These loans will be delivered by the loan branch, with a markup loan rate determined by both the wholesale branch (due to the CAR consideration) and loan branch (due to the monopolistically competitive nature of this branch).
Wholesale Branch

Each wholesale unit operates under a perfectly competitive market and functions to manage the balance sheet of the bank as follows:

\[
\text{Risk-free assets, total loans, total deposits, reserve ratio, bank capital.}
\]

Where is risk-free assets, is total loans extended by the bank, is total deposits accrued, is the reserve ratio set by the bank and determined by the reserve ratio requirement set by the central bank and is bank capital.

**Wholesale Deposit Rate**

\[
\text{Under conditions where reserve requirement, then — , while under conditions where then a bank will endure an increase in opportunity cost when extending funds, hence the bank will react to lower that cost by reducing total deposits, equivalent to decreasing .}
\]

**Wholesale Loan Rate**

\[
\text{Under conditions where then . Meanwhile, under conditions where , then a bank will react to lower CAR by increasing the allocation of loans (decreasing ), thus the level of CAR will approach the statutory minimum, .}
\]
Collecting deposits from patient household with a markdown deposit rate. Markdown occurs due to the monopolistically competitive nature of the branch. Without any stickiness/adjustment cost, the markdown interest rate will be:

\[
\text{Stickiness in Deposit Rate}
\]

\[
\frac{(\quad)}{(\quad)} \quad \frac{(\quad)}{(\quad)} \quad (\quad)
\]

- Adjustment cost \( H \) has a negative relation with its deposit rate adjustment. \( H \) corresponds to a low deposit rate adjustment to a change in the wholesale rate.
- Adjustment cost for deposit rate is set lower than lending rate.
The loan unit receives wholesale loans, from the wholesale unit at a rate of interest, and then extends the loan to households and entrepreneurs applying two different levels of mark-up. In order to apply stickiness and investigate the implications of imperfect bank pass-through, it is assumed that each respective bank faces a quadratic adjustment cost when adjusting its lending rate. In addition, for entrepreneur loan, bank also consider the default risk in determining their lending rate.

**Stickiness in Household Lending Rate**

\[
\frac{\text{\text{\textbf{(rate)}}}}{\text{\text{\textbf{(rate)}}}(\text{\text{\textbf{(rate)}}})} \quad \frac{\text{\text{\textbf{(rate)}}}}{\text{\text{\textbf{(rate)}}}}
\]

- Adjustment cost \( \text{\text{\textbf{(rate)}}} \) has a negative relation with its lending rate adjustment. \( \text{\text{\textbf{(rate)}}} \) corresponds to a low lending rate adjustment to a change in the wholesale rate.
- Adjustment cost for lending rate is set higher than deposit rate.

**Stickiness in Entrepreneur Lending Rate**

- Similar to household lending rate. However, bank also consider the default risk in determining entrepreneur lending rate.
Estimation and Calibration

- Quarterly data Q.I 2001 – Q.IV 2012 is used for Bayesian estimation.
  - Real sector: GDP and its components, exchange rate, inflation, etc.
  - Financial sector: deposit rate, credit, bank capital, NPL, BI Rate, etc.
- A number of parameters are calibrated using the values found in other models developed by Bank Indonesia and related empirical research, e.g:
  - Capital share in the production function is set at 0.54 (BI model).
  - The home bias parameter is calculated based on the HP filter value of the import to absorption ratio of Indonesia.
  - The parameters that determine the elasticity of substitution between domestic and foreign goods as well as export goods are based on the research of Zhang and Verikios (2006).
  - The values of the risk premium and that which controls the cost of managing bank capital are calculated through the steady state correlation between several variables included in the model.
  - The Calvo parameter for labour follows the estimation results of the BI model.
Contractionary BI Rate Shock

POLICY RATE INCREASE
- The fastest response to an increase in the BI rate is transmitted to the deposit rate, since the deposit rate has a lower level of stickiness than the lending rate.
- The increase in the lending rate would exacerbate the risk of default, which is demonstrated by an increase in non-performing loans and ultimately erodes a bank’s capital adequacy ratio due to the high risk-weighted assets.
- A decline in the extension of total credit would lower bank LDR and eventually also dissuade investment and undermine capital.
- The increase in the lending rates decreases households’ ability to consume, thus compelling producers to reduce production.
- Rupiah appreciation stemming from the hike in the BI rate suppresses exports. Imports would also slump because of weaker demand for consumption and investment.
- Against this backdrop, inflation will decrease.

POLICY MIX (Policy Rate Increase + LTV Decrease)
- Credit growth plunges deeper than conditions without an LTV shock.
- GDP and the rate of inflation decline but only moderately compared to conditions when only BI rate policy is used.
- Instituting a policy mix enables the slump in consumption to be offset by the slowdown in imports, hence GDP tends to remain more stable.
- In addition to helping to stabilize GDP and inflation, policy mix also controls consumption thus reducing the demand for imported goods. Coupled with stable exports, the decline in imports would favorably impact the current account.

The effect of the financial accelerator mechanism can be observed in the idiosyncratic shock, which is higher ex-post than ex-ante, which forces banks to bear risk and reduce their capital. The higher Idiosyncratic shock ex-post compared to ex-ante is the result of banks overvaluing their assessment of the return on capital from the entrepreneur due to an ongoing economic contraction that means the actual return on capital is not as large as that predicted by the bank.
Household’s LTV Ratio Shock

**Household’s LTV Ratio Increase**

- Triggers an increase in the volume of household credit due to an incentive stemming from the larger volume of loan that can be allocated by the banks and backed by the collateral of the household.
- By raising the LTV ratio, but with the same asset value, households could borrow more from a bank.
- The increase in loan volume encourages banks to manage their asset portfolio by lowering the volume of credit extended to entrepreneurs.
- Increasing total bank loans would raise bank LDR and reduce bank CAR due to credit expansion implemented by the bank.
- A high level of credit allocation also increases bank profit and would ultimately bolster bank capital in subsequent periods.
- The increase in total loans extended to households would cause impatient households to increase their level of consumption, which would prompt producers to ramp up production of final goods output.
- Such conditions would eventually stimulate GDP growth.
- Economic expansion due to greater GDP growth would increasingly expedite credit allocation due to the financial accelerator mechanism.

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**The effect of the financial accelerator mechanism can be observed in the idiosyncratic shock, which is lower ex-post than ex-ante, which shows that the actual return on capital from entrepreneurs is higher than the banks’ expectations. This helps to lower the level of non-performing loans (NPL).**
CAR Requirement Shock

**CAR REQUIREMENT INCREASE**

- Banks tend to transfer their assets by reducing credit extension, both to households and entrepreneurs, and increasing risk-free assets.
- Such conditions would lower the LDR ratio as the disbursement of credit slows.
- On the other hand, however, banks would enjoy an increase of capital as a result of the reduction in credit allocation, thus raising the level of CAR.
- An increase in bank CAR would not be as pronounced as the increase in the CAR requirement, which is possible due to the small adjustment cost of the difference in the CAR requirement estimated in the model because of how far apart the steady state value of CAR is compared to the CAR requirement.
- This kind of shock in the banking sector also impacts the real sector, which is represented by a reduction in the disbursement of credit that erodes investment and the production of final goods by producers.
- Accordingly, the GDP of Indonesia would decline.
World GDP Shock

WORLD GDP INCREASE

- An increase in world GDP would trigger a surge in exports followed by growth in final goods output.
- The increase in final goods output would lead to an increase in investment and imports of raw materials required for production.
- Such circumstances would raise GDP as well as income and ultimately boost public purchasing power.
- Greater public purchasing power would bolster consumption and spark inflationary pressures in the economy.
- Consumer loans would also expand in line with solid public consumption.
- Greater public purchasing power would also occasion an increase in deposits held at banks, which are subsequently allocated by the banks in the form of loans to the household sector.
- An increase in loan disbursements would also improve bank profits and subsequently buoy bank capital, thereby eventually raising bank CAR.

- Under expansive economic conditions, when the production of goods increases due to the positive shock of stronger international demand, the financial accelerator also encourages the banking sector to expand credit allocation.
- Such behaviour is observed in the variable, idiosyncratic shock, for which the ex-post value is smaller than the ex-ante value, therefore non-preforming loans are lower and the external finance premium becomes increasingly small.
- Such conditions make it easier to access credit from the banking sector.
Exchange Rate Shock

RUPIAH DEPRECIATION

- Boost the competitiveness of export products, hence creating a surge in exports accompanied by an increase in final goods output.
- The increase in production of final goods would be followed by a greater requirement for investment, thereby raising GDP and income.
- Greater income would strengthen public purchasing power and drive consumption.
- The gains in consumption, however, would exacerbate inflationary pressures in the economy.
- The requirement for greater production of goods by producers would cause entrepreneurs to borrow more from the banks.

- During an expansive economic phase, when the production of goods increases to meet the surge in exports, the financial accelerator compels banks to lend more.
- The effect of the financial accelerator mechanism can be observed in the variable, idiosyncratic shock, which is lower ex-post than ex-ante, thus non-performing loans are low and the external finance premium also becomes increasingly small.
- Such conditions make it easier to access credit from the banking sector.
Concluding Remarks

• A DSGE model was developed in this research for the small open economy of Indonesia, complemented with financial frictions in the form of collateral constraints and the financial accelerator mechanism. This model met all of its development objectives, namely to simulate monetary policy (BI rate) and macro-prudential policy (CAR and LTV requirement).

• Hence, analysis can be conducted for a mixed policy between monetary and macroprudential.
  – Simulations show that a policy mix combining monetary policy and macroprudential policy would not only spur stable GDP growth and inflation but also control consumption and alleviate demand for imports. Coupled with stable exports, weaker imports would favourably impact the current account.

• By including the banking sector in the model, analysis was possible of the policies required to overcome shocks originating from the banking sector.
  – A shock in the banking sector in the form of a more stringent CAR requirement would force the banks to reduce credit allocation to the household sector and entrepreneurs, precipitating a decline in bank LDR. Such a shock would also impact the real sector through a decline in loan disbursements that would undermine investment and reduce the production of final goods by producers. Consequently, GDP and the rate of inflation would both decelerate.
Caveat and Next Agenda

• The definition and assumption of the LTV in the model is not fully aligned with the concept of the LTV applied in Indonesia since 2012. Consequently, the results of the simulations performed using this model must be more carefully interpreted.

• Develop a model that supports a broader application relating to interaction between a range of monetary and macro-prudential policies. This could be achieved, among others, by endogenously modelling macro-prudential policy rule (CAR, RR, LTV) and their interaction with the Taylor rule (Policy rate).

• Trying to capture the behavior of interbank in the model because it is an important mechanism that can spread crisis through its probability of default, which in turn will increase the interbank loan rate and to be transmitted to the real sector.

• Develop a model that could not only be used as a simulation but also to project macro variables as well as variables linked to balance sheets and conditions in the banking sector.
THANK YOU
References

References

• Gerali, Andrea & Stefano Neri & Luca Sessa & Federico M. Signoretti, 2010,"Credit and banking in a DSGE model of the euro area," Temi di discussione (Economic working papers) 740, Bank of Italy, Economic Research and International Relations Area.
# Calibrated Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark-up parameter in labor market (\text{mark-up} = \ldots)</td>
<td>11</td>
<td>Model GEMBI (2006)</td>
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<tr>
<td>Depreciation rate of capital</td>
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<td>Gerali et al (2010) and Brzezina (2011)</td>
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<tr>
<td>Depreciation rate of housing asset</td>
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<td>Capital share in production function</td>
<td>0.54</td>
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<td>Home bias parameter</td>
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<td>The probability of given labor (from patient and impatient HH) is selected not to reoptimize its wage</td>
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<td>Reserve equation’s parameter</td>
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</tbody>
</table>

- BISMA: Bank Indonesia Structural Macro Model (2009)
- MODBI: Medium term model (2012)
### Bayesian Estimated Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Distribution</th>
<th>Prior Distribution</th>
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