Assessing the Economy-wide Impacts of Strengthened Banks Capital Requirements in Indonesia using a Financial-Computable General Equilibrium Model

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Abstract

After the 2008 global financial crisis, authorities across the globe stressed the importance of equity capital to absorb losses. While many countries have raised their banks' capital adequacy requirements (CARs), the comprehensive impact assessment of this policy for emerging economies remains largely unexplored. We use a financial computable general equilibrium (FCGE) model of Indonesia called AMELIA-F to investigate the economy-wide impact of a 100 basis points increase in the CAR of Indonesian banks. We find that this causes small negative consequences on the economy. Bank balance sheets contract as they move away from holding riskier assets. This reduces investment in both non-housing and housing sectors, as equity financing raises banks weighted average costs of capital (WACC). The falling of real investments decreases foreign financing requirement, causing appreciation of the nominal exchange rate.

Keywords: *FCGE, WACC, CAR, Indonesia.*
JEL classification: D58, G21, G28.

1. Introduction

Following the 2008 Global Financial Crisis (GFC), authorities across the globe stressed the importance of financial sector reform. In 2010, the Basel Committee on Banking Supervision (BCBS) introduced the Basel III regulatory standard as a reform package to strengthen stability in the global financial sector. The regulatory standard highlights the role of the equity capital of commercial banks to absorb losses during crises. While enhancing financial stability, higher bank capital requirements raise the weighted average cost of capital (WACC) of commercial banks, potentially slowing credit growth and weakening the real economy [e.g., Miles et al., (2012); Slovik & Cournède (2011); Bank for International Settlements (2010); Taskinsoy (2018); IIF (2011); Surhaningsih, et al. (2015); Giesecke et al. (2017)].

With more countries adopting bank capital reforms, there are nonetheless few studies investigating the economy-wide impacts of strengthening mandated bank capital requirements in emerging countries.[1] For instance, Surhaningsih et al. (2015) explain that for maintaining the existing return on equity (ROE) when CAR is increased, Indonesian commercial banks must increase lending interest rates. Fang et al., (2018) analyse the impact of banks' capital reforms on lending growth in Peru. They find that a 1 percentage point increase in banks' capital adequacy ratio (CAR) leads to a 4-6 percentage points fall of lending growth in the first quarter and the fall diminishes after 6 two quarters. Taskinsoy (2018) finds that an increase in bank capital requirements has a negative impact on the long run GDP growth in ASEAN5.

[1] Bank for International Settlement (BIS) reports that in 2014 there are 23 of 27 BCBS countries (85%) have issued final or draft rules on the leverage ratio (CAR) (Bank for International Settlements, 2014). Another BIS report in 2017 mentions that 16 of 100 surveyed jurisdictions (16%) outside BCBS countries have also implemented Basel III banks' capital requirement (Hohl et al., 2018).

2013	2014	2015	2016	2017	2018	2019
t-1	t	t+1	t+2	t+3	t+4	t+5
1	2	3	4	5	6	7
Capital regulation enacted	CET1=4.5% +AT1= 6% +Tier2=8%	Capital Conservation Buffer enacted	0.625ppt	1.25ppt	1.875ppt	2.5ppt (for capital >Rp5tr.)
		Capital Counter-cyclical Buffer enacted	Maximum 0.625ppt	Maximum 1.25ppt	Maximum 1.875ppt	Maximum 2.5ppt
		Capital Surcharge D-SIB enacted	1-3.5ppt			

Source: Adapted from Indonesian Banking Booklet 2019.
Note: ppt = percentage points, AT1=Alternative Tier-1 capital equivalent, Tier2= Tier2 capital equivalent, D-SIB = domestically systemic important bank.

Table 1 Implementation of Basel III Principles on Capital Requirements in Indonesia

Beginning in 2013, Indonesia has steadily implemented bank capital reforms as recommended by the Basel III principles (Table 1). In 2014, banks were required to set the Common Equity Tier-1 (CET1) at the minimum of 4.5 per cent of risk weighted assets (RWA).[2,3] The CET1 is supplemented by the Alternative Tier-1 capital equivalent (AT1), therefore increasing the regulatory capital ratio to 6 per cent of RWA. Adding Tier 2 capital to the CET1 and AT1 increases the minimum capital ratio to 8 per cent of RWA in 2014 (Column 2 of Table 1). Indonesia financial services authority (FSA or OJK)[4] implemented risk-based capital regulation to differentiate banks' capital requirements based on individual risk profiles. Banks with the lowest risk level (risk level 1) must hold a minimum CAR of 8 per cent; banks with a medium risk level (risk level 2) must hold a minimum CAR of 9 per cent; banks with

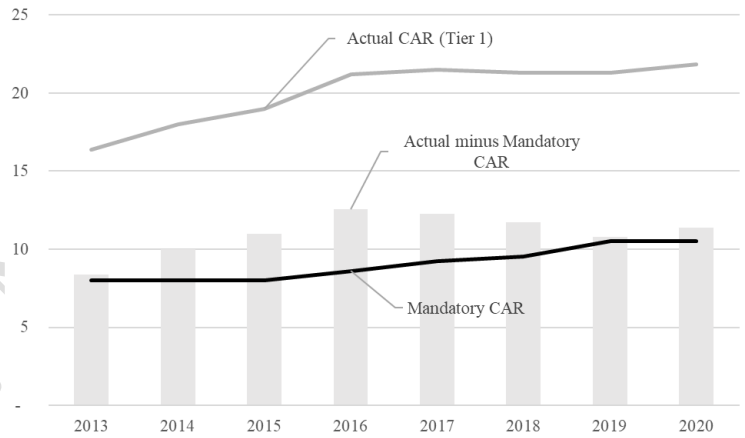
[2] Common Equity Tier 1 is the equity component of the banks' capital that can be used directly to absorb losses (Bank for International Settlements, 2010b).

[3] The risk weighted asset (RWA) explains to what extent that banks' assets are exposed to the market risks. The RWA is calculated by summing up the different types of assets after multiplied by regulatory risk weights.

[4] OJK stands for Otoritas Jasa Keuangan.

risk level 3 must hold a minimum CAR of 10-11%; while banks with the highest risk level (risk level 4 and 5) must hold a minimum CAR of between 11 per cent and 14 per cent.

In 2015, banks were obliged to provide supplementary capital buffers (Table 1 column 3). Supplementary capital buffers are categorised into: (i) capital conservation buffer; (ii) countercyclical buffer, and (iii) capital surcharge for the largest banks.[5] The supplementary capital buffers were gradually increased between 2016 and 2019 (Column 4 to 7 of Table 1). In 2019, banks with capital exceeding Rp 5 trillion had to increase CAR further by 2.5 percentage points under capital conservation buffer requirements. The capital countercyclical buffer (CCB) is used as a macroprudential policy instrument to manage changes in credit risks. The CCB can be tightened during a credit boom cycle to reduce excessive lending expansion and relaxed in a slower credit cycle to support a slowing down economy. In 2019, the CCB rose maximum of 2.5 percentage points. In the same year, the banks within the D-SIB category are required to hold additional CAR of 1 to 3.5 percentage points.



Source: CEIC
Note: The mandatory CAR is calculated based on the information in Indonesian Banking Booklet 2019

Figure 1 Indonesia's Mandatory and Actual Banks' CAR, Tier-1 (%)

[5] Domestic systemic important bank (D-SIB). The OJK and Bank Indonesia define D-SIBs based on the size of balance sheets, business complexity, and interconnectedness in the financial markets.

	2013	2014	2015	2016	2017	2018	2019	2020*
Private Banks	16.4	18.0	19.0	21.2	21.5	21.3	21.9	22.2
State Owned Banks	15.9	17.1	19.3	21.0	21.1	20.9	21.2	18.8
Regional Banks	17.6	17.8	20.6	21.7	21.7	22.0	21.2	22.1
Foreign Banks	34.5	44.8	46.5	48.9	53.1	47.9	50.4	54.6

Source: CEIC
*as of November 2020

Table 2 Indonesia's Banks' CAR by Type of Ownership (%)

The actual banks' CAR in Indonesia rises along with the scheduled increases in mandatory CAR. The increase in actual banks' CAR occurs in all types of banks (Table 2). The increase in CAR of foreign banks is much larger than other banks, as they mostly fund their activities by equity. In general, banks tend to hold a relatively stable wedge between mandatory and actual CAR over time (Figure 1). The financial authority in Indonesia always advices the banks to maintain enough buffer, and the banks show a strong indication to comply.[6] The banks' compliance to the mandated CAR is also highlighted in Murtiyanti et al. (2015). For this reason, we expect that when the authority raises the level of the mandated CAR, the actual CAR will rise by approximately the same amount.

In 2020, the authority reported that the aggregate CAR of Indonesian banks reached 22 per cent of risk weighted assets, which is larger than the mandated level by authority. The high level of CAR is not unusual for many countries. Table 3 reports the banks' capital and profitability indicators for several ASEAN and major advanced countries. That shows banks in these countries normally hold CAR above requirement. Banking crisis, unreliable interbank markets, and search for quality possibly motivate the banks to have a large capital buffer

[6] For instance, when the Bank Bukopin faced a falling CAR to 12 per cent on May 2020, it is was considered as an alarming level as it is near to the threshold. The OJK encouraged the bank's major investor to add more capital to the Bank Bukopin. As a result, the CAR increased to 16 per cent on August 2020 [Kontan.co.id, (2020a); Kontan.co.id, (2020b)].

(Andrle et al. 2019). Interbank in Indonesia is characterised as a fragmented market. Large banks that have ample domestic currency supply are more likely to transact with foreign banks with large foreign currencies supply (International Monetary Fund, 2018). The better capitalised banks could gain more counterparty trust, thus strengthening the banks position to access the interbank markets.

Miles et al., (2012) explains the optimal banks' capital is acquired when the marginal benefits equal to the marginal costs of holding capital. The marginal benefits represent the value of avoiding losses from a banking crisis. The marginal costs are the additional costs of having more capital instead of deposits and bonds in the funding side. Miles et al., (2012) further note that after the GFC in 2008 banks tended to accumulate more equity capital as self-insurance against a banking crisis. The study suggests that the optimal CAR of banks in the United Kingdom (U.K.) ranged between 16 and 20 per cent (also larger than the Basel III requirements).

Country's	Indonesia 2019Q1	Malaysia 2019Q1	Thailand 2018A1	Australia 2019Q1	Japan 2018Q3	U.K. 2018Q3	U.S. 2019Q1
Capital ratios							
Capital to RWA	23.3	18.0	17.8	14.7	17.0	20.9	14.8
Tier 1 Capital to RWA	21.6	14.3	15.0	12.7	14.8	17.7	13.8
Profitability							
Return on Assets	2.5	1.3	1.3	0.8	0.3	0.5	0.4
Return on Equity	16.4	11.9	9.4	12.9	7.3	7.4	3.4

Source: IMF Financial Soundness Indicators

Table 3 Bank Capital and Profitability Indicators in Selected Countries (%)

According to Bank Indonesia (2018), the high banks' CAR in Indonesia is obtained through offering new shares to the existing equity holders (right issue), issuing new debt instruments for capital formation, and retained earnings. Banks in the emerging countries mostly raise their CAR via retained earnings [Andrle et al. (2019); Cohen & Scatigna (2016)]. This option is likely to be undertaken by the banks with the high profitability. High profitability allows banks to increase equity capital without reducing payments dividend to the existing

shareholders. By doing this, banks raise the attractiveness of the equity and increase the portion of equity in bank balance sheets.

Several studies find that a rise in banks' CAR causes banks' weighted average cost of capital (WACC) to rise, which in turn raises the WACC of other financial agents, and impacts negatively on the real economy [e.g., Miles et al., (2012), Slovik & Cournède (2011), Bank for International Settlements (2010), Taskinsoy (2018), IIF (2011), and Giesecke et al., (2017)]. This contrasts with the Modigliani-Miller theorem (MM theorem) which assumes that more equity capital has no impact on banks' cost of capital (Modigliani and Miller, 1958). According to the MM theorem, adding equity capital lowers rates of return for both equity and debt instruments because it lowers risk on both instruments. This causes bank capital costs to remain unaffected. However, Baker & Wurgler (2013) argue that this effect is not supported empirically, and indeed, contradicted by the "low risk anomaly", whereby better-capitalised (and thus lower risk) banks have higher rates of return on equity.

Table 4 compiles previous studies investigating the impacts of an increase in bank capital on several economies. Most of the studies show that the increase causes a relatively modest impact on real GDP growth [e.g., Miles et al., (2012); Slovik & Cournède (2011); Bank for International Settlements (2010); Taskinsoy (2018); Surhaningsih, et. al. (2015); and Giesecke et al., (2017)]. Bank for International Settlements (2010), IIF (2011), and Miles et al., (2012) use a two-step approach to calculate the impact of an increase in bank capital on the economy. First, they use balance sheet data to calculate the effects of an increase in bank CAR on bank WACC. Second, the WACC effects thus calculated are input as shocks to their macroeconomic models. Taskinsoy (2018) uses Probit and Ordinary Least Square (OLS) regressions to calculate the impact of an increase in bank capital on ASEAN5 economies. Surhaningsih et. al., (2015) perform accounting-based analysis to calculate the impacts on interest rate spreads of a 100 basis point increase in the CAR of Indonesian banks. They find

that if Indonesian banks maintain the current ROE, a 100 bps increase in CAR forces banks to raise the lending rate by 6 basis points. The increase in the lending rate varies across groups of banks. The high ROE / low capitalised banks require a larger increase in lending rates, and vice versa. However, this approach does not account for general equilibrium effects in the economy, such as the details of macroeconomic adjustments, monetary policy responses, and reactions of other financial institutions.

Study	Impact on banks' WACC	Impact on real GDP growth	Scope
Miles et al., (2012)	18 basis points increase	0.15% reduction in the long run real GDP growth	U.K.
Slovik & Cournède (2011)	50 basis points increase	0.05-0.15% reduction in the real GDP growth in 5 year	OECD countries
BIS (2010)	13 basis points increase	0.09% reduction in real GDP growth	6,600 banks in emerging and advanced countries in 1993-2007
Taskinsoy (2018)	N.A.	0.33% reduction in average long run real GDP	ASEAN5
IIF (2011)	N.A.	3.2% reduction in average real GDP in 5 years	U.S., E.A., Japan, U.K., and Switzerland
Surhaningsih, et. al., (2015)	6 basis points increase	N.A.	Indonesia
Giesecke et al., (2017)	4 basis points increase	0.005% reduction in the long run real GDP relative to baseline	Australia
Nassios et al., (2020)	decrease in WACC	Increase in real GDP growth relative to baseline	U.S.

Table 4 Summary of Previous Studies

Giesecke et al., (2017) and Nassios et al., (2020) employ a computable general equilibrium (CGE) framework with a detailed financial module for the Australian and U.S. economies respectively. Their financial CGE (FCGE) models connect the traditional CGE framework with financial markets via networks of financial instruments and financial agents. Giesecke et al., (2017) find that a rise in bank CAR in Australia causes small negative economy-wide impacts. Using a similar framework, Nassios et al., (2020) find a contrasting small positive impact on the U.S. economy. In the U.S., the increase in bank WACC induces

substitution towards non-bank financial providers that, relative to banks, have smaller asset holdings with the central bank and higher propensities to lend to investors, therefore stimulating real investment.

2. The AMELIA-F financial computable general equilibrium (FCGE) model

2.1.Overview of the model

For this study, we develop a CGE model for Indonesia with a detailed financial module, hereafter AMELIA-F (A Model of Economic Linkage-Financial). The general structure of AMELIA-F comprises two parts: the core model and the financial model. The core part of the model explains the real economy under the neo-classical theoretical framework in which closely follows the MONASH model by Dixon and Rimmer (2002). The financial module includes the theories on financial agents' interactions and the linkages to the real side economy. The theories in financial module closely follow the model theories explained in Giesecke et al., (2017) and Nassios et al., (2020). The remainder of this section describes details of the model's theory and database. The core model is explained in 2.2. The theory underlying the model's financial elements is described in 2.3. Settings for the CAR simulation are detailed in 2.4. The database for both the model's core and financial theory is explained in 2.5.

2.2.Core CGE model

Economic agents in the real side model are optimisers of their objective functions subject to specific constrains. The behaviours of the key economic agents are modelled as follows: industries produce the level of output that maximise revenue subject to Constant Elasticity of Transformation (CET) functions. This optimisation creates commodity supply functions that connects the output with activity level and domestic prices. At any given level of activity, industries choose inputs to production and investment in a cost-minimising fashion subject to nested fixed-proportions and Constant Elasticity of Substitution (CES) production

functions. This creates input demand functions that connect input demands to industry activity levels and input prices. Demands for source-specific inputs depend on relative prices of domestic and imported supplies. Inputs of labour and capital respond to movements in wage rates and capital rental prices.

Commodity-specific household demand functions are derived from budget-constrained utility-maximisation assumptions. Commodity-specific demands for exports are negative functions of foreign currency prices. Margin commodities (e.g., retail trade) facilitate the distribution of non-margin commodities from suppliers to users. Demands for margins follow the movement of the use of commodities by the user agents. For example, demands for margins to facilitate inputs to production are a fixed proportion of the associated intermediate input demands. Economic agents are assumed to operate in competitive markets. Production prices for each industry are determined from the total unit cost of production, hence we formally impose a zero pure profit condition in our core model. Markets clear so that the prices of commodities and factors are determined by the equalisation of supply and demand.

2.3. Financial module

In the financial module, there are eight financial agents and five financial instruments (as described in Table 5 and 6). Each financial agent is simultaneously concerned with managing both the asset and liability sides of their balance sheets. Hereafter, when a financial agent is concerned with asset acquisition and disposal, we refer to them as an "asset agent" (AA). When an agent is concerned with liability issuance and repayment, we refer to them as "liability agents" (LA). In their actions as both asset agents and liability agents, financial agents are assumed to behave as constrained optimisers.

There are three matrices used to parameterise the financial module. First, $A_{(s,f,d)}$ is the beginning-of-year financial stock of the financial instrument f ϵ FI issued by liability agent s ϵ

LA and held by asset agent d ϵ AA. Second, $F_{(s,f,d)}$ describe the within-year flows of financial instrument f ϵ FI issued by s ϵ LA and held by asset agent d ϵ AA. Third, $R_{(s,f,d)}$ is the matrix of the power of the rate of return (one plus percentage rate of return) on financial instrument f ϵ FI issued by liability agent s ϵ LA and held by asset agent d ϵ AA.

No	Agent short name	Description
1	Inds	Non-financial industry, excluding housing
2	CB	Indonesia central bank
3	Banks	Commercial banks
4	NBFI	Non-bank financial institutions, including insurers and pension funds
5	Govt	Government
6	HH	The representative household
7	ROW	Rest of the world
8	Housing	Single representative housing sector

Table 5. Financial Agents in AMELIA-F

No	Instrument short name	Description
1	GldSDR	Gold or Special Drawing Rights
2	Cash	Cash
2	DepLoans	Currency and deposits
3	Debt	Interest-bearing securities, e.g., bonds, of varying terms of maturity
5	Equity	Claims that lie further along the risk-return spectrum than debt and loans

Table 6. Financial Instruments in AMELIA-F

When the elements of the conventional real-side CGE model are integrated with the financial model theory, they can influence each other. The results of the real side of the model are constrained by the results of the financial side of the model. Similarly, the results in the financial side are affected by the outcomes of the real side of the model. There are four main channels that connect the core and financial sides of the model. First, the public sector borrowing requirement (PSBR) or government deficit defined in the real side determines net liability issuance by the financial-side government agent. Second, gross fixed capital formation within the model's real side determines the net liability issuance of the financial-side industry

or housing agents (the two capital creator agents). Third, household saving determines the net asset acquisitions by the household financial agent. Fourth, the current account deficit determines external borrowing requirement, which must equal net domestic asset acquisitions by foreigners.

2.3.1. Modelling asset allocation and capital structure decisions

Liability agents in the financial module set their capital structure by minimising a constant elasticity of transformation (CET) function of the weighted cost of financial capital. Subject to the need to raise a given level of new financial capital ($NEWLIAB_{(s)}$), liability agent s ϵ LA decides the issuance of liability instrument f ϵ FI held by asset agent d ϵ AA that minimises the financial payment at the end of the year. Algebraically, this is written as follow:

$$\text{Minimise} \quad : CET\left(A1_{(s,f,d)} \cdot R_{(s,f,d)}, \forall f, d\right) \qquad (s \epsilon LALF)^{7}$$

$$\text{Subject to} \quad : NEWLIAB_{(s)} = \sum_f \sum_d \left(A1_{(s,f,d)} - A0_{(s,f,d)} \cdot V_{(s,f,d)}\right).$$

where $R_{(s,f,d)}$ is the power of rates of return, $A1_{(s,f,d)}$ and $A0_{(s,f,d)}$ are the financial instrument f ϵ FI issued by liability agent s ϵ LA and held by asset agent d ϵ AA at the end of the year and the beginning of the year respectively. $V_{(s,f,d)}$ are revaluation terms.

With the similar settings, we define the optimal behaviour of the asset agents. The asset agent d ϵ AA sets their (asset) instrument f ϵ FI issued by s ϵ LA to maximise their portfolio-weighted average rate of return at the end of the year. The optimisation problem is written as follow:

$$\text{Maximise} \quad : CES\left(A1_{(s,f,d)} \cdot R_{(s,f,d)}, \forall s, f\right) \qquad (d \epsilon LALF)$$

[7] where $LALF$ is the set of domestic asset and liability agents ($LALF = LA - ROW$).

Subject to $: NEWASSET_{(d)} = \sum_s \sum_f \left(A1_{(s,f,d)} - A0_{(s,f,d)} \cdot V_{(s,f,d)}\right).$

In percentage change, the liability and asset agents optimisation are declared in the following forms

$$a1_{(s,f,d)} = liabilities_{(s)} - \tau_{(s)}\left(r_{(s,f,d)} - wacc_{(s)}\right), \qquad (s \epsilon LALF), \tag{1}$$

$$a1_{(s,f,d)} = assets_{(d)} + \sigma_{(d)}\left(r_{(s,f,d)} - averor_{(d)}\right), \qquad (s \epsilon LALF). \tag{2}$$

where $a1_{(s,f,d)}$ and $r_{(s,f,d)}$ are the percentage changes of coefficient $A1_{(s,f,d)}$ and $R_{(s,f,d)}$ respectively. The $liabilities_{(s)}$ and $assets_{(d)}$ are the percentage changes of coefficient $NEWLIAB_{(s)}$ and $NEWASSET_{(d)}$ respectively. The $wacc_{(s)}$ is the percentage change of weighted average cost of capital of liability agent s ϵ LA. The $averor_{(d)}$ is the percentage change of average rates of return of asset agent d ϵ AA. The $\tau_{(s)}$ and $\sigma_{(d)}$ are the parameters that regulate the sensitivity of the liability and asset agents respectively. Equation (1) and (2) describe demand and supply of financial instruments by liability and asset agents respectively.

2.4. Modelling the capital adequacy ratio

2.4.1. Asset demand by commercial banks

To run the CAR simulation in our model, we incorporate the risk weighted calculation into banks asset acquisitions decisions. The commercial banks asset acquisition at the end of year is defined by the following expressions

$$U\left(R_{(s,f,Banks)} \times A1_{(s,f,Banks)}, \forall s, f\right), \tag{3}$$

subject to

$$\sum_{s,f} A1_{(s,f,Banks)} = BB_{(Banks)}, \tag{4}$$

and

$$\sum_d A1_{(Banks,Equity,d)} = MAX\left[\sum_d A1zero_{(Banks,Equity,d)}, KAR \times \sum_{s,f} W_{(s,f,Banks)} \times \sum_d A1_{(Banks,Equity,d)}\right]. \quad (5)$$

where the U is the CES function, KAR is the coefficient of capital adequacy ratio, $W_{(s,f,Banks)}$ is the regulatory risk weighted,[8] $\sum_d A1zero_{(Banks,Equity,d)}$ is the commercial banks equity issuance with the absence of capital adequacy requirement, $BB_{(Banks)}$ is the value of commercial banks asset.

When the banks follow the regulatory CAR requirement, the equation (5) becomes

$$\sum_d A1_{(Banks,Equity,d)} = KAR \times \sum_{s,f} W_{(s,f,Banks)} \times \sum_d A1_{(Banks,Equity,d)}. \quad (5.1)$$

The left-hand side of equation is the equity issued by banks held by asset agents is determined by capital adequacy requirement (KAR) times risk weighted assets ($\sum_{s,f} W_{(s,f,Banks)} \times \sum_d A1_{(Banks,Equity,d)}$). Since equity liability is likely to be more expensive, the commercial banks try to choose the assets composition ($A1_{(s,f,Banks)}$) for all instrument f ϵ FI issued by s ϵ LA to minimise:

$$U\left(NR_{(s,f,Banks)} \times A1_{(s,f,Banks)}, \forall s, f\right), \quad (6)$$

subject to:

$$\sum_{s,f} A1_{(s,f,Banks)} = BB_{(Banks)}, \quad (7)$$

and

$$NR_{(s,f,Banks)} = R_{(s,f,Banks)} - \Psi \times KAR \times W_{(s,f,Banks)}, \quad (8)$$

[8] We use the regulatory risk weights similar to those in Giesecke et al. (2017) and Nassios et al. (2020).

where Ψ is a positive parameter that shows the difference between equity rate of return and other liabilities and $NR_{(s,f,Banks)}$ is net return of commercial banks from their asset holdings. Equation (8) explains that banks net return is the return of $R_{(s,f,Banks)}$ minus penalty rate from having a higher CAR ($\Psi \times KAR \times W_{(s,f,Banks)}$). For example, if Ψ = 0.1, KAR = 0.1, and W = 1.0, equation (8) implies that the commercial banks receives a 0.01 or 100 basis points penalty rate from regulatory CAR. By increasing value of KAR to 0.12, the penalty rate increases to 0.012 or 120 basis points (rising 20 basis points). If the banks choose to own a financial asset with a lower risk weight (W) of 0.5, the penalty rate would become 0.005 or 50 basis point (falling 50 basis points). The process described here illustrates how equation (6)-(8) cause changes in the portfolio choice of commercial banks in our model.

2.4.2. Commercial bank liabilities and equity

We exclude the banks equity capital from the optimisation settings in equation (1) and (2) as we want the equity capital to follow regulatory CAR requirement. Herein, we set equations (9) - (14) to explain the key behavioural relations that relevant to the CAR simulation.

$$RABANK \times prabank = \sum_{s\in LA}\sum_{f\in FI}\left[RISKWGT_{(s,f)} \times A1_{(s,f,Banks)}\right] \times \left(priskwgt_{(s,f)} + a1_{(s,f,Banks)}\right), \quad (9)$$

$$EQBANK \times peqbank = \sum_{d\in AA} A1_{(Banks,Equity,d)} \times a1_{(Banks,Equity,d)}, \quad (10)$$

$$pratio = peqbank - prabank, \quad (11)$$

$$BBNEQ_{(Banks)} \times pbblneq_{(Banks)} = BBL_{(Banks)} \times pbbl_{(Banks)} - \sum_{d\in AA} A1_{(Banks,Equity,d)} \times a1_{(Banks,Equity,d)}, \quad (12)$$

$$averorne_{(Banks)} = \sum_{d \in AA} \sum_{f \in FINEQ} \left[A1_{(Banks,f,d)} / BBNEQ_{(Banks)}\right] \times rpow_{(Banks,f,d)}, \quad (13)$$

$$a1d_{(Banks,f)} = pbblneq_{(Banks)} + TAU \times \left[rpowd_{(Banks,f)} - averorne_{(Banks)}\right], \quad (14)$$

where $(f \in FINEQ)$.

The definition of variables, coefficients, and sets are presented in Table 7.

Variable	Description
$BBL_{(Banks)}$	The level of total end-of-year commercial bank liabilities (including equity).
$BBNEQ_{(Banks)}$	The level of the equity-exclusive value of end-of-year commercial bank liabilities.
$RABANK$	The level of the value of end-of-year risk-weighted bank assets.
$RISKWGT_{(s,f)}$	The level of the risk weights attaching to financial instrument f issued by liability agent s.
$A1_{(s,f,d)}$	The level of end-of-year holdings by agent d of asset type f issued by agent s.
TAU	A parameter governing the sensitivity of the composition of commercial bank liabilities to changes in the relative costs of financial instruments issued to particular asset agents.
$EQBANK$	The value of bank equity.
$prabank$	The percentage change in risk-weighted bank assets.
$priskwgt_{(s,f)}$	The percentage change in the value of the risk weight attached to commercial bank holdings of financial instrument f issued by liability agent s.
$a1_{(s,f,d)}$	The percentage changes in end-of-year holdings by agent d of asset type f issued by agent s.
$peqbank$	The percentage change in end-of-year bank equity.
$pbblneq_{(Banks)}$	The percentage change in the equity-exclusive value of commercial bank liabilities.
$pbbl_{(Banks)}$	The percentage change in end-of-year (equity-inclusive) commercial bank liabilities.
$averorne_{(Banks)}$	The percentage change in the average rate of return on non-equity financial instruments issued by commercial banks as liability agents.
$rpow_{(Banks,f,d)}$	The percentage change in the power (one plus the rate) of the rate of interest/return paid to asset agent d on financial instrument f issued by commercial banks as liability agents.
$a1d_{(Banks,f)}$	The percentage change in end-of-year non-equity liabilities issued by commercial banks as liability agents.
$rpowd_{(Banks,f)}$	The percentage change in the power of the rate of interest paid by commercial banks on non-equity financing instrument f.

Table 7 Variables and Coefficients in the Main Capital Adequacy Equations

Equation (9) represents accounting relationship to form banks risk weighted asset in percentage change form. Equation (10) represents the percentage change of the value of commercial bank equity at the end of the year, as the weighted average of percentage changes of banks equity held by asset agent d ϵ AA. Equation (11) is the percentage change in the capital adequacy ratio, expressed as the ratio of outstanding equity liabilities divided by risk weighted assets. Equation (12) calculates the value of commercial banks non-equity liabilities, as the total liabilities issuance minus equity issuance. Equation (13) is the formation of the average rates of return of the commercial bank assets. The equation (14) accounts for the optimisation behaviour of the commercial banks toward non-equity liabilities.

As aforementioned, aggregate CAR in Indonesia is higher than the required level. In our model, we assume the excess banks' capital (aggregate CAR minus required CAR) is exogenous determined. By this assumption, the change in required CAR causes the change in aggregate CAR. We note that theorising the excess banks' capital in our model could become an improvement for future research.

2.5.Database

The database in AMELIA-F consists of two parts, namely: the core database and the financial database. We use the 2010 Indonesia Input-Output table to develop the required database by the core model (Badan Pusat Statistik, 2015). We update the 2010 input-output database to 2018 using published national accounts data available in the Indonesian Financial Statistics (Bank Indonesia, 2020). The real side database distinguishes 51 unique commodities and industries. This is an aggregation of the core database the original 185 sectoral disaggregation the 2010 Indonesia Input-Output table. The financial database is developed using the 2018 financial account and balance sheet data for Indonesia (FABSI) provided by Bank Indonesia. We create single representative housing sector and assign the banks financing amount from mortgage available in published Indonesian Financial Statistics (Bank Indonesia,

2020). Using debt to equity ratio of property and real estate sector at the Indonesian stock market statistics (Indonesia Stock Exchange, 2020), we estimate the equity finance of the housing agent held by the households.

2.6.Closure and implementation method

The closure assumptions we use in our model are similar to those in Giesecke et al. (2017) and Nassios et al. (2020), with the following key elements:

(i) In line with neo-classical framework, the nominal wage is sticky while the employment is flexible in the short run. The nominal wage adjusts over the medium to long run to ensure the employment rate returns to the baseline forecast level in the long run.

(ii) The government consumption and the ratio of public deficit/GDP in are assumed to be fixed. As consequence, the government revenue side needs to be flexible i.e., we endogenously determine tax on households' income.

(iii) We set other GDP expenditures (household consumptions, investments, exports, import, and stocks) endogenously determined.

(iv) Capital stocks are prevented to move in the short run and adjust to respond the movement of expected real of return of industries over medium to long run.

(v) The central bank responds to the deviation in the employment rate and the inflation rate from their medium-term targets according to the Taylor rule [Taylor (1993); Orphanides (2007); Giesecke et al. (2017); Nassios et al. (2020)]. When the economy weakens, the central bank responds by reducing the policy rate to create an expansionary monetary policy.

3. Results

The 100 basis point increase in the CAR causes the commercial banks to adjust their capital structure (the composition of the liability side of their balance sheet). To increase the

CAR, commercial banks raise equity issuance and reduce their reliance on deposits and bonds finance (Figure 2). The commercial banks raise the issuance of equity around 3.3 per cent from the baseline and reduce deposits and bonds finance to nearly 3 per cent from the baseline in the policy year.

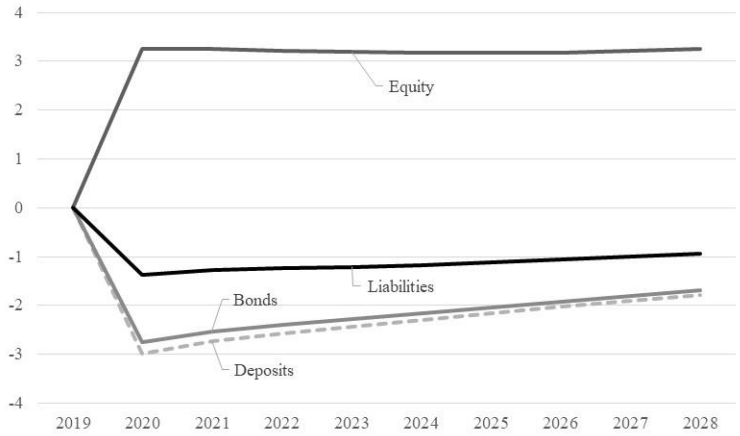


Figure 2 Financing Instruments of the Commercial Banks (% Deviation from Baseline)

To elicit asset agents to hold additional equity, banks raise the rate of return on equity, while offering a lower rate of return on deposits and bonds finance (Figure 3). The lower rate of return on deposits and bonds causes the overall liabilities to shrink. Deposits play an important role in banks finance (69 per cent of the total liabilities) and 70 per cent of this are held by households. Figure 3 reports a decrease of banks deposits by the large holders (foreigners, households, and NBFI). The fall in deposits finance cannot be offset by the overall increase in equity capital, thus causes the banks total liabilities to decrease (Figure 2).

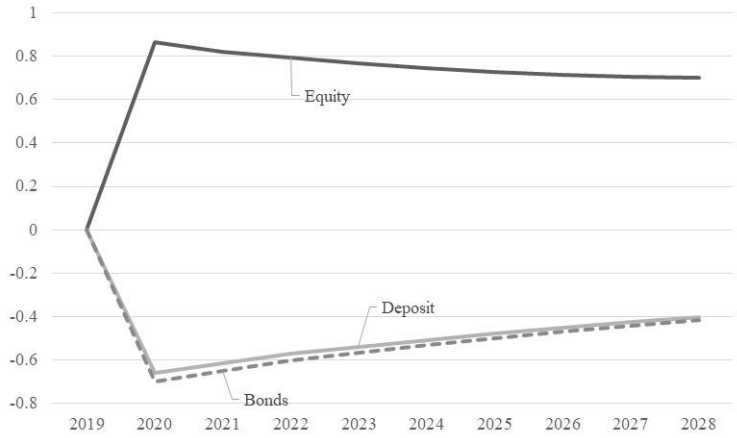


Figure 3 Power of Rates of Return on Commercial Bank Liabilities (% Deviation from Baseline)

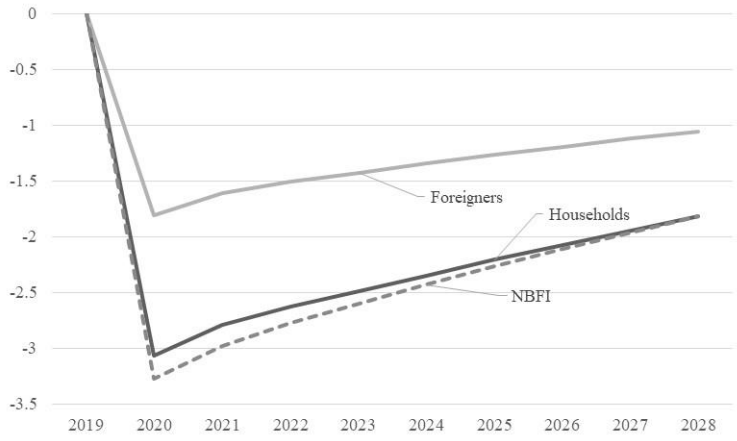


Figure 4 Household and Foreign Deposits with Commercial Banks (% Deviation from Baseline)

The increase in the use of equity finance drives a rise in the weighted average cost of bank capital (WACC) (Figure 4). Equity typically requires higher rate of return than other financing instruments. Given the higher required rate of return of equity, an increase in the rate of return of equity causes the overall banks WACC to rise. Figure 5 reports that the increase of banks WACC impacts on other institutions WACC. We see that the NBFI and Housing agents have more increase in WACC as they are more banks reliant than other agents. The increase of other agents WACCs explains how the banks lending channel impacts the economy at the first round of the policy simulation.

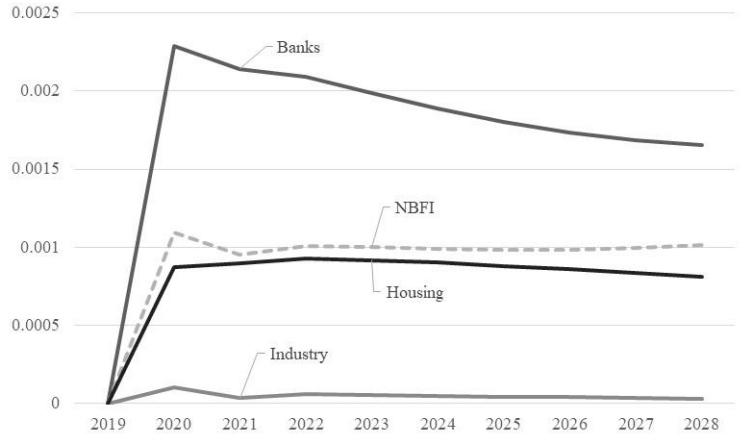


Figure 5 Weighted Average Cost of Capital of Banks, NBFI, Housing, and Industry (Basis Point Change from Baseline)

On the assets side, the commercial banks reduce the value of their risk weighted assets to achieve an increase in banks CAR (Figure 6). The banks move away from riskier assets and weakly retain the less risky assets. Banks tend to reduce their equity holding larger in relative to other assets, as equity carries a high-risk weight of 3.0. Meanwhile, the reduction of safer assets, e.g., bonds and cash, are smaller in relative to the riskier assets. In the long run, the safer assets fall further along with loans to the order of 0.4 per cent deviation from the baseline.

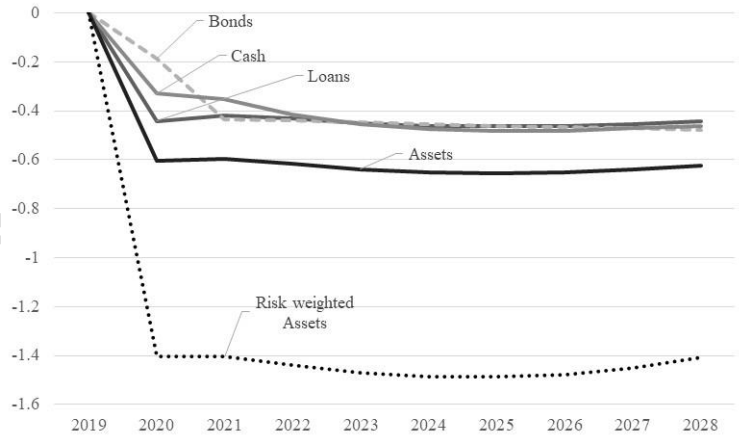


Figure 6 Asset Acquisition by the Commercial Banks (% Deviation from Baseline)

The contraction in commercial banks assets reflects the reduction of loans to the industry (non-housing) and housing agents (Figure 7 and 8). There are a relatively stronger substitution effects in industry agent financing than in the housing agent financings. As banks'

loans get more expensive, industry agent moves away from the banks loans and substitutes the banks loans with bonds and equity. Figure 8 reports that the industry agent liabilities slightly fall in the short run and quickly return to the baseline thereafter. Meanwhile, with limited financing alternatives, the fall in banks loans cause a larger impact on the housing sector. The total liabilities of the housing sector do not quickly return to the baseline after the event year, although equity finance raises as a response of reduced banks loans. This is because the housing agent is more banks reliant in relative to the non-housing agent.

In AMELIA-F database, foreigners finance 42 per cent of non-housing investments. We would have expected that a reduced domestic banks loans to the industry induces a large foreign investments penetration to the country. However, this does not occur in our simulation. There are two reasons that constrains the foreign investments coming to the economy. As we shall see, the foreign financing requirement falls as real investment decreases due to a rise in industry and housing WACC, i.e., the current account deficit moves towards surplus (Figure 16). This is an economy-wide reduction in foreign capital demands that constrains the capacity to absorb foreign investments. Second, as banks increase the rate of return on equity in order to achieve the regulatory CAR, their rate of return becomes more attractive than the rates of return of the industry agent. Figure 8 reports that foreigners are more attracted to invest more in banks equity than in the industry.

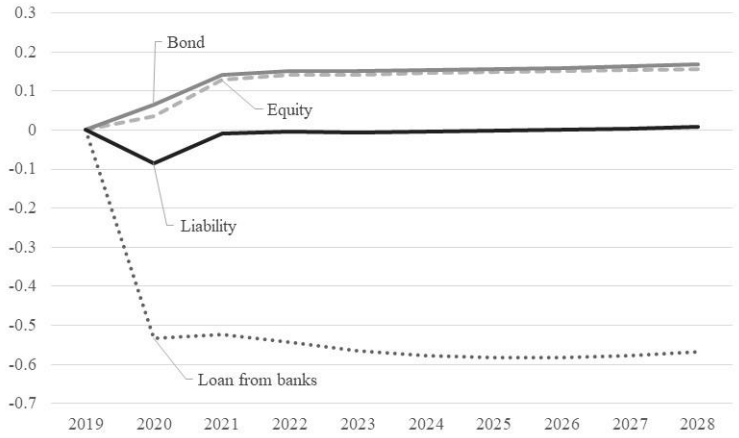


Figure 7 Industry Financing Instruments
(% Deviation from Baseline)

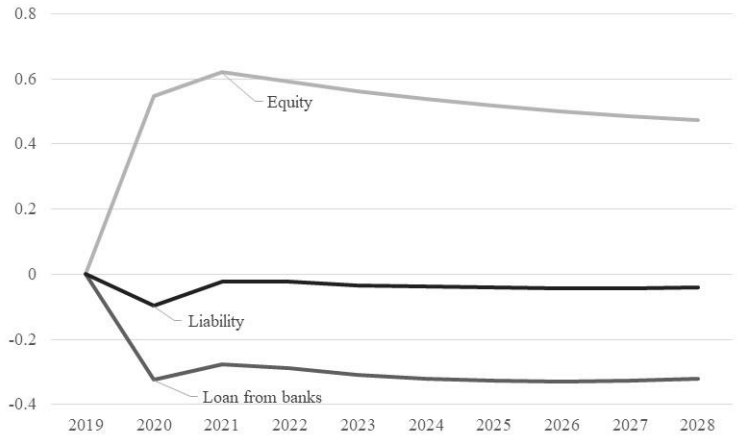


Figure 8 Housing Financing Instruments
(% Deviation from Baseline)

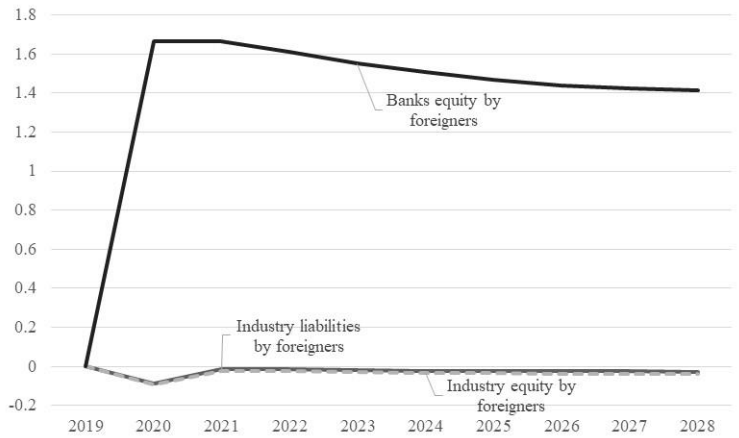


Figure 9 Foreigner Assets Holding
(% Deviation from Baseline)

With banks move away from riskier financial assets, the WACC of the housing and industry agents increases, driving real investment activity below the baseline. Figure 10 reports the gross capital formation of industry and housing sector that represents real investment in the economy. The housing investment fall deeper because they are more banks reliant than the non-housing investment. In the AMELIA-F database, 80 per cent housing financing comes from the banks loans, while the rest of financing is in the form of equity held by households. With the limited financing alternatives, a constrained banks financing impacts the housing investment severely. The housing investment is 15 per cent of total investment costs. Meaning that deeper negative impact in housing investment will be offset by the smaller decline of non-housing investment. Eventually, aggregate real investment slightly reduces of 0.02 percent from the baseline in the policy year and adjust slowly toward baseline in the long run (Figure 9).

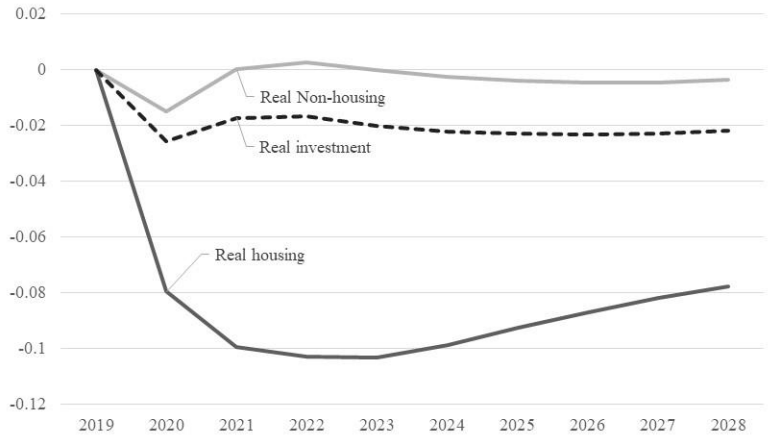


Figure 10 Real Industry Investment, Housing Investment, Aggregate Investment (% Deviation from Baseline)

The central bank to some extent counters the negative impact of the increase in capital adequacy policy. Figure 11 reports the reaction of the central bank toward management of the macro consequences of a 100 basis point increase in CAR. The central bank decreases its policy rates (both deposit and financing rates) in response to the weakened economy. The central bank is assumed to act according to the Taylors rule that the policy rates are a function of deviation

of the employment rate from the non-accelerated inflation rate of unemployment (NAIRU), and the actual inflation from the inflation target. Figure 12 reports the negative deviation of employment rate and the consumer price from the baseline in the policy year. The Taylor rule translates this into a negative deviation in the policy rate of 6.7 basis points in the event year. In the long run, policy rates move gradually to the order of 4 basis point. The fall in the central bank policy rates in the event year causes commercial banks to reduce their allocation of what to excess reserve deposits in the central bank that equivalent to a monetary expansion.

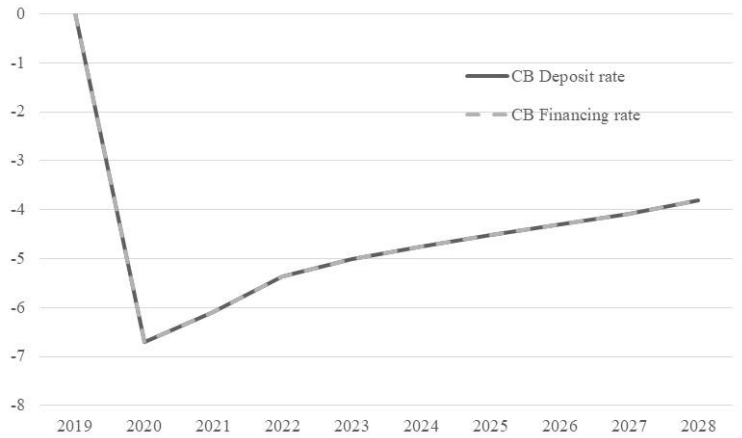


Figure 11 Central Bank Policy Rates
(Basis Point Change from Baseline)

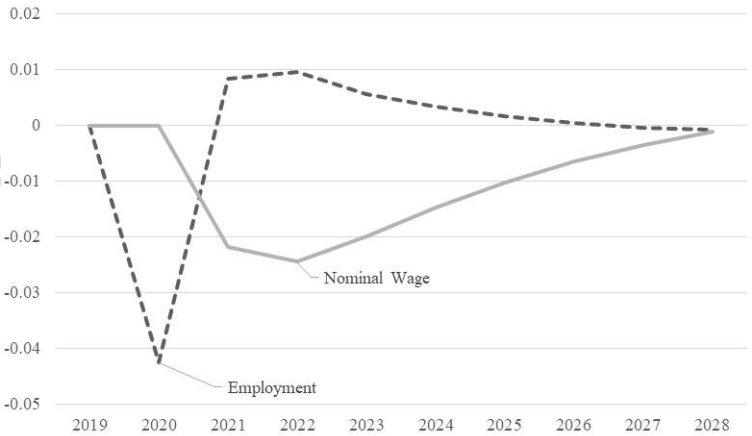


Figure 12 Employment Rate and Nominal Wage
(Percentage Deviation from Baseline)

Figure 13 reports the deviation from baseline of real GDP, employment, and the capital stock. As the capital stock is fixed in the event year, the movement of the real GDP only depends on the short run employment response. As aforementioned, employment falls in the

event year due to a weaker economy. In the event year, the nominal wage is fixed (Figure 12) while GDP deflator falls relative to the baseline (Figure 14). A negative deviation in the GDP deflator in an environment of nominal wage rigidity causes the real producer wage to rise in the short run. With physical capital stocks unchanged and the real producer wage rising, the employment rates must fall. With 29 per cent employment contribution to the value of the GDP, given fixed capital stock, a -0.04 per cent deviation of the employment translates to -0.01 per cent real GDP deviation in the event year (=-0.04*0.29). The negative deviation of real investment impacts the capital stock in the second year of the simulation and adjusts to the baseline as the real investment returns to the baseline in the long run. In our sim, the real GDP adjust immediately to the baseline after the policy shock but continues to decline thereafter. This is because employment adjust to the baseline in the long run. Meanwhile, the capital stock takes very long to return to the baseline.

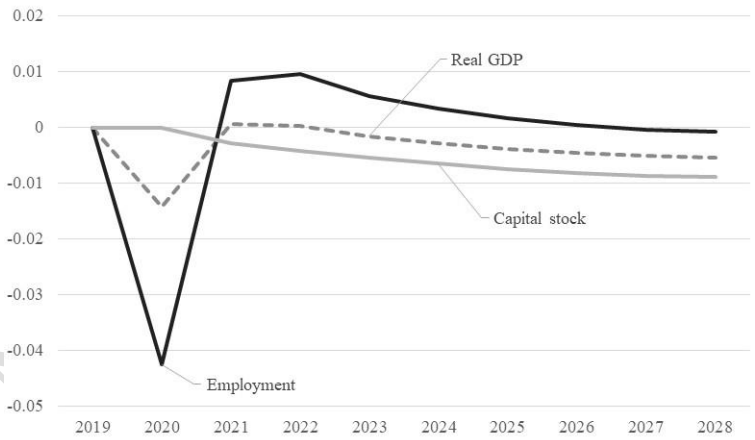


Figure 13 Real GDP, Employment, and Capital Stock (% Deviation from Baseline)

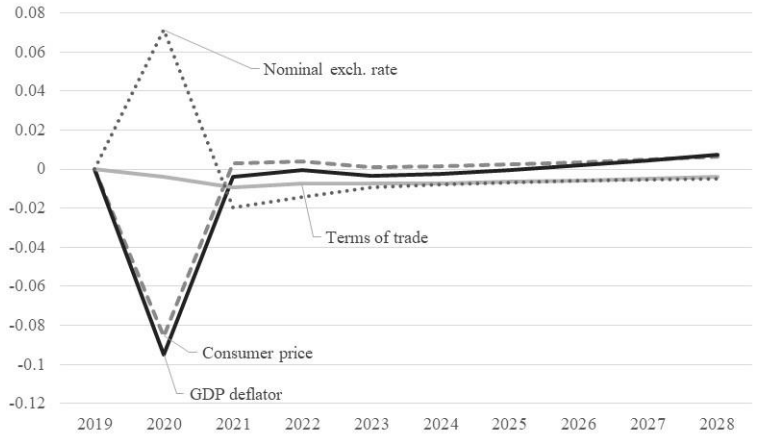


Figure 14 GDP Deflator, Consumer Price, Nominal Exchange Rate and Terms of Trade (% Deviation from Baseline)

Figure 15 reports the percentage deviation away from baseline for the expenditure components of the GDP. In line with income GDP, the expenditure GDP falls to the order of 0.01 per cent from the baseline in the policy year and adjust to baseline thereafter. As GDP falls, households consumption decreases. A fall in real investment and households consumption induce imports demands for capital and consumption goods respectively. Public consumption is unaffected as we set this exogenously determined as aforementioned in closure section (2.6.). The smaller negative deviation of the real GDP than the real GNE indicates the positive change in the trade balance. Falling in domestic prices leads to the lower terms of trade and stimulates exports to increase from the baseline. The current account deficit moves towards surplus, muting the economy-wide external financing requirement.

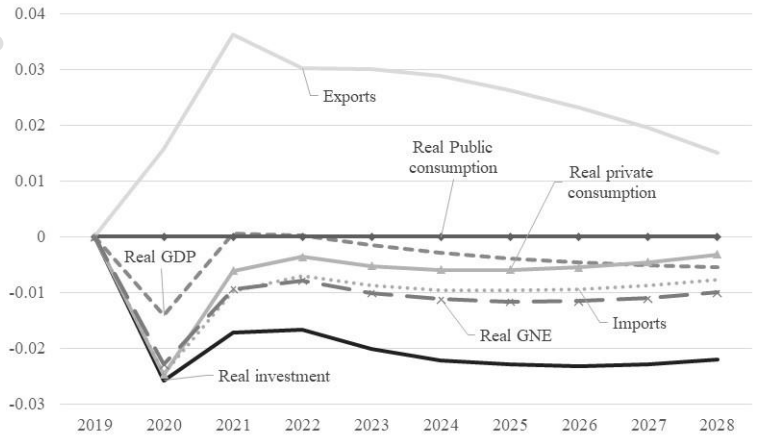


Figure 15 Expenditure-side Components of Real GDP at Market Prices

(% Deviation from Baseline)

The nominal exchange rate appreciates as the foreign capital penetration to the domestic economy are limited by the slowing down of the aggregate real investment. Positive deviation in the current account deficit reduces the domestic currency amount (Rp) of foreign investments. As the foreigners are assumed to have a fixed budget to be invested, the less foreign investment causes lower amount of Rp per foreign currency (i.e., U.S. dollar). This means an appreciation of nominal exchange rate. Appreciation of the nominal exchange rate ensures that the fixed investment budget of the foreigners meets the lower domestic financing requirement.

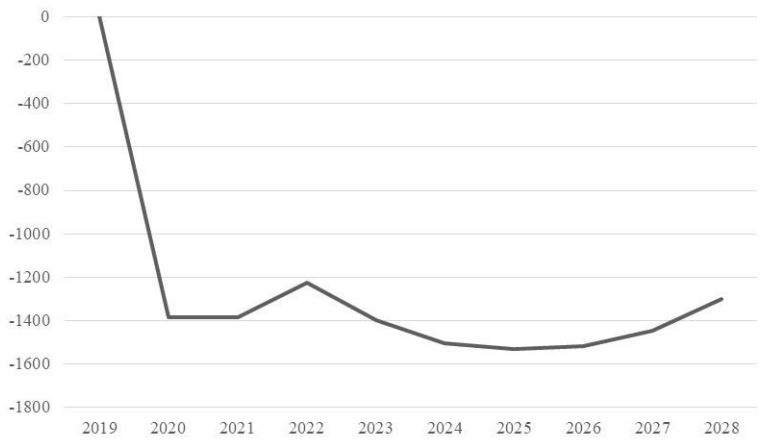


Figure 16 Current Account Deficit (Rp billion)

4. Conclusion

After the 2008 global financial crisis (GFC) authorities across the globe stressed of the importance of strengthening commercial banks capital adequacy ratio according to Basel III. With many countries raising banks' CAR, there are only a few studies evaluate the impacts of the policy for emerging countries from a broader macroeconomic perspective. This paper investigates the economy-wide impacts of a 100 basis points increase in banks CAR in

Indonesia using a Financial CGE model we call AMELIA-F. The model has the core CGE model with detailed finance module.

The core part of the model explains the real economy under the neo-classical theoretical framework in which closely follows the MONASH model by Dixon and Rimmer (2002). The financial module includes the theories on financial agents interactions and the linkages to the real side economy following those in Giesecke et al., (2017) and Nassios et al., (2020). The core side of the model is connected to the financial module via four channels, namely: industry and housing investment are financed by net liability raisings by the corresponding financial liability agents, the current account deficit is financed by net asset purchases of the foreigners investors, households savings are ties down net asset purchases by the households agent, and the government deficit is financed by the net liability issued by the government financial agent. The financial database is taken from the 2018 Financial Account and Balance Sheet of Indonesia (FABSI) by Bank Indonesia.

Our model simulation finds a 100 basis points increase in the banks CAR causes a small negative consequences on the economy. The commercial banks experience a balance sheet reduction as they move away from the riskier assets. This impacts negatively on the industry and housing agents capacity to invest in physical capital formation (the real investment). Real investment falls by 0.02 per cent deviation from the baseline in the event year and returns gradually to the baseline in the long run. Real GDP decreases by 0.01 per cent from the baseline in the event year and returns to the baseline thereafter. The central bank reduces its policy rates to counter the negative impacts on employment rate and consumer price. Falling real investments decreases external financing requirement as indicated by a positive change in current account deficit. The positive foreign capital inflows and smaller external financing requirement translates into an appreciation of the nominal exchange rate.

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