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

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Assessing the Economy-wide Impacts of Strengthened Bank 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 bank 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 fall in real investment decreases foreign financing needs.

Keywords: *Financial CGE model; weighted average cost of capital; capital adequacy ratio; macro prudential policy; Indonesia.*

JEL classification: C68; D58; E17; E44; G21.

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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), Lin and Yang (2016), Slovik & Cournède (2011), Akram (2014), Liu & Molise (2019), 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 bank capital reforms on lending growth in Peru. They find that a 1 percentage point increase in bank capital adequacy requirements (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 bank capital requirements (Hohl et al., 2018).

2013	2014	2015	2016	2017	2018	2019
Capital regulation enacted	CET1=4.5% +AT1= 6% +Tier2=8%	Capital Conservation Buffer enacted	0.625ppt	1.25ppt	1.875ppt	2.5ppt (for capital >Rp5 trillion)
		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

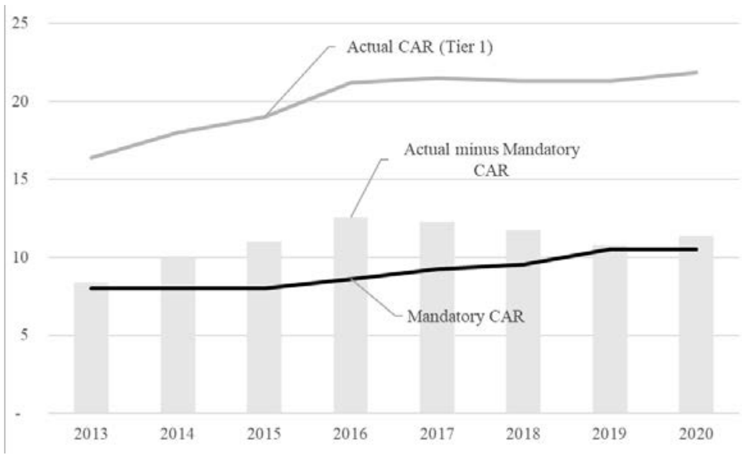
Beginning in 2013, Indonesia has steadily implemented bank capital reforms as recommended by the Basel III principles (Table 1). In 2014, banks were required to set the Common Equity Tier-1 (CET1) at the minimum of 4.5 per cent of risk weighted assets (RWA).[2,3] The CET1 is supplemented by the Alternative 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's Financial Services Authority, the Otoritas Jasa Keuangan (OJK) implemented risk-based capital regulation to differentiate bank 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 risk level 3 must hold a minimum CAR of 10-11%; while banks with

[2] Common Equity Tier 1 is the equity component of bank 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 bank assets are exposed to market risks. RWA is calculated by summing up the different types of assets after multiplied by their respective regulatory risk weights.

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.[4] The supplementary capital buffers were gradually increased between 2016 and 2019 (Columns 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 economy. In 2019, the CCB rose to a maximum of 2.5 percentage points. In the same year, the banks within the D-SIB category were 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 Bank CAR, Tier-1 (%)

[4] 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 (%)

An interesting characteristic of the Indonesian banking sector is that the actual CAR of the banking sector exceeds the mandated CAR (Figure 1). Moreover, actual bank CAR rises in lock step with scheduled increases in mandatory CAR. This phenomenon is manifested across all types of banks (Table 2). In general, banks tend to hold a relatively stable wedge between mandatory and actual CAR over time (Figure 1). The financial authority in Indonesia routinely advises banks to maintain enough buffer, and the banks show a strong inclination to comply.[5] Bank 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 bank capital and profitability indicators for several ASEAN and major advanced countries. This shows banks in these countries normally hold CAR above requirement. Banking crises, unreliable interbank markets, and search for quality possibly motivate the banks to have larger capital buffers than mandated (Andrle et al. 2019). Interbank in Indonesia is characterised as a fragmented market. Large

[5] For instance, when Bank Bukopin experienced a fall in its CAR to 12 per cent in May 2020, it was considered an alarming level as it was near the threshold. The OJK encouraged Bank Bukopin's major investor to add more capital. As a result, the CAR increased to 16 per cent on August 2020 [Kontan.co.id, (2020a); Kontan.co.id, (2020b)], well above the mandated CAR.

banks that have ample domestic currency supply are more likely to transact with foreign banks with large foreign currency supplies (International Monetary Fund, 2018). The better-capitalised banks could gain more counterparty trust, thus strengthening their position to access the interbank markets.

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 (%)

In general, the high bank CAR in Indonesia is obtained through offering new shares to the existing equity holders (via rights issue) and through retained earnings (Bank Indonesia, 2018). Banks in 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 higher profitability. High profitability allows banks to increase equity capital without reducing dividend payments 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 bank CAR causes the weighted average cost of bank capital (WACC) to rise, in turn raising the WACC of other financial agents, and negatively impacting on the real economy [e.g., Miles et al., (2012), Slovik & Cournède (2011), Liu & Molise (2019), Kapuściński & Stanisławska (2018), 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 will have no impact on bank capital costs (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 bank 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 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 the 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 constraints. The behaviours of the key economic agents are modelled as follows: industries produce levels of commodity-specific output that maximise revenue subject to constant elasticity of transformation (CET) functions. This optimisation creates commodity supply functions that connect output by industry, differentiated by commodity, with industry activity levels and relative prices across commodities. 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. Industry demands for labour and capital respond to movements in industry activity levels, 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 (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 "asset agents" (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 $f \in FI$ issued by liability agent $s \in LA$ and held by asset agent $d \in AA$. 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
3	DepLoans	Currency and deposits
4	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 $s \in LA$ decides the issuance of liability instrument $f \in FI$ held by asset agent $d \in AA$ that minimises the financial payment at the end of the year. Algebraically, this is written as follow:

$$\text{Minimise} \quad : CET\left(A1_{(s,f,d)} \cdot R_{(s,f,d)}, \forall f, d\right) \qquad (s \epsilon LALF)$$ [6]

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

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 $f \in FI$ issued by liability agent $s \in LA$ and held by asset agent $d \in AA$ 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 $d \in AA$ sets their (asset) instrument $f \in FI$ issued by $s \in LA$ to maximise their portfolio-weighted average rate of return at the end of the year. The optimisation problem is written as follow:

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

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

Subject to : $\mathrm{NEWASSET}_{(d)} = \sum_s \sum_f \left(\mathrm{A1}_{(s,f,d)} - \mathrm{A0}_{(s,f,d)} \cdot \mathrm{V}_{(s,f,d)}\right).$

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

$$\mathrm{a1}_{(s,f,d)} = \mathrm{liabilities}_{(s)} - \tau_{(s)}\left(\mathrm{r}_{(s,f,d)} - \mathrm{wacc}_{(s)}\right), \quad (s\epsilon \mathrm{LALF}), \tag{1}$$

$$\mathrm{a1}_{(s,f,d)} = \mathrm{assets}_{(d)} + \sigma_{(d)}\left(\mathrm{r}_{(s,f,d)} - \mathrm{averor}_{(d)}\right), \quad (s\epsilon \mathrm{LALF}). \tag{2}$$

where $\mathrm{a1}_{(s,f,d)}$ and $\mathrm{r}_{(s,f,d)}$ are the percentage changes of coefficient $\mathrm{A1}_{(s,f,d)}$ and $\mathrm{R}_{(s,f,d)}$ respectively. The $\mathrm{liabilities}_{(s)}$ and $\mathrm{assets}_{(d)}$ are the percentage changes of coefficient $\mathrm{NEWLIAB}_{(s)}$ and $\mathrm{NEWASSET}_{(d)}$ respectively. The $\mathrm{wacc}_{(s)}$ is the percentage change of weighted average cost of capital of liability agent $s \epsilon$ LA. The $\mathrm{averor}_{(d)}$ is the percentage change of average rates of return of asset agent $d \epsilon$ 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

$$\mathrm{U}\left(\mathrm{R}_{(s,f,\mathrm{Banks})} \cdot \mathrm{A1}_{(s,f,\mathrm{Banks})}, \forall s, f\right), \tag{3}$$

subject to

$$\sum_{s,f} \mathrm{A1}_{(s,f,\mathrm{Banks})} = \mathrm{BB}_{(\mathrm{Banks})}, \tag{4}$$

and

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

where the U is the CES function, KAR is the coefficient of required capital adequacy (comprising the mandated capital requirement and the fixed buffer above the mandated rate), $W_{(s,f,Banks)}$ are the regulatory risk weights,[7] $\sum_{d} A1zero_{(Banks,Equity,d)}$ is the commercial banks equity issuance with the absence of capital adequacy requirement, $BB_{(Banks)}$ is the value of commercial banks asset.

When banks are constrained by KAR, equation (5) becomes

$$\sum_{d} A1_{(Banks,Equity,d)} = KAR \cdot \sum_{s,f} W_{(s,f,Banks)} \cdot A1_{(s,f,Banks)}. \quad (6)$$

We allow bank decision making regarding the composition of bank asset holdings to be influenced by capital adequacy requirements, the relatively higher return required on equity liabilities, and risk weights, via equation (7) - (9):

$$CES\left(NR_{(s,f,Banks)} \cdot A1_{(s,f,Banks)}, \forall s, f\right), \quad (7)$$

subject to:

$$\sum_{s,f} A1_{(s,f,Banks)} = BB_{(Banks)}, \quad (8)$$

and

$$NR_{(s,f,Banks)} = R_{(s,f,Banks)} - \Psi \cdot KAR \cdot W_{(s,f,Banks)}, \quad (9)$$

[7] 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 reflecting the difference between the rate of return on bank equity and other bank liabilities. Equations (8) and (9) express the idea that banks will be mindful of a rate of return concept when adjusting bank assets that accounts for both the return on the asset ($R_{(s,f,Banks)}$) and any penalty required by having to raise additional funding via relatively expensive equity ($\Psi \times KAR \times W_{(s,f,Banks)}$). For example, if Ψ = 0.1, KAR = 0.1, and W = 1.0, equation (8) implies that commercial banks receives a 0.01 or 100 basis points penalty rate from regulatory CAR. By increasing the 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 (7) - (9) 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 the regulatory capital requirement together with any fixed additional buffer (jointly described by KAR). Herein, we set equations (10) - (15) to explain the key behavioural relations that relevant to the CAR simulation.

$$\mathrm{RABANK} \cdot \mathrm{prabank} = \sum_{s \in LA} \sum_{f \in FI} \left[\mathrm{RISKWGT}_{(s,f)} \cdot \mathrm{A1}_{(s,f,Banks)}\right] \cdot \left(\mathrm{priskwgt}_{(s,f)} + \mathrm{a1}_{(s,f,Banks)}\right), \tag{10}$$

$$\mathrm{EQBANK} \cdot \mathrm{peqbank} = \sum_{d \in AA} \mathrm{A1}_{(Banks,Equity,d)} \cdot \mathrm{a1}_{(Banks,Equity,d)}, \tag{11}$$

$$\mathrm{pratio} = \mathrm{peqbank} - \mathrm{prabank}, \tag{12}$$

$$\mathrm{BBNEQ}_{(\mathrm{Banks})} \cdot \mathrm{pbblneq}_{(\mathrm{Banks})} = \mathrm{BBL}_{(\mathrm{Banks})} \cdot \mathrm{pbbl}_{(\mathrm{Banks})} - \sum_{d \in AA} \mathrm{A1}_{(\mathrm{Banks,Equity,d})} \cdot \mathrm{a1}_{(\mathrm{Banks,Equity,d})}, \quad (13)$$

$$\mathrm{averorne}_{(\mathrm{Banks})} = \sum_{d \in AA} \sum_{f \in FINEQ} \left[\mathrm{A1}_{(\mathrm{Banks,f,d})} / \mathrm{BBNEQ}_{(\mathrm{Banks})}\right] \cdot \mathrm{rpow}_{(\mathrm{Banks,f,d})}, \quad (14)$$

$$\mathrm{a1d}_{(\mathrm{Banks,f})} = \mathrm{pbblneq}_{(\mathrm{Banks})} + \mathrm{TAU} \cdot \left[\mathrm{rpowd}_{(\mathrm{Banks,f})} - \mathrm{averorne}_{(\mathrm{Banks})}\right], \quad (15)$$

where ($f \in FINEQ$).

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

Variable	Description
$\mathrm{BBL}_{(\mathrm{Banks})}$	The level of total end-of-year commercial bank liabilities (including equity).
$\mathrm{BBNEQ}_{(\mathrm{Banks})}$	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.
$\mathrm{RISKWGT}_{(\mathrm{s,f})}$	The level of the risk weights attaching to financial instrument f issued by liability agent s.
$\mathrm{A1}_{(\mathrm{s,f,d})}$	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.
$\mathrm{priskwgt}_{(\mathrm{s,f})}$	The percentage change in the value of the risk weight attached to commercial bank holdings of financial instrument f issued by liability agent s.
$\mathrm{a1}_{(\mathrm{s,f,d})}$	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.
$\mathrm{pbblneq}_{(\mathrm{Banks})}$	The percentage change in the equity-exclusive value of commercial bank liabilities.
$\mathrm{pbbl}_{(\mathrm{Banks})}$	The percentage change in end-of-year (equity-inclusive) commercial bank liabilities.
$\mathrm{averorne}_{(\mathrm{Banks})}$	The percentage change in the average rate of return on non-equity financial instruments issued by commercial banks as liability agents.
$\mathrm{rpow}_{(\mathrm{Banks,f,d})}$	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.
$\mathrm{a1d}_{(\mathrm{Banks,f})}$	The percentage change in end-of-year non-equity liabilities issued by commercial banks as liability agents.
$\mathrm{rpowd}_{(\mathrm{Banks,f})}$	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 (10) represents accounting relationship to form banks risk weighted asset in percentage change form. Equation (11) 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 (12) is the percentage change in the capital adequacy ratio, expressed as the ratio of outstanding equity liabilities divided by risk weighted assets. Equation (13) calculates the value of commercial banks non-equity liabilities, as the total liabilities issuance minus equity issuance. Equation (14) is the formation of the average rates of return of the commercial bank assets. The equation (15) 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 bank capital (aggregate CAR minus required CAR) is exogenously determined. By this assumption, the change in required CAR causes the change in aggregate CAR. We note that theorising the excess bank 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

We investigate the effects of a mandated 100 basis point increase in bank capital adequacy requirements. This can be implemented either via a rise in the regulatory floor CAR in the presence of fixed discretionary buffers, or via persuasion by regulatory authorities that banks raise their discretionary buffer while leaving the regulatory floor CAR unchanged, or via a combination of both.

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 by approximately 3.3 per cent relative to baseline, and reduce deposit and bond finance by nearly 3 per cent relative to baseline.

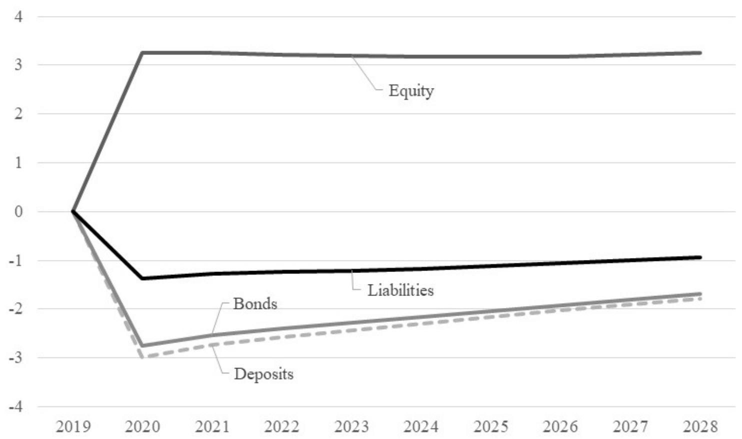


Figure 2 Financing Instruments of the Commercial Banks (% Deviation from Baseline)

To convince 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). 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 does not offset by the overall increase in equity capital, thus total bank liabilities decrease (Figure 2). This reflects the overall contraction in bank activity, caused by the rise in the relate weighted average cost of bank capital (Figure 5) generated by the move towards more expensive equity in bank financing.

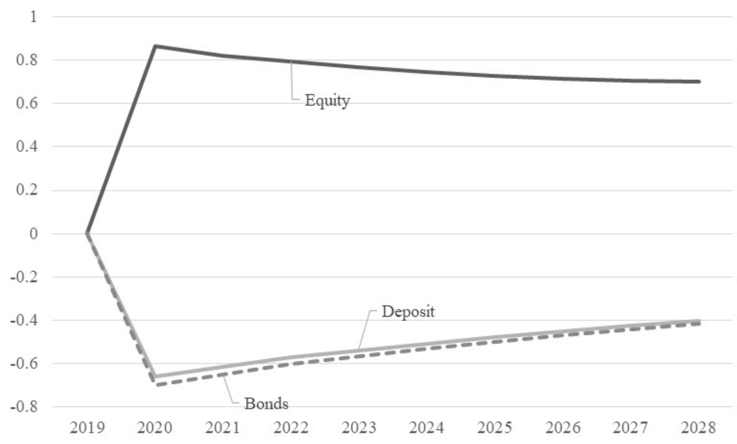


Figure 3 Power of Rates of Return on Commercial Bank Liabilities (% Deviation from Baseline)

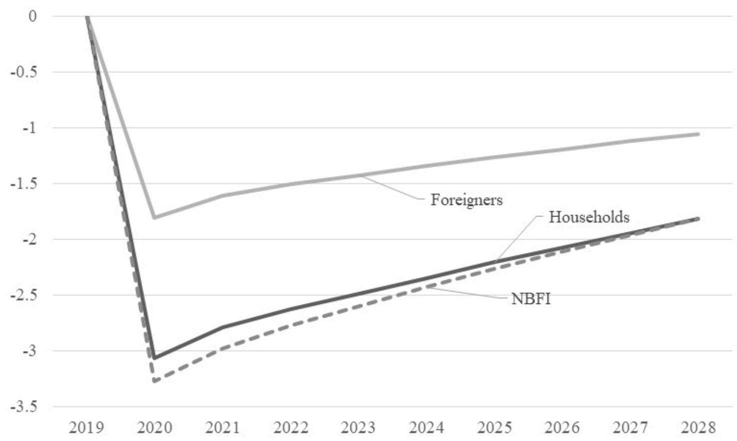


Figure 4 Household and Foreign Deposits with Commercial Banks (% Deviation from Baseline)

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

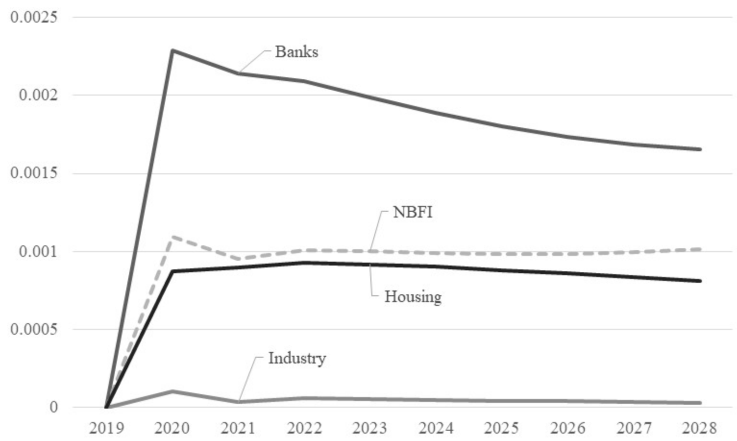


Figure 5 Weighted Average Cost of Capital of Banks, NBFI, Housing, and Industry (Basis Point Change from Baseline)

On the asset side, the commercial banks reduce the value of their risk weighted assets in response to the rise in CAR (Figure 6). The banks move away from riskier assets and weakly retain the less risky assets. Banks tend to reduce their equity holding more relative to other assets, as equity carries a high-risk weight. Reductions in holdings of safer assets (e.g., bonds and cash) are smaller relative to the riskier assets This reflects the operation of equation (9), which imposes a lower penalty (via lower risk weights) on holdings of safer assets.

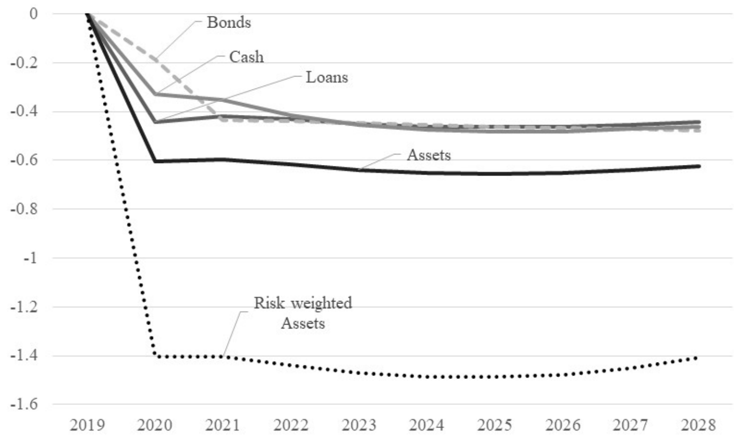


Figure 6 Asset Acquisition by the Commercial Banks (% Deviation from Baseline)

The contraction in commercial bank assets reflects the reduction of loans to the industry (non-housing) and housing agents (Figure 7 and 8). As bank loans get more expensive, the industry agent moves away from banks loans and substitutes the banks loans with industry-issued bonds and equity (Figure 7). Meanwhile, with more limited financing alternatives, the fall in banks loans causes a larger impact on the housing sector. Unlike industry, the total liabilities of the housing sector do not return to the baseline after the event year, although equity finance raises as a response to reduced banks loans. This is because the housing agent is more reliant on bank funding relative to the non-housing agent.

In the AMELIA-F database, foreigners finance 42 per cent of non-housing investments. We would have expected that a reduction in domestic bank loans to industry induces a large foreign investment penetration to the country. However, this does not occur in our simulation. There are two things that constrain foreign investment 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 investment. 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 9 reports that foreigners are more attracted to invest more in bank equity than in the industry.

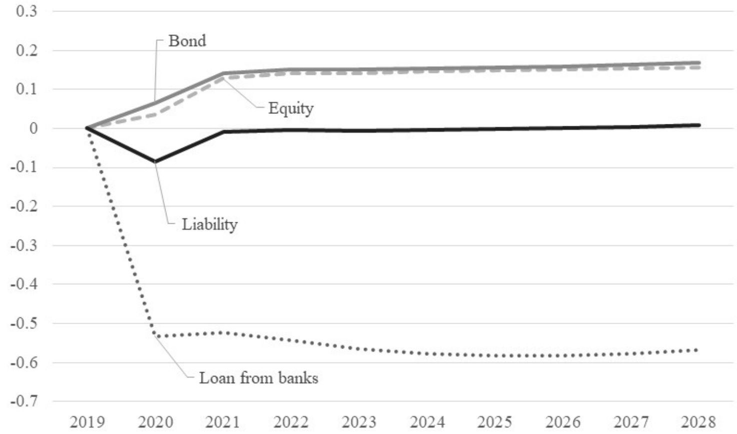


Figure 7 Industry Financing Instruments (% Deviation from Baseline)

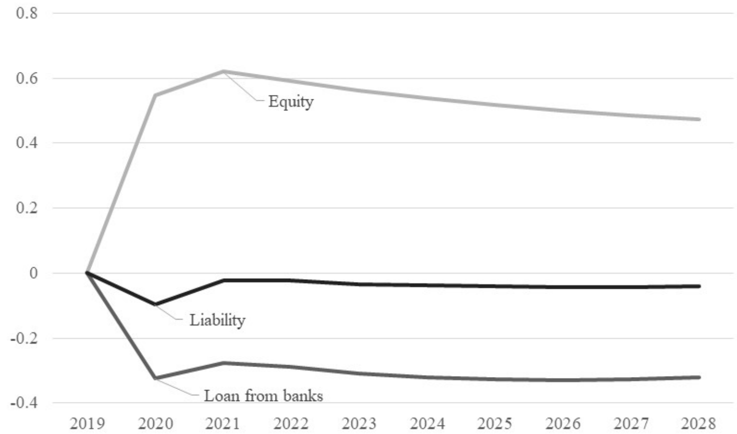


Figure 8 Housing Financing Instruments (% Deviation from Baseline)

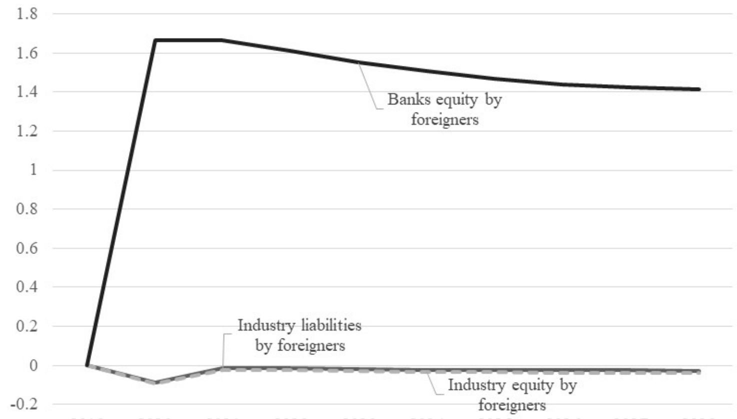


Figure 9 Foreigner Assets Holding
(% Deviation from Baseline)

With the commercial banks move away from riskier financial assets, the WACC of the housing and industry agents increase, driving real investment activity below baseline. Figure 10 reports the gross fixed capital formation of the industry and housing sectors, which together constitute economy-wide real investment expenditure. The housing investment fall is deeper because they are more bank reliant than the non-housing investment. In the AMELIA-F database, 80 per cent of housing financing comes from banks loans, while the rest of financing is in the form of equity held by households. Non-housing investment moves back towards baseline in the long-run, reflecting greater access to non-bank financing options for this sector. In contrast, with more limited financing alternatives, constrained bank financing impacts housing investment more severely.

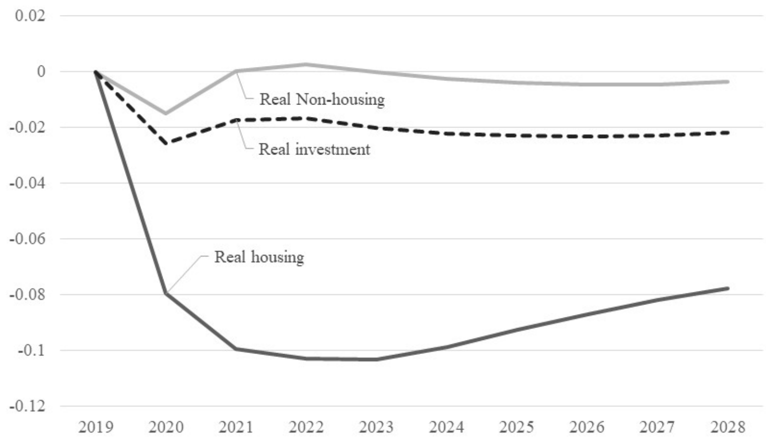


Figure 10 Real Industry Investment, Housing Investment, Aggregate Investment (% Deviation from Baseline)

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 Taylor rule whereby policy rates are a function of the deviation of the unemployment rate from the natural rate of unemployment, and the actual inflation rate from the inflation rate target. Figure 12 reports the negative deviation of the 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 below baseline.

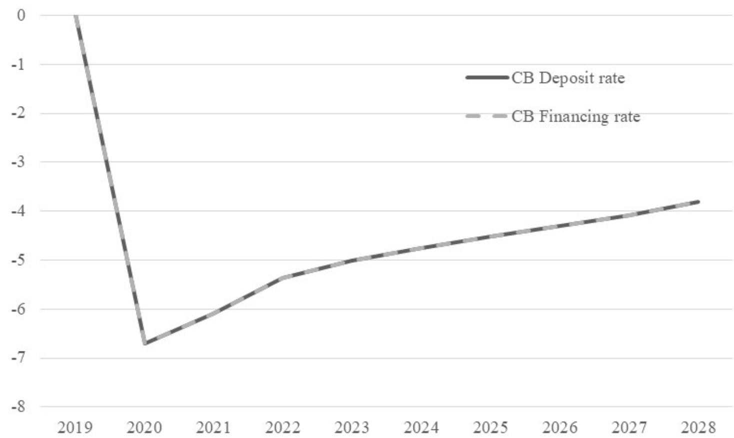


Figure 11 Central Bank Policy Rates (Basis Point Change from Baseline)

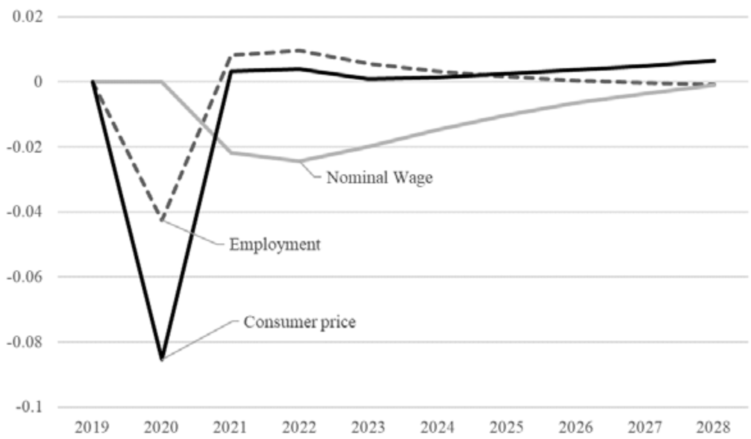


Figure 12 Employment Rate and Nominal Wage (Percentage Deviation from Baseline)

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 in 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 the 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 rate must fall. With a 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). Despite the eventual return of employment to baseline, real GDP is permanently below baseline. This reflects the permanent decline in the capital stock.

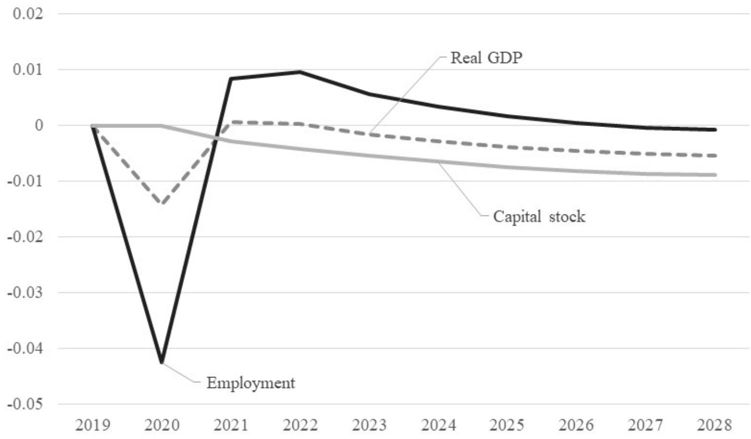


Figure 13 Real GDP, Employment, and Capital Stock (% Deviation from Baseline)

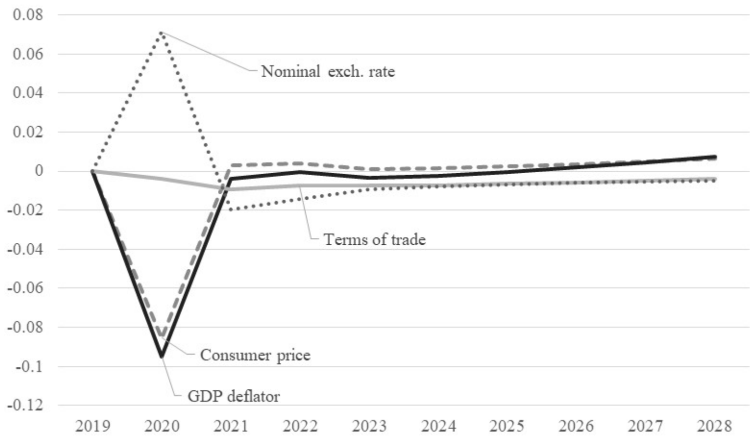


Figure 14 GDP Deflator, Consumer Price, Nominal Exchange Rate and Terms of Trade (% Deviation from Baseline)

Figure 15 reports the percentage deviation away from baseline for the expenditure components of GDP. In line with income GDP, the expenditure GDP falls in the order of 0.01 per cent from the baseline in the policy year and adjusts to baseline thereafter. As GDP falls, household consumption decreases. A fall in real investment and household consumption induces falls in import 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 signals a movement towards surplus in the trade balance. This is supported by a fall in domestic prices relative to foreign prices, which is manifested in the lower terms of trade and rise in export volumes relative to baseline. The current account deficit moves towards surplus, muting the economy-wide external financing requirement.

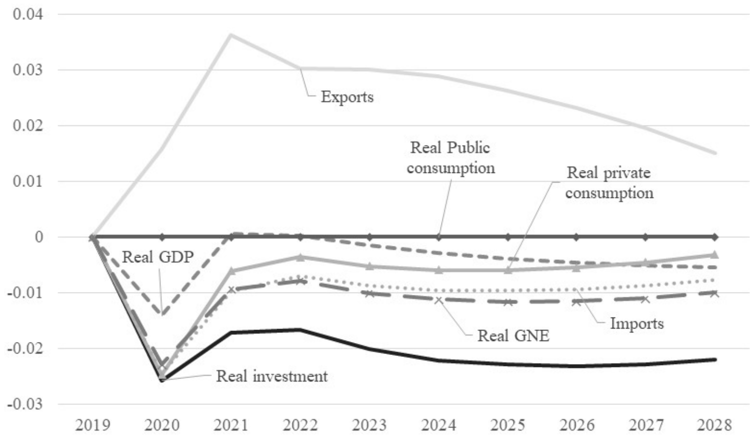


Figure 15 Expenditure-side Components of Real GDP at Market Prices (% Deviation from Baseline)

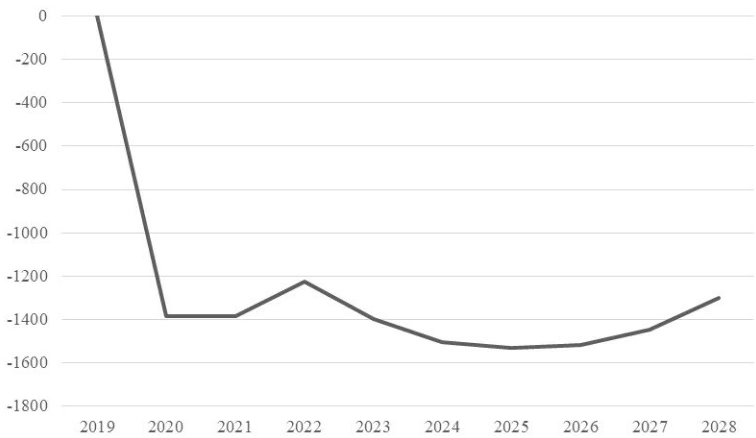


Figure 16 Current Account Deficit (Rp billion)

4. Conclusion

After the 2008 global financial crisis (GFC) authorities across the globe stressed the importance of strengthening commercial bank capital adequacy in accord with Basel III. With many countries raising bank capital adequacy requirements, there are only a few studies evaluating 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 bank CAR in Indonesia using a Financial CGE model we call AMELIA-F. The model comprises a core CGE model integrated with a detailed finance model.

The core part of the model explains the real economy under a neoclassical theoretical framework, following 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 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 raised by the corresponding financial liability agents, the current account deficit is financed by net asset purchases by the foreigners investors, households savings tie down net asset purchases by the households agent, and the government deficit is financed by the net liability issued by the government financial agent.

Our model simulation finds a 100 basis points increase in bank CAR causes small negative consequences for the economy. The commercial banks experience a balance sheet reduction as they move away from riskier assets and finance more of their activity by relatively expensive equity rather than debt. This impacts negatively on the industry and housing agents capacity to invest in physical capital formation. Hence real investment falls by 0.02 per cent relative to 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 the employment rate and consumer prices. Falling real investments decreases external financing requirement as indicated by a positive change in current account deficit.

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