The Effects of Countercyclical Capital Rules on Banking Stability and Macroeconomic Dynamics in Iran

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Abstract

The financial soundness indicators reveal significant signs of serious problems in the Iranian banking sector. An important question is whether the implementation of the countercyclical capital requirement rules in the form of the Basel III type-rules increases the stability of the banking sector in Iran. The literature on macroprudential policy in Iran lacks a model to study the effects of the countercyclical capital requirements rules on the ratio of capital to loans as an important indicator of the soundness of the banking sector in the presence of an adverse supply shock. Moreover, no study has investigated the impact of this macroprudential policy tool on the dynamics of consumption and investment in Iran. To fill these gaps, we developed and estimated a New Keynesian dynamic stochastic general equilibrium (DSGE) model. The model was estimated by the Bayesian method for three different capital requirements rules, namely (1) the constant capital requirements, (2) the countercyclical capital requirements rule that reacts to the ratio of loans to output, and (3) the countercyclical capital requirements rule that responds to economic growth. The results showed that when a negative supply shock hit the economy, the implementation of the countercyclical capital requirements rule reduced the instability of the banking sector in Iran. Moreover, we found that the model with the countercyclical capital requirements rules produces more stable output, inflation, consumption, and investment. Furthermore, the results suggested that the countercyclical capital rule that reacts to economic growth enhances banking stability in Iran. These findings might have important policy implications for policymakers when implementing macroprudential policies in Iran.

Keywords: Macroprudential policy, Countercyclical capital rules, Macroeconomic dynamics, Banking stability, Iran.

JEL Classification: E44, G21, G28.

1. Introduction

The financial soundness indicators reveal significant signs of serious problems in the Iranian banking sector. For example, the data shows that in the last 12 years (from 2007 to 2019), the ratio of nonperforming loans (NPLs) to total

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loans as one of the most important financial soundness indicators has been above 10% in Iran. Even, in some periods this ratio has exceeded 18%. According to the IMF, this ratio should be less than 10%. Demirguc Kunt, and Detragiache (1998, 2005) argue that the NPL ratio greater than 10% is a sign of a banking crisis. Moreover, in recent years the ratio of capital to loans, as another important financial soundness indicator, has been below 8% in Iran's banking sector.

In 2010, Basel III introduced a countercyclical capital requirement to maintain the soundness of the banking sector and the stability of the financial system. According to this requirement, banks are required to increase their capital level when the economy is expanding. Banks can use this buffer to supply more loans during the recession. Thus, the countercyclical capital requirements might help an economy to move out of a downturn. More specifically, it allows banks to compensate for the losses caused by adverse financial shocks (BCBS, 2010b: 64-57). Many studies such as Ag´enor et al. (2013), Angeloni & Faia (2013), Angelini et al. (2014), Rubio & Carrasco-Gallego (2016), Tayler & Zilberman (2016), Karmakar (2016), Clancy & Merola (2017) and Bekiros et al. (2018) show that countercyclical capital requirements lead to macroeconomic and financial stability. Many researchers have used the Dynamic Stochastic General Equilibrium (DSGE) framework to investigate the effect of using countercyclical capital requirements on macroeconomic dynamics. Bekiros et al. (2018), for example, examined the effects of different countercyclical capital rules on banking and macroeconomic stability showing that credit growth is not an appropriate index for implementing this rule.

The literature on macroprudential policy in Iran points to the lack of a model to study the effect of the countercyclical capital requirements on the ratio of bank's capital to loans as an important indicator of the soundness of the banking sector in the presence of an adverse supply shock. Moreover, no study has investigated the impact of this macroprudential policy tool on the dynamics of consumption and investment in Iran. The main goal of this paper is to examine whether the implementation of countercyclical capital requirements improves the banking stability in Iran. Following Bekiros et al. (2018), we used the ratio of capital to loans to measure the stability of the banking sector. To achieve our goal, we developed and estimated a New Keynesian dynamic stochastic general equilibrium (DSGE) model by the Bayesian method for three different capital requirements rules, namely (1) the constant capital requirements, (2) the countercyclical capital requirements rule, which reacts to the ratio of loans to output, and (3) the countercyclical capital requirements rule, which responds to economic growth. This allowed us to compare the effects of implementing the last two countercyclical capital requirements rules on banking stability in Iran. Moreover, we examined the dynamics of inflation, output, consumption, and

investment under these capital requirements rules when an adverse supply shock hit the economy.

The paper is organized as follows. After the introduction, we present the model in Section 2. Section 3 is devoted to data and methodology. The estimation results are reported in Section 4. Section 5 presents the concluding remarks.

2. Model
2.1. Household

A representative household is assumed to maximize the following expected lifetime utility function:

$$U = E \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_t^{1-\sigma}}{1-\sigma} + \varsigma_1 \ln(m_t) - \left(\frac{\varsigma_2}{1+\varphi} \right) N_t^{(1+\varphi)} \right\}. \tag{1}$$

Where C_t, m_t, and N_t denote consumption, real money balances, and labor hours, respectively. β is the discount factor, σ is the inverse of the intertemporal elasticity of substitution, and φ is the inverse of the elasticity of labor supply. ς_1 represents the weight on real money balances in the utility function and ς_2 shows the weight on the disutility of working hours. The household faces the budget constraint (2) and the law of motion for capital accumulation (3).

$$C_t + m_t + I_t + d_t = w_t N_t + \frac{P_{t-1}}{P_t} m_{t-1} + r_{k,t} K_{t-1} + \left(1 + R_{d,t-1} \right) \frac{P_{t-1}}{P_t} d_{t-1} - t_t \tag{2}$$

$$K_t = (1-\delta)K_{t-1} + \left(1 - \frac{\omega}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right) I_t \tag{3}$$

Where, P_t, w_t, $R_{d,t}$, and $r_{k,t}$ denote the price level, real wage, nominal interest rate on deposit, and the rental rate of physical capital, respectively. d_t indicates represents real bank deposit, K_t denotes physical capital stock, I_t denotes investment [1], and t_t is real value of lump-sum tax (or transfer if negative). δ denotes the depreciation rate and ω shows the investment adjustment cost coefficient. Following Christiano et al., (2005), $\frac{\omega}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 I_t$ was considered as the adjustment cost. The household chooses C_t, m_t, N_t, d_t, I_t and K_t to maximize its expected lifetime utility function (1) subject to constraints (2) and (3).

2.2. Final good producer

The final good Y_t is produced by using the intermediate good $Y_t(j), j \in [0,1]$ in a perfect competition market with the following technology:

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1. We assume that the price of investment goods is equal to the price level.

$$Y_t = \left[\int_0^1 Y_t(j)^{\frac{\theta-1}{\theta}} \, dj \right]^{\frac{\theta}{\theta-1}} \tag{4}$$

Where the parameter θ is a constant elasticity of substitution between intermediate goods $Y_t(j)$. The final good producer chooses $Y_t(j)$ to maximize its profit subject to (4). As a result, the demand of households for the intermediate good j is given by:

$$Y_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\theta} Y_t \tag{5}$$

where $P_t(j)$ is the price of the intermediate good $Y_t(j)$.

2.3. Intermediate good producer

In this section, we followed Hristov and Hülsewig (2017) to model intermediate good producer behavior. We assumed that the intermediate good is produced in a monopolistic competition market by using the following technology:

$$Y_t(j) = A_t K_t^{\alpha}(j) N_t^{1-\alpha}(j) \tag{6}$$

in which A_t denotes technology shock and α is the share of physical capital in production. We assume that the real costs of the labor force and physical capital are financed through the bank's loans.

$$l_t(j) = r_{k,t} K_t(j) + w_t N_t(j) \tag{7}$$

where $l_t(j)$ denotes the real amounts of loans. The intermediate good producer chooses $P_t(j)$ to maximize its profit (8) subject to (5), (7), and the price adjustment cost $\frac{\gamma}{2} \left(\frac{P_t(j)}{P_{t-1}(j)} - 1 \right)^2 Y_t(j)$ proposed by Rotemberg (1982).

$$
\begin{aligned}
\max E \Big(\sum_{t=0}^{\infty} \beta_t^p \Big[&\frac{P_t(j)}{P_t} \left(\frac{P_t(j)}{P_t} \right)^{-\theta} Y_t(j) \\
&- \left(\frac{(1+R_{l,t})}{(1+\pi_t)} \left(r_{k,t} K_t(j) + w_t N_t(j) \right) \right) \\
&- \frac{\gamma}{2} \left(\frac{P_t(j)}{P_{t-1}(j)} - 1 \right)^2 Y_t(j) - mc_t \left(\frac{P_t(j)}{P_t} \right)^{-\theta} Y_t \Big]
\end{aligned}
\tag{8}
$$

where $\beta_t^p = \beta \dfrac{u'_{C_{t+1}}}{u'_{C_t}}$ is producer's stochastic discount factor, π_t denotes inflation, γ is the price adjustment cost parameter and $mc_t = \dfrac{(1+R_{l,t})\, w_t^{1-\alpha} r_{k,t}^\alpha}{(1+\pi_t)\, \alpha^\alpha 1-\alpha^{1-\alpha} A_t}$ indicates real marginal cost[1].

2.4. Bank

The banking sector as a key part of our model is built on Clancy and Merola (2017). Our innovation in this part is the introduction of credit risk to the model. In our model, credit risk is a result of the producer's loans instead of mortgage loans used in the literature. More specifically, the default on the producer's loan occurs when the real cost exceeds the principle and the interest on her/his loans in real terms due to idiosyncratic and/or systematic shocks to production cost. More specifically, we assume:

$$\left(r_{k,t}K_t(j) + w_t N_t(j)\right)\exp\varepsilon_{a,t}(j)\exp\varepsilon_{b,t} > \frac{\left(1+R_{l,t}\right)}{(1+\pi_t)}l_t(j) \qquad (9)$$

$$Q_t(j) + \varepsilon_{a,t}(j) + \varepsilon_{b,t} > \tilde{Q}_t(j) \qquad (10)$$

where $\varepsilon_{a,t}(j)$ denotes idiosyncratic shock, $\varepsilon_{b,t}$ is systematic shock, $Q_t(j) = ln\left(r_{k,t}K_t(j) + w_t N_t(j)\right)$ and $\tilde{Q}_t(j) = ln\left(\frac{(1+R_{l,t})}{(1+\pi_t)}l_t(j)\right)$. Moreover, following Clancy and Merola (2017), we assumed a Bernoulli distribution $Z_t(j)$ to describe the default probability of loan $L_t(j)$ given by:

$$Z_{t+1}(j) = \begin{cases} 0 & loan\ performs, \quad if\ Q_t(j) \le \tilde{Q}_t \\ 1 & loan\ defaults, \quad if\ \ \ Q_t(j) > \tilde{Q}_t \end{cases} \qquad (11)$$

We assume all producers are identical, and the probability of default for all loans are the same. Hence, we dropped the index j. For simplicity, we ignored the idiosyncratic shock and assumed that the conditional expectation of default $Z_{c,t}$ (the NPLs ratio) depends on systematic shock. The default expectation is given in Eq. (12).

$$\begin{aligned} E_t\left(Z_{t+1}\big|\,\varepsilon_{b,t}\right) = pr\left(Z_{t+1}=1\big|\,\varepsilon_{b,t}\right) &= Z_{c,t+1} \\ &= x + (1-x)pr\left((Q_t > \tilde{Q}_t)\big|\,\varepsilon_{b,t}\right) \end{aligned} \qquad (12)$$

Where the parameter $x \in (0,1)$ denotes a share of the NPLs ratio when there is no shock. We can rewrite Eq. (12) as $Z_{c,t+1} = x + (1-x)\left(1 - \Phi\left[\frac{\tilde{Q}_t - Q_{t+1}}{\sigma_b}\right]\right)$

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1. The derivation of the marginal cost is available upon request.

in which Φ is the cumulative distribution function of a standard normal distribution and σ_b denotes the standard deviations of systemic shock.

We followed Clancy and Merola (2017) and assumed that the representative bank maximizes the expected dividends of the shareholders. More specifically, it maximizes the following function:

$$\max E_t \beta_t^b \left[\frac{(1+R_{l,t})}{(1+\pi_t)}(1 - sZ_{c,t+1})l_t - \frac{(1+R_{d,t})}{(1+\pi_t)}d_t - f\left(\frac{j_t}{l_t}, Cap\right)l_t \right] \\ - j_t \left[1 + \frac{\zeta}{2}\left(\ln\left(\frac{j_t}{j_{t-1}}\right)\right)^2 j_t \right] \tag{13}$$

In this equation, β_t^b is the stochastic discount factor, j_t denotes the real value of the bank capital, Cap is the minimum capital adequacy[1] 8%, the parameter s captures the loss given default (LGD). The term $f(\frac{j_t}{l_t}, Cap)l_t$ captures the share of loans that the bank should pay as a penalty to authorities for not meeting the capital requirements ratio in a way that $f(\frac{j_t}{l_t}, Cap)$ is the penalty function specified as $\nu\left(\exp\left(Cap - \frac{j_t}{l_t}\right)\right)$ and $\nu \in (0,1)$ is the penalty parameter. The last term $\frac{\zeta}{2}\left(\ln(\frac{j_t}{j_{t-1}})\right)^2 j_t^2$ is the capital adjustment cost, where ζ denotes capital adjustment cost parameter. The bank chooses l_t and j_t to maximize the shareholder's dividend.

2.5. Countercyclical capital requirements rules

As mentioned earlier, we compare two different countercyclical capital rules to examine the implementation of which rule leads to more stablilityin the banking sector. Following Angelini et al. (2014), we assumed that the first countercyclical rule responds to loans- output ratio LY_t according to Eq. (14).[2]

$$Cap_t = (1 - \psi_1)\overline{cap} + \psi_1 Cap_{t-1} \\ + (1 - \psi_1)\psi_2(ln(LY_t) - ln(\overline{LY})) \tag{14}$$

Next, we follow Karmakar (2016) and assumed that the second countercyclical rule reacts to economic growth according to Eq. (15).

$$Cap_t = (1 - \psi_1)\overline{cap} + \psi_1 Cap_{t-1} \\ + (1 - \psi_1)\psi_2(ln(Y_t) - ln(Y_{t-1})) \tag{15}$$

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1. In the case of the countercyclical capital requirement rule, Cap is not constant anymore. In this case, we will treat Cap_t as a variable.
2. Basel Committee on Banking Supervision (BCBS, 2010a) advocates the implementation of a countercyclical capital requirements rule that reacts to the ratio of loans to output.

where Cap_t denotes countercyclical capital requirements ratio. The parameter $0 \leq \psi_1 \leq 1$ captures the persistence of the policy rule and $\psi_2 > 0$ measures the response of countercyclical capital requirements ratio to the indicators (loans-output ratio and economic growth) and the bar on top of a variable denotes its value in the steady state.

2.6. Money rule

Walsh (2017) argued that monetary authority can choose between a money growth rule and an interest rate rule. Given the fact that the monetary authorities have adapted profit rate rule very recently (March 2020), and since our dataset covers the period prior to 2020, we followed Eslamloueyan and Mehralian (2015) and Mirfatah et al., (2019) and used the following monetary rule:

$$MG_t = a_p(\pi_t - \bar{\pi}) + a_y(Y_t - \bar{Y}) + a_o oil_t + e_{m,t} \tag{16}$$

where MG_t denotes the nominal growth rate of the money supply and $e_{m,t}$ is a monetary shock. $\bar{\pi}$ and $\bar{Y}$ represents inflation rate and output in the steady state, respectively. Hence, $(\pi_t - \bar{\pi})$ is the inflation gap and $(Y_t - \bar{Y})$ denotes the output gap. We introduced oil income, oil_t into the above monetary rule because oil revenue affects the growth of money supply in Iran. The parameters $a_p < 0$, $a_y < 0$, and $a_{oil} < 0$ denote the weights that policymaker puts on inflation gap, output gap, and oil revenue, respectively.

2.7. Government

The government budget constraint is given by (17).

$$g_t + \frac{1 + R_{l,t-1}}{1 + \pi_t} b_{t-1} = t_t + oil_t + b_t + rcb_t \tag{17}$$

where g_t denotes government expenditure, b is government bonds, and rcb_t denotes government borrowing from the Central Bank. All variables are in real terms. In Iran, as an oil-exporting country, the budget of the government depends on oil revenues.

We solved our DSGE model for three different capital requirements rules, including (1) the constant capital requirements 8% (Model 1), (2) the countercyclical capital requirements rule, which responds to the ratio of loans to output (Model 2), and (3) the countercyclical capital requirements rule, which reacts to economic growth (Model 3).[1] Model 1 consists of 26 log-linearized equations and Models 2 and 3 each includes 27 log-linearized equations. Each model contains 7 forward-looking variables and 5 exogenous shocks.[2]

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1. The detailed solution of the model, including the first-order conditions, is available upon request.
2. The log-linearized models are not presented here but are available upon request.

3. Data and Methodology

The models are estimated by the Bayesian method for the period 2010:1-2018:1. The data were obtained from Statistics and Economic Trends published by the Central Bank of Iran. Table 1 presents the prior and posterior distributions of structural parameters. To check robustness of the results, we used the acceptance ratio, the prior and posterior distributions, and the univariate convergence diagnostic drawing on Brooks and Gelman's (1998) study. Table 2 reports the acceptance ratio and Figs. 1-3 illustrate the results of the Brooks and Gelman (1998) test.[1]

Table 1: Prior and posterior distributions of structural parameters

Parameters	Dist.	Prior mean	Post. mean (model 1)	Post. mean (model 2)	Post. mean (model 3)
σ	Normal	0.75	1.557	2.306	2.25
β	Beta	0.96	0.932	0.935	0.933
ς_1	Beta	0.25	0.276	0.246	0.251
ω	Gamma	1	0.986	0.969	0.963
δ	Beta	0.03	0.031	0.0301	0.0304
θ	Gamma	4.33	7.769	6.162	6.221
γ	Gamma	60.5	60.451	60.489	60.467
α	Beta	0.38	0.475	0.514	0.515
φ	Normal	2	0.887	0.767	0.769
σ_b	Normal	0.3	0.306	0.2995	0.3003
s	Beta	0.5	0.482	0.5004	0.4997
x	Beta	0.02	0.0202	0.02	0.0201
ν	Gamma	0.035	0.037	0.036	0.0365
ζ	Gamma	0.01	0.0101	0.01	0.0099
ψ_1	Beta	0.8	-	0.797	0.802
ψ_2	Gamma	0.9	-	0.89	0.894
a_p	Normal	-1.245	-1.244	-1.244	-1.244
a_y	Normal	-0.189	-0.199	-.1889	-0.1896
a_o	Normal	-0.16	-0.157	-0.156	-0.156
ρ_b	Beta	0.91	0.912	0.912	0.914
ρ_t	Beta	0.7	0.702	0.663	0.663
ρ_{rcb}	Beta	0.7	0.702	0.749	0.748
ρ_o	Beta	0.2	0.229	0.23	0.234
ρ_p	Beta	0.9	0.8998	0.521	0.522

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1. The prior and posterior distributions are not presented here but are available upon request.

Table 2: Acceptance ratio per chain in Metropolis Hastings algorithm

Metropolis Hastings	Chain 1 (Model 1)	Chain 2 (Model 1)	Chain 1 (Model 2)	Chain 2 (Model 2)	Chain 1 (Model 3)	Chain 2 (Model 3)
Acceptance ratio	32.15%	25.55%	39.34%	39.09%	33.57%	33.56%

Source: Authors' calculations.
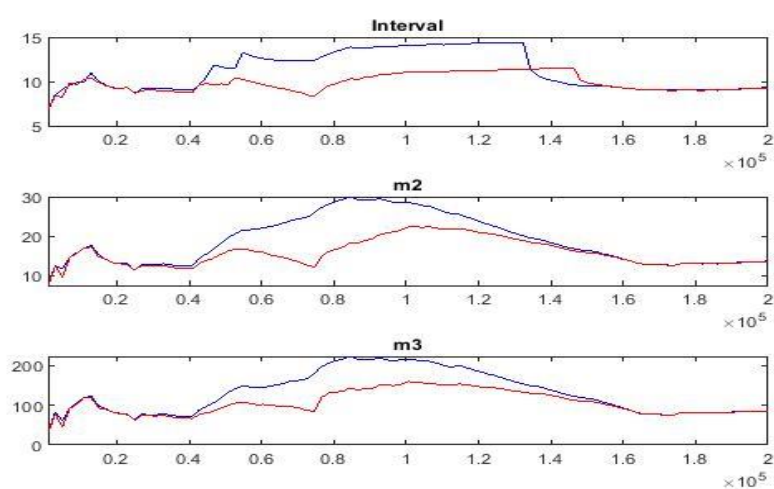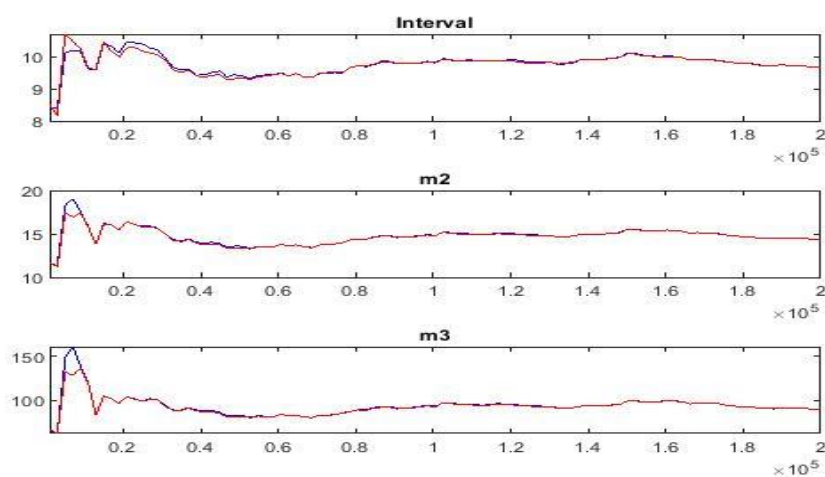

Fig. 1: Brooks & Gelman's (1998) test (Model 1)
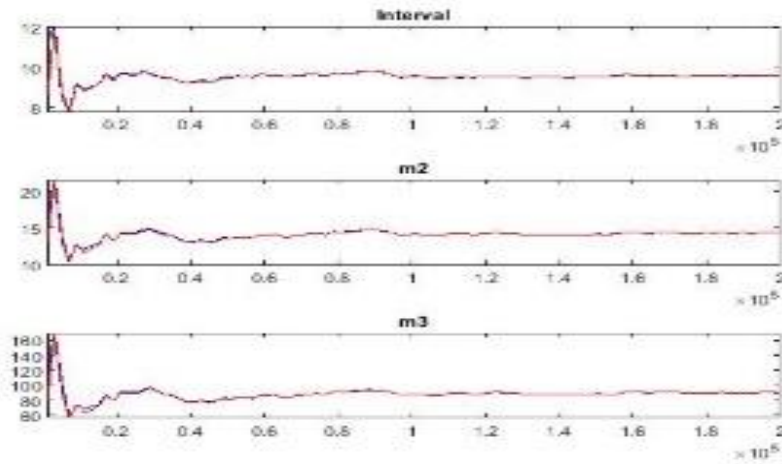

Fig. 2: Brooks & Gelman's (1998) test (Model 2)

Fig. 3: Brooks and Gelman's (1998) test (Model 3)

4. Results

In this section, we studied the effects of an adverse supply shock [1] on macroeconomic dynamics. Figures 4-6 illustrate the impulse responses to a negative supply shock under three different capital requirement rules. The figures show that the implementation of the countercyclical rules in comparison with the constant capital requirement rule reduces output and inflation fluctuations. This might be due to the fact that in this case, when an adverse supply shock hits the economy, Cap_t declines and the banks supply more loans to firms. This, in turn, might boost the output and, hence, can partially compensate for the reduction in output. Moreover, a lower decrease in output and factor productivity due to the implementation of the countercyclical rules might reduce the fluctuation in inflation. This result confirms the findings of Ag´enor et al. (2013), Angeloni and Faia (2013), Angelini et al. (2014), Rubio and Carrasco-Gallego (2016), Karmakar (2016), Tayler and Zilberman (2016), and Clancy and Merola (2017).

Furthermore, in the presence of a negative supply shock, the application of the countercyclical capital requirement rules reduces the investment and consumption fluctuations. These verify the findings of Karmakar (2016) and Clancy and Merola (2017). Moreover, the results showed that in this case, the implementation of the countercyclical rules strengthened the financial stability through decreasing the fluctuations in the NPLs ratio, credit spread, capital to loans ratio, and the ratio of loans to output as measures of financial stability.

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1. We assume that the supply shock follows an AR(1) process. More specifically, $e_{p,t} = \rho_p e_{p,t-1} + e_{p2,t}$. where $\rho_p = 0.9$.

These results are in line with those of Angelini et al. (2014), Clancy and Merola (2017), and Bekiros et al. (2018).

The results of comparison of the impulse responses to a negative supply shock, as presented in Figures 5 and 6, show that in the presence of the countercyclical capital requirement rule that reacts to economic growth (i.e., Model 3), the capital to loans ratio is less volatile and converges smoothly to its steady-state level. It, hence, enhances banking stability in Iran. This finding confirms the results of Karmakar (2016).
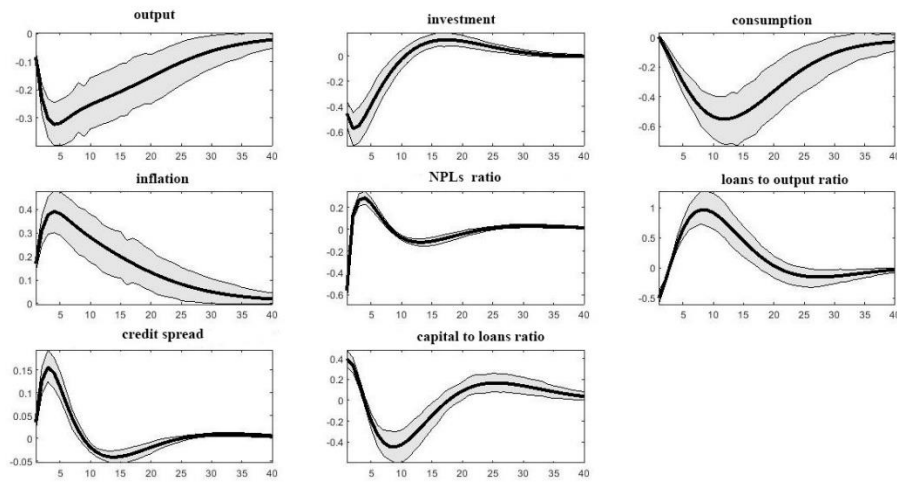

Fig. 4: Impulse responses to a negative supply shock under constant capital requirement rule
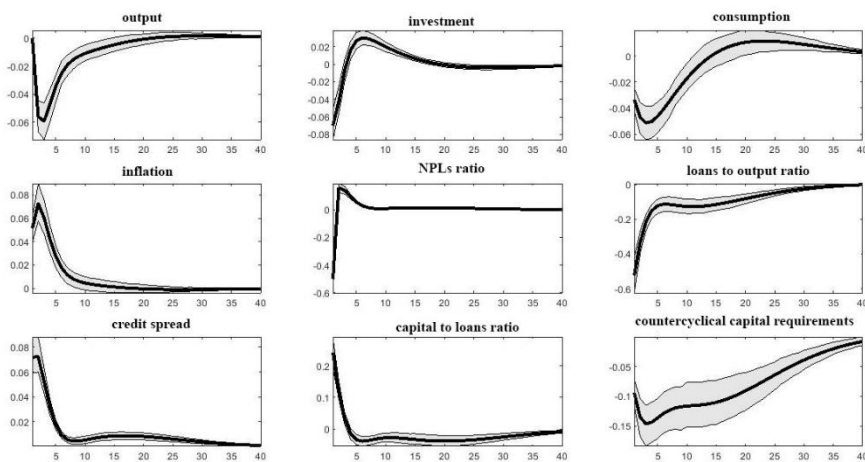

Fig. 5: Impulse responses to a negative supply shock in Model 2 (the countercyclical capital requirement rule that reacts to the ratio of loans to output)
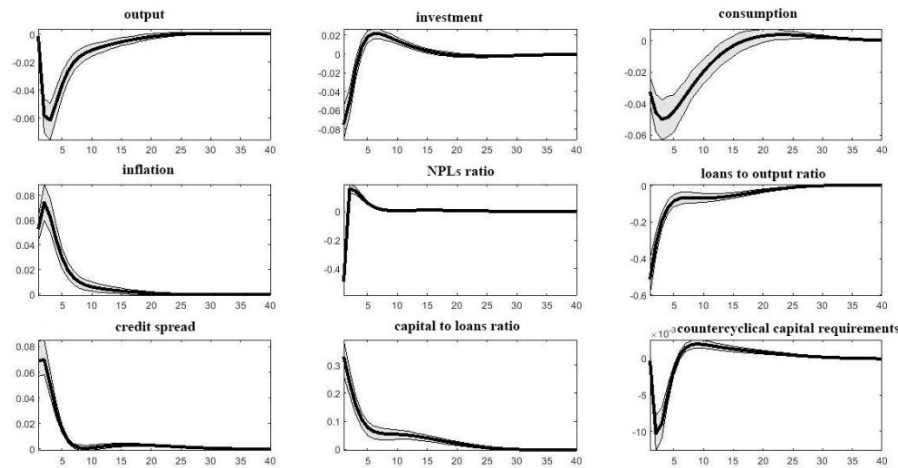
Fig. 6: Impulse responses to a negative supply shock in Model 3 (the countercyclical capital requirement rule that reacts to economic growth)

5. Conclusion

The financial soundness indicators show that the banking sector in Iran suffers from serious problems. An important question is whether the implementation of the countercyclical capital requirement rules in the form of the Basel III type-rules increases the stability of the banking sector in Iran. The literature on macroprudential policy in Iran lacks a model to study the effects of the countercyclical capital requirements rules on the ratio of bank's capital to loans as an important indicator of the soundness of the banking sector in the presence of an adverse supply shock. Moreover, no study has investigated the impact of this macroprudential policy tool on the dynamics of consumption and investment in Iran. To fill these gaps, we developed a New Keynesian dynamic stochastic general equilibrium (DSGE) model. The model was estimated by the Bayesian method for three different capital requirements rules, namely (1) the constant capital requirement, (2) the countercyclical capital requirement rule, which reacts to the ratio of loans to output, and (3) the countercyclical capital requirements rule, which responds to economic growth. The results show that when a negative supply shock hits the economy, the implementation of the countercyclical capital requirements rule reduces the instability of the banking sector in Iran by changing the capital-loans ratio. Besides, we found that the model with the countercyclical capital requirements rules leads to more stable output, inflation, consumption, and investment. Furthermore, our results suggest that the countercyclical capital rule that reacts to economic growth enhances banking stability in Iran. These findings might have important policy implications for policymakers when implementing macroprudential policies in Iran.

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