Journal of Money and Economy
Vol. 12, No. 4, Fall 2017
pp. 389-418

Modeling Basel Regulatory in DSGE with Emphasis on Adequacy Regulatory

Maryam Khoshnevis[1] **Azam Ahmadyan**[2]

Received: 26 Aug 2018 Approved: 19 Jan 2019

In this paper Basel regulation is modeled in Dynamic Stochastic General Equilibrium (DSGE) framework. For this purpose, using data from 1981-2017 for Iran, capital adequacy as an importance regulation is modeled. Results show Basel regulation has procyclical effect. According to the results of the model and according to the realities of economy and banking system of Iran, in recession, lending and credit risk increase and repayment probability decrease. Despite these conditions, capital adequacy does not increase. This confirms that risks are less relevant in determining capital. If elasticity of repayment probability with respect to capital loan ratio is zero, Basel II is more procyclical than Basel I. If elasticity of repayment probability with respect to capital loan ratio is 0.5, Basel II is less procyclical than Basel I.

Keywords: Basel Regulation, Capital Adequacy, DSGE Model, Banking in Iran.
JEL Classification*:* E44, E51

1 Introduction

The Bank for International Settlements, with the aim of preserving the resources and interests of banks as one of the key elements of the economic system, set up a committee called the Basel Committee in the late 1980s. In 1998, the Bank's Supervisory Committee conducted Basel I, and in 2004 directed Basel II, with the aim of creating international convergence in the regulatory framework for the global operation of banks.

Basel includes the definition of capital rules, the identification and measurement of risk-taking and regulatory frameworks for determining the level of capital needed to protect banks against such risks. The capital adequacy standard determines the combination of risk-adjusted assets and

[1] Department of Economics, Semnan Branch, Islamic Azad University, Semnan, Iran. m.khoshnevis@semnaniau.ac.ir (Corresponding Author)
[2] Faculty Member, Monetary and Banking Research Institution, Iran. azam_ahmadyan@yahoo.com

We would like to express our gratitude to the Semnan Branch, Islamic Azad University for their financial support regarding this research study (No. 3158).

risk-exposed items outside the balance sheet in order to ensure the sufficient capital and reserves to meet the obligations.

In Iran, according to Article 3 of the Capital Adequacy Regulations, the minimum capital adequacy ratio for all banks and credit institutions (both governmental and non-governmental) is set at 8%. In accordance with these regulations, the Central Bank of the Islamic Republic of Iran, in cases of the need to maintain the health of banks and credit institutions, may set a higher ceiling for all or some of the banks and credit institutions.

The form and structure of capital varies in private and public banks of Iran. In Other countries where interest rates are used as a monetary policy tool, banks use diverse combinations in their portfolio of capital. Because they can use interest rate mechanism to attract new shareholders to raise capital. Dual-capital investment instruments (debt-capital) and long term subordinated debt are those that carry interest rates and help to reduce the risk of losses when incurred. Such instruments do not exist in the Iran's banking system, not only because of the elimination of interest rate, but also because of the structure of Iranian banks. The ordinary shares that are held by the private banks of other countries do not exist in the capital of Iranian banks.

Also, non-performing loan in Iranian banks is very high. Non-performing loan in Iranian banks, between 2006 and 2017, was more than 15%. The lack of flexibility of the interest rate and high volume of non-performing loan the capital adequacy of banks have been reduced in recent years. Such that the capital adequacy ratio in most Iranian banks is less than 8%.

Considering the importance of the capital adequacy, and the reaction between the rules of the bank's capital and macroeconomic fluctuations, its modeling has been studied in recent studies. So in this article, it is attempted to model the capital adequacy principle in the context of dynamic stochastic general equilibrium model to study and analyze the real effects. The overall structure of the paper is as follows. Section 2 presents methodology. Section 3 is literature review. Section 4 presents the model. The parameter estimation is presented in section 5.Section 6 presents impulse-response function. Conclusion is at section 7.

2 Theoretical Foundation

2.1 The Need to Supervising and Monitoring Banking Performance

Though there are many arguments for monitoring the activities of banks, it remains to the regulatory and supervisory bodies of the banks. There are two important points in this regard. The first point is that the financial market and especially the banks do not need to be monitored and the financial market can control and monitor the performance of banks. According to the second view, without the Central Bank supervision, the banks get into trouble and the financial market, as an observer, cannot improve the performance of the banks. According to the first opinion, Dowd (1996) looks at the feasibility of establishing a free financial market.

The feasibility study for the establishment of a free financial market shows that, in the absence of a final lender without government guarantees, the financial market will be regulated, in particular, through the supervision of depositors. In this theoretical model, depositors will threaten to withdraw as soon as they get the signs of risk in the banking network. These conditions make banks to have a conservative and transparent approach in their lending policy. Therefore, a sufficient level of capital protects the bank against potential losses. Dowd 1996, states that more capital, while cost-effective for the bank, protects the bank against more potential losses and sudden withdrawal of depositors. Therefore, the bank's position in the competitive environment will be improved and the bank's ability to respond to customers will increase. According to this theory, capital is determined by the capital market.

In contrast to this theory, Dowd (1996) has stated that the financial market requires supervision and regulation. According to this view, banks' performance in free market conditions causes banks to suffer severe crises, in which case the Central Bank intervenes. In this way, the free market conditions for banks are faltering. Dowd (1996) is based on the conditions of a particular economy, where money plays an important role but is associated with uncertainty. Unlike businesses, banks use their debts as money, so the purpose of the regulations is to make banks' assets sufficiently transparent to be able to adequately respond to customers. Dowd (1996), in response to the question that why the bank needs supervision, states that bank debt are a public commodity.

In this regard, Santos (2000) states that banks need to monitor and enforce regulations, because they play an important role in financial intermediation and provide the liquidity needed by economic activists and the information needed by businesses. The role of financial intermediation increases the likelihood of a systemic risk for banks and increases social costs. The systemic connection of banks, facing a crisis, will lead to the transfer of the crisis to other banks and a systemic risk will be created. Therefore, it is important to create a mechanism for insurance coverage of banks.

On the other hand, depositors are also unable to monitor the activities of banks due to information asymmetry. According to Dewatripont and Tirole (1994), the logic of regulation and supervision of the performance of banks is based on the corporate representation and governance. In the structure of a bank, ownership must be separate from management, otherwise create the moral hazard problem and the bad choice. The cost of controlling and monitoring the performance of banks is very high. Therefore, the issue of free-riding arises due to the cost of monitoring. Consequently, regulation and supervision allow communication between the two sides, that are supervisors and depositors, and does not bear the cost of overseeing to depositors (Santos, 2000).

If regulations and supervision of banking performance are vital, then the question arises that why capital regulations are very important. The answer is, banks have two sources of finance: one through deposits and one through capital. Mainly deposits are allocated to facilities, and the return of concessional facilities is also used as a source for more facilities. Which, in the event of defaults, puts banks at credit risk and liquidity risk due to inadequate funds. Funding through capital is when the bank faces financial fragility and resource cuts. The greater the capital of a bank, the more powerful the bank will be to meet the tough conditions (Federal Deposit Insurance Corporation, 2003).

3 Literature Review

Frach et al. (2017) develop a DSGE model for a small, open economy with an endogenous banking sector as default in order to perform a realistic assessment of macro prudential tools: Countercyclical Capital Buffer (CCB) and Dynamic Provisions (DP). The model is estimated with data from Uruguay, where dynamic provisioning is in place since early 2000s. They find that: (i) To select the appropriate indicator variable under the CCB rule, and to calibrate the size of the DP, the source of shock affecting the financial system matters. (ii) Given a positive external shock, CCB generates buffers without major real effects. (iii) GDP as an indicator variable has quicker and stronger effects over bank capital; and (iv) the ratio of credit to GDP decreases, which discourages its use as an indicator variable. (v) DP generates buffers with real effects, and (vi) DP outperforms the CCB in terms of smoothing the cycle.

Tayler and Zilberman (2016) have been investigated the role of prudential regulation of capital adequacy and monetary policy on borrowing costs. In their paper, friction, credit risk, bank losses, and bank capital costs are considered. The friction is due to the accelerator mechanism and the application of precautionary measures. Following credit shocks, countercyclical regulations are more effective than monetary policy in improving price stability, financial stability and macroeconomic stability. For shocks, the combination of prudential rules with a stronger anti-inflation policy is an optimal policy. The findings indicate the importance of the 3rd regulation to reduce the succession of production inflation by the Central Bank, and hesitate to use Taylor's rule in financial stress. The most important feature is that it is based on a randomized dynamic equilibrium framework that includes nominal adhesion, exogenous credit friction, and borrowing cost channel, which communicates between the real sector and the macroeconomic sector. The existence of prudential rules will make the financial response to macroeconomic shocks insignificant and make banks less exposed to credit risk. Also, the precautionary principle acts as a buffer and prevents the financial sector from affecting the real sector.

Silvo (2016) design a random dynamic general equilibrium model in which investment financing has been affected by a moral hazard problem. In this paper, optimal monetary policy and macroeconomic policy are interlinked and the economic and welfare effects of this relationship have been examined. In codified policy, social planning seeks to maximize social welfare and inflation control at an optimal level. In this paper, the banking system is included as the most important financial intermediary in the DSGE model and the effects of its business cycle are examined. The most important feature of this paper is to design a model that solves the coded problem by employing macro precautionary policy. In this way, the planner can achieve the first best results, without a succession of policies.

It is pointed out that when financial friction is added to the nominal price stickiness, an optimal monetary policy is the first to be replaced if social planners apply monetary and cautious macroeconomic policies to control inflation and investment levels. Applying monetary policy alone is not only insufficient for economic stability, but also leads to a succession of stable inflation and product cuts. When monetary policy used exclusively, the instability is greater than when monetary policy is accompanied by precautionary measures. In fact, the application of macroeconomic policy along with monetary policy will help to create financial stability. By controlling the leverage ratio of the banking sector and smoothing the business cycle, macroeconomic policy can effectively prevent financial shock to the real sector of the economy.

On the other hand, when the instability of the supply and demand of the economy but not of the financial sector increases, the existence of a cautious macroeconomic policy is important. Hence, macroeconomic policy is conducive to economic adjustment by modifying investment. In this situation, the Central Bank needs to develop a financial system for the effectiveness of monetary policy.

Mendicino et al. (2015) model capital adequacy regulations in a dynamic stochastic general equilibrium model that includes the banking sector. In this model, households, firms, banking sector and capital adequacy precautionary regulations are demonstrated. The shocks studied in this paper, in addition to the usual shockwave of dynamic equilibrium models, are related to the bank's capital, whose effects on banks' balance sheets and corporate and household behavior have been investigated. The findings of the paper indicate that the most important role of capital regulation is to preserve banks against potential losses and macroeconomic shocks. In fact, these regulations help banks to have enough capital to deal with the risk of bankruptcy. Anti-corruption adjustment is good for capital adequacy, but its welfare benefits are small. Adherence to capital adequacy rules has different effects on savings and borrowings. Improving the capital adequacy of the fundamentals leads to a reduction in the social cost of bankruptcy and an increase in the bank's profits, thus saving more profits and reducing the risk of banks influence. But in terms of borrowers, improving the capital adequacy, because of blocking part of bank's resources in the capital category, reduces granting the facility and limits credit supply.

Cao and Chollete (2014) model capital adequacy capability in a dynamic stochastic general equilibrium model. The most prominent feature of this paper is to consider systemic risk taking into account bank failures using capital adequacy regulations and liquidity requirements. The model also shows how financial fragility is reached by increasing competition. This paper presents a good framework to model fundamentals and other regulatory provisions. The well-defined framework is also capable of reflecting the bank's response to monetary policies when the bank operates under the Basel regulatory. The specification of the model is that a dynamic banking model has been developed in which banks increase capital and deposits to protect their investment in risk-free government bonds and when they are in a financial crisis. Banks, in terms of riskiness, choose the leverage ratio and the shield of capital externally, and their solution is different from social planning, which considers the banks' bankruptcy problem. The results of this paper show that the provision of capital is costly, so the social cost of regulation may be reduced if capital requirements are met with other instruments, such that of liquidity requirements. According to the findings of this paper, the leverage ratio have both periodic behavior and anti-periodic behavior. In the context of banks operating under the Basel framework, the ratio of capital adequacy is less than the time that banks are not in this framework. Because when banks operate within the framework of the Basel, they try to limit the risky behavior, so the supply of risk loans is limited. The results also show that the ratio of capital adequacy is countercyclical behavior. Since this paper assumes there is a freedom of entry and exit for banks, it is considered that banks' bankruptcy and the application of regulatory decisions are not specific to a particular bank.

Iacoviello (2014) model capital adequacy requirements by using a DSGE model and a business method. The purpose is to examine the role of capital regulation in absorbing the negative effects of macroeconomic shocks on the banking network. For this purpose, a model is first designed only with the family, firm, and bank sections, and the capital requirements regulations are not modeled. Then the model is expanded and the capital adequacy regulations is added to the model. In this paper, it is assumed that households are borrowers from banks. If banks do not have enough capital and do not meet the capital adequacy requirements in accordance with the fundamentals, banks are at risk of bankruptcy by increasing borrowers' default. Therefore, in order to prevent bank failures, banks need to increase their capital. Increasing capital absorbs negative effects from macroeconomic shocks and prevent its spread. Also, increasing capital prevents the spread of shocks to the real sector.

Agenor et al. (2012) investigate the cyclic effects of implementing capital adequacy rules based on the principles of Basel I and II for Brazil, using the dynamic stochastic equilibrium model. The distinction of this article is in the assumption that at the end of each period the bank will become bankrupt and a new bank will begin working. Therefore, banks redeem stocks at the end of each period, and all profits, including revenues from redemption of government bonds, are distributed and new shares are issued at the beginning of each period. The central bank injects liquidity into the banks and sets the new interest rate based on the inflation target and the production gap. The shocks are from changes in bank capital such as productivity shocks, and supply shocks which must be absorbed. The results indicate that:

- The negative shock in the bank's capital and savings will reduce the supply of credit, resulting in the production and increase of inflation.
- The implementation of the Basel II regulations has two cyclic effects less than the Basel I principles.

- If the bank's capital is strong enough, the Basel II principles may have fewer cyclic effects than the fundamentals.

Suh (2011) in consideration of various precautionary measures, has expanded the banking sector model in DSGE for Spain. The precautionary considerations have variety of types such as, the precautionary policies associated with the bank balance sheet, for instance the requirement of capital adequacy, the requirement for liquidity restrictions, credit regulations such as the loan-to-value ratio that is purchased with the loan, and debt-to-income ratio. A review of various prudential policies suggests that capital adequacy policies, better than other prudential policies, reduce the volatility of production and inflation. If there is no precautionary policy, the application of monetary policy to the extent that the precautionary policy is combined with monetary policy will reduce production volatility and inflation. On the other hand, the existence of a precautionary policy create a stable supply of credit. In other words, a decrease in the capital adequacy ratio will reduce the supply of credits.

4 The Model

In this paper a closed economy is considered that includes five entities: households, firms, commercial banks, governments and central banks. Considering the structure of Iran's economy, the oil sector has also been added to the model. The banks supply loan for firms to finance their workforce. The loan is elastic to the loan interest rate. It is assumed that the maturity of corporate loans and maturities of loans to households is similar. In each period, the loan is received for production and at the end of the period it is also reimbursed by the sale of production. In order to avoid the complexity of the discussion, defaults in the corporate sector are not considered. Households deposit money in the bank and withdraw them after closing the market. The bank issues shares to be able to meet the capital adequacy requirements. The bank receives collateral for repayment lending. It also pays dividends to the households for their money. The stocks are redeemed at the end of each period. Distributing dividends are at the end of each period, and publishing new shares are at the beginning of each period. The central bank injects liquidity and sets the repayment rate.

As pointed out by Giri (2014), we assume banking sector confronts shortage of liquidity and borrows from interbank. We use the models in previous studies (Aliaga-Diaz, & Oliver, 2010; Atta-Mensa & Dib, 2008; Bester, 1994; Boot et al., 1991; Coleman et al. 2002; Dewatripont & Tirole, 1994) for the structure of Iran's banking and economy.

4.1 Households

The household consumes, holds financial assets (including shares issued by the bank), and supplies labor to firms. It also owns the economy's stock of physical capital, which provides them for firms. The objective of the household is to maximize utility function:

$$U_t = E_t \sum_{i=0}^{\infty} \beta^s \left[\frac{(c_{t+s})^{1-\zeta^{-1}}}{1-\zeta^{-1}} + \eta_n \ln(1 - N_{t+s}) + \eta_x ln x_{t+s} \right] \tag{1}$$

where $\beta(0,1)$ is the inter-temporal discount factor, C_t denotes real consumption, N_t is supply of labor in goods sector, x_t a composite index of real monetary assets, and E_t is the expectation operator conditional on the information available at period t, $\zeta > 0$ is the inter-temporal elasticity of substitution in consumption and $\eta_n > 0$ $\eta_x > 0$. The composite monetary asset is generated by combining real cash balances, m_t^h and real bank deposits, d_t, through a Cobb- Douglas function:

$$x_t = \left(m_t^h\right)^{\nu} d_t^{1-\nu} \tag{2}$$

where $\nu \epsilon (0,1)$. Nominal wealth of the household at the end of period t, A_t, is given by:

$$A_t = M_t^h + D_t + B_t^h + P_t K_t \tag{3}$$

where P_t is the price of the final good, $M_t^h = P_t m_t^h$ nominal cash holdings, $D_t = P_t d_t$ nominal bank deposits, B_t^h holding of one period nominal government bonds and K_t the real stock of physical capital held by household at the beginning of period t.

The household enters period t with K_t real units of physical capital and M_{t-1}^h holding of cash. It also collects principal plus interest on bank deposits at the rate contracted in t-1, $(1 + i_{t-1}^D)D_{t-1}$ which is paid on maturing government bonds ρ where i_{t-1}^D is the interest rate on deposits.

At the beginning of the period, the household chooses the real levels of cash, deposits, capital equity, and bonds, and supplies labor and physical capital to firms, for which it receives total real factor payment $r_t^k K_t + w_t N_t$ where r_t^k is rate of return on physical capital and $w_t = \frac{W_t}{P_t}$ is the economy-wide real wage, with W_t denoting the nominal wage.

The household receives all the profits made by the firms, $J_t^f \int_0^1 \pi_{jt}^f \, d_j$. In addition, it receives all the profits of the bank, J_t^b which is liquidated at the end of the period. It also pays a lump-sum tax, whose real value is T_t, and purchases the final good for consumption and investment, in quantities C_t and I_t, respectively. Investment turns into capital available at the beginning of the next period.

The household's end of period budget constraint is given by:

$$M_t^h + D_t + B_t^h = P_t\left(r_t^k K_t + w_t N_t - T_t\right) + \left(1 + i_{t-1}^d\right)D_{t-1} + (1 + \rho_B)B_{t-1}^h + M_{t-1}^h - P_t(C_t + I_t) + J_t^f + J_t^b \quad (4)$$

The stock of capital at the beginning of period $t + 1$ is given by

$$K_{t+1} = (1 - \delta)K_t + I_t - \frac{\theta_\kappa}{2}\left(\frac{K_{t+1}}{K_t}\right)^2 K_t \quad (5)$$

where $\delta \epsilon (0,1)$ is the constant rate of depreciation and the last term is the capital adjustment cost function specified in standard fashion, with $\theta_\kappa > 0$ denoting an adjustment cost parameter.

Each household maximizes lifetime utility with respect to $C_t, N_t, m_t^h, d_t, b_t^h = \frac{B_t^h}{P_t}, K_t$, taking as given in period $t - 1$ as well as P_t and T_t. Let $\pi_{t+1} = \frac{(P_{t+1} - P_t)}{P_t}$ denotes the inflation rate; maximizing (1) subject to (2)-(5) yields the following solutions:

$$C_t^{\frac{-1}{\zeta}} = \beta E_t\left[(C_{t+1})^{\frac{-1}{\zeta}}\left(\frac{1 + i_t^b}{1 + \pi_{t+1}}\right)\right] \quad (6)$$

$$N_t = 1 - \frac{\eta_n}{w_t}(C_t)^{\frac{1}{\zeta}} \quad (7)$$

$$m_t^h = \frac{\eta_x}{\rho}\nu C_t^{\frac{1}{\zeta}}(1 + \rho) \quad (8)$$

$$d_t = \frac{\eta_x(1 - \nu)(C_t)^{\frac{1}{\zeta}}(1 + \rho)}{\rho + i_t^d} \quad (9)$$

$$-\lambda_t\left[1 + \theta_\kappa\left(\frac{K_{t+1}}{K_t} - 1\right)\right] + \beta\left\{\lambda_{t+1}^k\left[r_{t+1}^k + 1 - \delta - \frac{\theta_k}{2}\left(\frac{K_{t+2}^2 - K_{t+1}^2}{K_{t+1}^2}\right)\right]\right\} = 0 \quad (10)$$

where λ_t is the Lagrange multiplier associated with the budget constraint.

Eq. (6) is the standard Euler equation. Eq. (7) relates labor supply positively to the real wage and negatively to consumption. Eq. (8) relates the real demand for cash positively with consumption and negatively with the opportunity cost of holding money, measured by the return on government bonds. Similarly, Eq. (9) relates the real demand for deposits positively with consumption and the deposit rate, and negatively with the bond return. Eq. (10) can be rewritten as

$$E_t\left(\frac{1+\rho}{1+\pi_{t+1}}\right) = E_t\left\{\left[\theta_k\left(\frac{K_{ht+1}}{K_{ht}}-1\right)+1\right]\left[1-\delta+r_{t+1}^{k}-\frac{\theta_k}{2}\left(\frac{\Delta K_{ht+2}^{2}}{K_{ht+1}^{2}}\right)\right]^{-1}\right\} \quad (11)$$

where the left hand side is the expected real return on bonds (that is, the opportunity cost of unit of capital), and the right-hand side is the expected return on the last unit of physical capital invested (corrected for adjustment costs, incurred both in t and t+1).

4.2 Final Good Producer

The final good, Y_t is divided between private consumption, government consumption, and investment. It is produced by assembling a continuum of imperfectly substitutable intermediate goods Y_{jt} with $j\epsilon(0,1)$:

$$Y_t = \left\{\int_0^1 [Y_{jt}]^{\frac{\theta-1}{\theta}}\right\}^{\frac{\theta}{\theta-1}} \quad (12)$$

where $\theta \succ 1$ is the elasticity of demand for each intermediate good.

The firm sells its output at a perfectly competitive price. Given the intermediate-goods prices P_{jt} and the final- good price P_t, it chooses the quantities of intermediate goods, Y_{jt} that maximize problem of firm. Thus:

$$Y_{jt} = \arg maxP_t\left\{\int_0^1 [Y_{jt}]^{\frac{\theta-1}{\theta}} d_j\right\} - \int_0^1 P_{jt}\, Y_{jt} d_j \quad (13)$$

The first- order conditions yield:

$$Y_{jt} = \left(\frac{P_{jt}}{P_t}\right)^{-\theta} Y_t, \forall j\epsilon(0,1) \quad (14)$$

Imposing a zero-profit condition leads to the following final good price:

$$P_t = \left\{\int_0^1 (P_{jt})^{1-\theta} d_j\right\}^{\frac{1}{1-\theta}} \quad (15)$$

4.3 Intermediate Goods-Producing Firms

Each firm j produces (using both labor and capital) a distinct, perishable good that is sold on a monopolistically competitive market. Each firm must also borrow to pay wages in advance, that is, before production and sale have taken place. Price adjustment is subject to quadratic costs, as in Rotemberg (1982).

Production technology involves constant returns in labor and capital:

$$Y_{jt} = A_t N_{jt}^{1-\alpha} K_{jt}^{\alpha} \tag{16}$$

where N_{jt} is labor hours, $\alpha \epsilon (0,1)$ and A_t is a common technology shock, which follows the process of:

$$lnA_t = \rho_A lnA_{t-1} + \xi_t^A \tag{17}$$

where $\rho_A \epsilon (0,1)$ and $\xi_t^A \sim N(0, \sigma_{\xi^A})$.

Each firm j borrows the amount L_{jt}^f from the bank at the beginning of the period to pay capital and wage in advance. So the bank is financing γ_t proportion of cost of capital stock and labor. γ_t Is:

$$\gamma_t = (\bar{\gamma})^{1-\rho_\gamma} (\gamma_{t-1})^{\rho_\gamma} \qquad \rho_\gamma \epsilon (0,1) \tag{18}$$

The amount borrowed is therefore:

$$L_{jt}^F = \gamma_t (P_{jt} r_t^k K_{jt} + P_{jt} W_t N_t) \tag{19}$$

Repayment of loans occurs at end of the period, at the gross nominal rate $1 + i_{jt}^l$, where i_{jt}^l is the lending rate charged to firm j.

As in Rotemberg (1982), firms incur a cost in adjusting prices, of the form:

$$PAC_t^j = \frac{\Phi_f}{2} \left(\frac{P_{jt}}{\tilde{\pi}^G P_{jt-1}} - 1\right)^2 Y_t \tag{20}$$

where $\Phi_f \geq 0$ is the adjustment cost parameter (or, equivalently, the degree of price stickiness), $\tilde{\pi}^G = 1 + \tilde{\pi}$ is steady state gross inflation rate, and Y_t is aggregate output, defined in (12).

Firms are competitive in factor markets. Unit cost minimization yields the optimal capital – labor ratio as:

$$\frac{K_{jt}}{N_{jt}} = (\frac{\alpha}{1-\alpha})\left[\frac{w_t}{r_t^k}\right] \tag{21}$$

where the unit real marginal cost is:

$$mc_{jt} = \frac{\left[\gamma_t(1+r_t^l)w_t\right]^{1-\alpha}\left(\gamma_t(1+r_t^l)r_t^k\right)^{\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}A_t} \tag{22}$$

Each firm chooses a sequence of prices P_{jt} so as to maximize the discounted real value of all its current and future real profits, where nominal profits at t, π_{jt}^J, are defined as $\pi_{jt}^J = P_{jt}Y_{jt} - P_t mc_t Y_{jt} - PAC_t^j$ Taking $\{mc_{t+s}, P_{t+s}, Y_{t+s}\}_{s=0}^{\infty}$ as given, the first order condition for this maximization problem is:

$$\left\{1-\theta+\theta\left(\frac{P_t}{P_{jt}}\right)mc_{jt}\right\}\lambda_t\left(\frac{P_{jt}}{P_t}\right)^{-\theta}\frac{Y_t}{P_t} - \lambda_t\Phi_f\left\{\left(\frac{P_{jt}}{\tilde{\pi}^G P_{jt-1}}-1\right)\frac{Y_t}{\tilde{\pi}^G P_{jt-1}}\right\} +$$
$$\beta\Phi_f E_t\left\{\lambda_{t+1}\left(\frac{P_{jt+1}}{\tilde{\pi}^G P_{jt}}-1\right)Y_{t+1}\left(\frac{P_{jt+1}}{\tilde{\pi}^G P_{jt}^2}\right)\right\} = 0 \tag{23}$$

which gives the adjustment process of the nominal price P_{jt}.

4.4 Commercial Bank

At the beginning of each period t, the bank collects deposits D_t from the household. Funds are used for loans to firms, which use them to pay labor in advance. Thus, from (18)

$$L_t^F = \int_0^1 L_{jt}^F = P_t r_t^k K_t + P_t W_t N_t \tag{24}$$

where again $N_t = \int_0^1 N_{jt} dj$ and $K_t = \int_0^1 K_{jt}\, dj$. Upon receiving household deposits, and given loansL_t^F, the bank borrows from the central bankL_t^c, to fund shortfall in deposits. At the end of period, it repays the central bank, at the interest rater_t^c, which we refer to as the refinance rate. It also holds required reserves at the central bank, RR_t and government bonds, B_t^b.

If the bank is faced with a shortage of funds, then borrows from the interbank market D_t^i and pays r_t^i. Banks set interest rate of interbank by agreement together. r_t^i Must be less than r_t^l and more than of r_t^d. If r_t^i is more than r_t^l they do not claim to firms, because claim to interbank is riskless with high yield, so then decreases claim to firms. Where φdi is quadratic cost parameter.γ_t^i is repayment ratio due to interbank. If banks cannot make repayment timely, they are confronted with cost: $\frac{1}{2}\varphi di\big((1-\gamma_t^i)D_t^i\big)^2$.

$$\gamma_t^i = \left(\gamma_t^i\right)^{\rho_\gamma}(\tilde{\gamma})^{1-\rho_\gamma} \tag{25}$$

The bank's balance sheet is thus:

$$L_t + B_t^b + RR_t = D_t + K_t^b + L_t^c + D_t^i \tag{26}$$

where:

$$K_t^B = K_t^R + K_t^E \tag{27}$$

With K_t^R denotes required capital and K_t^E excess capital. We adopt Agenor et al. (2012) model due to prohibitive penalty or reputational costs, $K_t^B \geq K_t^R$ at all times. In fact, we will focus on the case where capital requirements are not strictly binding, that is, $K_t^E > 0$. Reserves held at the central bank do not pay interest. They are determined by:

$$RR_t = \mu D_t \tag{28}$$

where $\mu\epsilon(0,1)$ is reserve requirement ratio.

The bank is also subject to risk-based capital requirement; by law, it must hold an amount of equity that covers at least a given percentage of its loans, exogenously set by the central bank (which also acts as the financial regulator). Government bonds bear no risk and are subject to a zero weight in calculating capital requirements. The risk weight on loans to firm is σ_t^F:

$$K_t^R = \rho_k \sigma_t^F L_t^F \tag{29}$$

where $\rho_k\epsilon(0,1)$ is the capital adequacy ratio. Under Basel I, σ_t^F is fixed at $\sigma_0^F \leq 1$; under Basel II, in a manner similar to Agenor et al. (2012), we relate the risk weight to the repayment probability estimated by the bank, because it reflects its perception of default risk:

$$\sigma_t = \left(\frac{\alpha_t}{\bar{\alpha}}\right)^{-\Phi_\alpha} \tag{30}$$

where $\Phi_\alpha > 0$ and α_t is repayment probability and $\bar{\alpha}$ is the steady – state of α_t. In the steady state, the risk weight is therefore equal to unity.

The bank sets deposit and lending rates, excess equity capital and government bonds, so as to maximize the present discounted value of its profits.

The problem of profit maximization is:

$$max_{L_t,D_t,B_t,K_t} E_t \sum_{t=0}^{\infty} \left[(\beta^t \lambda_t) \frac{\Pi_t^b}{P_t} \right] \tag{31}$$

where profit is:

$$\frac{\Pi_{t+1}^B}{P_t} = \alpha_t(1 + r_t^l)L_t + (1 - \alpha_t)\kappa K_t + \mu d_t - (1 + r_t^d)d_t - (1 + r_t^c)L_t^c - (1 + r_t^i)\gamma_t^i D_t^i - \frac{1}{2}\varphi di\left((1 - \gamma_t^i)D_t^i\right)^2 + (1 + \rho_B)B_t^B - \gamma_b \frac{(B_t^B)^2}{2} - \frac{\chi_k}{2}(\frac{K_t^B}{L_t} - \theta_t^k)^2 K_t^B \tag{32}$$

where $\kappa\epsilon(0,1)$, $\varphi di, \gamma_b, \chi_k > 0$ and $\alpha_t\epsilon(0,1)$ is the repayment probability of firms, assumed identical across them. $\alpha_t(1 + r_t^l)L_t$ represents repayment on loans if there is no default, which occurs with probability α_t. $(1 - \alpha_t)\kappa K_t$ Represents what the bank earns in case of default, that is, under limited liability, the effective value of collateral pledged by borrower, κK_t. Raw collateral, therefore, consists of the physical assets of the firm and κ measures the degree of credit market imperfections.

μd_t represents the reserve requirements held at the central bank and returned to bank at the end of the period. The term $(1 + r_t^d)d_t$ represents payment of deposits (principal and interest) by bank. $\gamma_b \frac{(B_t^B)^2}{2}$ captures the cost associated with transacting in government bonds; for tractability, this cost is assumed to be quadratic. $(1 + r_t^c)L_t^c$ and $(1 + r_t^i)\gamma_t^i D_t^i$ are repayment of borrows from central bank and interbank market. $\frac{1}{2}\varphi di((1 - \gamma_t^i)D_t^i)^2$ is the cost of non-repayment borrow from interbank market.

Such as Hollander and Liu (2013), capital adjustment is costly $\frac{\chi_k}{2}\left(\frac{K_t^B}{L_t} - \theta_t^k\right)^2 K_t^B$ and χ_k is the quadratic function coefficient of the capital adjustment.

Maximizing (32) subject to (24)-(30) yields the following solutions:

$$r_t^d = \left(1 + \frac{1}{\eta_d}\right)^{-1} (1 - \mu)i_t^c \tag{33}$$

which shows that the equilibrium deposit rate set as a markup over the refinance rate, adjusted (downward) for the implicit cost of holding reserve requirements. Such as Agenor et al. (2012), η_d denotes the constant interest elasticity of the supply of deposits by the household and η_F denotes the interest elasticity of demand for loans. Using this definition, we have:

$$1 + r_t^l = \frac{1}{(1+\eta_F^{-1})\alpha_t}\left\{(1-\rho_k\sigma_t)(1+r_t^c) + \rho_k\sigma_t\left[\chi_k\left(\frac{K_t^B}{L_t} - \theta_t^k\right)\left(-\frac{K_t^B}{L_t^2}\right)\right]\right\} \quad (34)$$

which implies that the gross lending rate depends negatively on the repayment probability, and positively on a weighted average of marginal cost of borrowing from the central bank (at the gross rate $(1 + r_t^c)$) and the total cost of adjusted capital. Weight on each component of funding costs is measured in terms of share of capital in proportion of loans.

We adopt a quasi-reduced form, as in Curdia and Woodford (2010) and Agenor (2012), for instance, to relate the repayment probability to three sets of factors. First, in Iran, collateral is used as a repayment guarantee and is the only means of guaranteeing repayment of loans. For this reason, we relate α_t to borrowers net worth; it increases with the effective collateral provided by firms, $\kappa P_t K_t$ and falls with the amount borrowed, L_t. As argued by Boot et al. (1991), Bester (1994), and Agenor, et al. (2012), among others, by increasing borrowers' effort and reducing their incentives to take on excessive risk, collateral reduces moral hazard and raises the repayment probability.

Second, α_t depends on the cyclical position of the economy, as measured by $\frac{Y_t}{\bar{Y}}$ with $\bar{Y}$ denoting the steady state value of final output. This assumption is proportional to the structure of Iran's economy, which repayment increases during the boom. Because during the economic boom, borrowers' ability to repay loans is increasing. This captures the view that in periods of high (low) levels of activity, profits and cash flows tend to improve (deteriorate) and incentives to default diminish (increase). If net worth values are also procyclical, both of these effects are consistent with the large body of evidence suggesting that price-cost margins in banking are consistently countercyclical (Aliaga-Diaz and Olivero, 2010; Agenor et al., 2012).

Third, α_t increases with the bank's capital relative to the outstanding amount of loans $\frac{K_t^B}{L_t}$, because bank capital increases incentives for the bank to screen and monitor borrowers. In turn, greater monitoring mitigates the risk of default and induces lenders to reduce the cost of borrowing. This assumption is due to the conditions of Iran's economy in the last decade, that repayment of facilities has decreased and banks' credit risk has increased. In this case, capital is the best protection for credit risk. This is consistent with the evidence in Coleman et al. (2002), according to which well-capitalized banks charge lower loan rates than banks with low capital, and the results of Coleman et al. (2002), in which capital–constrained banks charge higher spreads on their loans. This effect is also consistent with the evidence in Agenor et al. (2012). Finally, the dependence of the repayment probability on the capital–loan ratio implies through (35), that it is also negatively related with bank lending spread. The direct support for this link, while accounting for the possibility of reserve causality, is provided by Fonseca et al. (2010) and Agenor et al. (2012).

The repayment probability is thus specified as:

$$\alpha_t = \varphi_0 \left(\frac{\kappa P_t K_t}{L_t}\right)^{\varphi_1} \left(\frac{P_t K_t^B}{L_t}\right)^{\varphi_2} \left(\frac{Y_t}{\bar{Y}}\right)^{\varphi_3} \tag{35}$$

where $\varphi_i > 0$, $\forall i$. Combining (33) and (34) implies that an increase in capital of bank, by improving incentives to monitor borrowers and reducing borrowers' default probability, lowers the lending rate.

The demand for bonds is:

$$b_t^B = \gamma_B^{-1}(\rho_k - r_t^c) \tag{36}$$

This is increasing in the bond rate and decreasing in the marginal cost of funds. The interest rate of inter banking market is:

$$1 + r_t^i = \frac{1}{\gamma_t^i}\left[(1 + r_t^c) + \varphi di(1 - \gamma_t^i)^2 D_t^i\right] \tag{37}$$

which implies that the gross inter-banking rate depends negatively to the repayment probability, and positively to weighted average of marginal cost of borrowing from the Central Bank (at the gross rate $(1 + r_t^c)$)and the total cost of adjusted borrowing from interbank.

4.5 The Central Bank

The Central bank's assets consist of holdings of government bonds, B_t^c and loans to commercial bank,L_t^c and foreign reserveFR_t, whereas its liabilities consist of currency supplied to households and firms, $M_t^s$and required reserves RR_t. The balance sheet of the Central Bank is thus given by:

$$B_t^c + L_t^c + FR_t = M_t^s + RR_t \tag{38}$$

which $FR_t = FR_{t-1} + OR_t$.

The Central Bank is able to set interest rate of borrowing based on Central Bank's reserve requirement. Interest rate of borrowing from Central Bank is:

$$(1 + r_t^c) = \left(\frac{1+r_{t-1}^c}{1+\bar{r}}\right)^{\rho_r} \left(\frac{1+\pi_t}{1+\bar{\pi}}\right)^{\rho_\pi} \left(\frac{y_t}{\bar{y}}\right)^{\rho_y} \left(\frac{\mu_t}{\bar{\mu}}\right)^{\rho_\mu} \varepsilon_{t,rc} \quad \varepsilon_{t,rc} \sim (0, \sigma_{t,rc}) \quad (39)$$

where $\rho_y, \rho_\pi, \rho_m, \rho_r$ are the weights assigned to the output, inflation, growth of money and interest rate of previous period. Growth rate of money is:

$$\mu_t = \frac{M_t}{M_{t-1}}(\pi_t). \quad (40)$$

Reserve requirement is:

$$\eta_t = \pi_t^{\Phi_\eta^\pi} \eta_{t-1}^{\Phi_\eta^\eta} \quad (41)$$

where $\Phi_\eta^\pi, \Phi_\eta^\eta$ are weights assigned to inflation rate and reserve requirement at previous period.

4.6 Government and Oil Sector

Government in financed with bond B_t, tax T_t, oil revenue OR_t and other revenue X_t. Government expenditure is:

$$G_t = (B_t)^{\Phi_B^g}(T_t)^{\Phi_t^g}(OR_t)^{\Phi_{or}^g}(X_t)^{\Phi_x^g}, \quad (42)$$

which we suppose $\Phi_B^g + \Phi_t^g + \Phi_{or}^g + \Phi_x^g = 1$.

Tax is:

$$T_t = (Y_t)^{\Phi_y^t}, \quad (43)$$

where Φ_y^t is a weight of output.

Other revenue is

$$X_t = \varphi_x^y Y_t, \quad (44)$$

which φ_x^y is coefficient of Y_t. Oil revenue shock is:

$$OR_t = (OR_{t-1})^{\rho_{or}}(\overline{OR})^{1-\rho_{or}}\varepsilon_{t,or} \quad \varepsilon_{t,or} \sim N(0, \sigma_{t,or}), \tag{45}$$

in which $\overline{OR}$ oil revenue at steady state. Bond is

$$B_t = B_t^h + B_t^c + B_t^E \tag{46}$$

4.7 Symmetric Equilibrium

In a symmetric equilibrium, all firms producing intermediate goods are identical. Thus, $K_{jt} = K_t$, $N_{jt} = N_t$, $Y_{jt} = Y_t$, $P_{jt} = P_t$, for all $j\epsilon(0,1)$. All firms also produce the same output, and prices are the same across firms. In the steady state, inflation is constant at $\bar{\pi}$.

Equilibrium conditions must also be satisfied for credit, deposit, goods, and money markets. Because the supply of loans by the bank, and the supply of deposits are perfectly elastic at the prevailing interest rates, the markets for loans and deposits clear through quantity adjustment. Equilibrium in the goods markets and money markets are:

$$Y_t = C_t + G_t + I_t + \frac{\Phi_f}{2}\left(\frac{1+\pi_t}{1+\bar{\pi}} - 1\right)^2 Y_t \tag{47}$$

$$M_t^s = M_t^h + L_t \tag{48}$$

5 Illustrative Calibration

This paper uses calibration to calibrate the structural parameters of the model. First, the first order condition is obtained and linearized. Then the model is solved. The Sample data is from 1981 to 2017. We use Central Bank of Iran database, such as national accounts and balance sheets of banks.

To analyze the model, the parameters of the model are initialized. To initialize the parameters, both the findings of the previous studies and actual data are used. In this way, the parameters of the model are rewritten according to the model's intrinsic variables, and then using the annual time series data, the values are obtained in a steady state and then, the values of the parameters are calculated. In order to calculate the steady state values, initially the time series data are DE trended. The following formula has been used for DE trending:

$$\log(x_t) = \acute{c} + \acute{r}.trend \tag{49}$$

Which c' is intercept and r' is coefficient of trend component. Anti-log of estimated intercept, calculates the value of this series in steady state. As for estimated coefficient for trend component, detrended time series are calculated with:

$$x_t^s = \frac{x_t}{(1+\acute{r})^t} \quad (50)$$

After rewriting the parameters according to the endogenous variables, the steady state values of the variables are embedded and thus the numerical value of the parameters is calculated using actual data.

Some parameters such as discount rate and depreciation rate are identified by solving the model. The weights assigned to the output, inflation stabilization, growth of money and interest rate of previous period, and weights assigned to the reserve requirement at previous period and weights of output are estimated according the their functions. Parameters of shocks are estimated by Eviews according the following equation:

$$\log(x_t) = c + \rho \log(x_{t-1}) + \epsilon_{x_t} \quad (51)$$

Where ρ is Autoregressive Coefficient and its standard deviation ofϵ_{x_t} is the standard deviation of variable. Productivity shock is selected appropriately to the structure of the model. Distribution of parameters are selected based on the characteristics of parameters and features of the distribution.

Table 1
Calibrated Parameter

Parameter	Value	Calibrated From	Description
Household			
$\boldsymbol{\beta}$	0.97	Solving model	Discount factor
$\boldsymbol{\zeta}$	0.93	Author calculations	Elasticity of intertemporal substitution
$\boldsymbol{\eta_n}$	0.63	Author calculations	Relative preference for leisure
$\boldsymbol{\eta_x}$	0.58	Author calculations	Relative preference for money holdings
$\boldsymbol{\nu}$	0.22	Author calculations	Share parameter in index of money holdings
$\boldsymbol{\theta_k}$	8.6	Agenor et al. (2012)	Adjusted cost parameter, investment
$\boldsymbol{\rho_B}$	0.2	Iran’s budget law	Yield of bonds
Production			
$\boldsymbol{\delta}$	0.034	Solving model	Depreciation rate of physical capital

$\boldsymbol{\theta}$	4.33	Mark-up 30%	Elasticity of demand, intermediate goods
$\boldsymbol{\alpha}$	0.78	Author calculations	Share of labor in output, intermediate good
$\boldsymbol{\Phi_f}$	4.26	Atta-Mensa and Dib (2010)	Adjusted cost parameter, prices
Bank			
$\boldsymbol{\mu}$	2.1	Central bank of Iran(2017)	Reserve requirement rate
$\boldsymbol{\rho_k}$	0.08 and 0.12	Basel I and Basel II	Capital adequacy ratio
$\boldsymbol{\Phi_\alpha}$	0.05	Agenor et al. (2012)	Elasticity of the risk weight repayment probability
$\boldsymbol{\kappa}$	0.2	Agenor et al. (2012)	Effective collateral – loan ratio
$\boldsymbol{\gamma_b}$	0.06	Appropriate structure of model	Cost adjustment, bond holdings
$\boldsymbol{\chi_k}$	0.1	Appropriate structure of model	Cost adjustment, Bank capital
$\boldsymbol{\varphi_1}$	0.7	Appropriate with banking system of Iran	Elasticity of repayment probability wrt collateral – loan ratio
$\boldsymbol{\varphi_2}$	0.0, 0.5	Basel I , Appropriate structure of model	Elasticity of repayment probability wrt capital – loan ratio
$\boldsymbol{\varphi_3}$	0.6	Appropriate structure of model	Elasticity of repayment probability wrt cyclical output
$\boldsymbol{\varphi_{di}}$	0.46	Author calculations	Cost adjustment, borrowing from interbank
Central Bank			
$\boldsymbol{\rho_y}$	0.45	Author calculations	Weights assigned to the output
$\boldsymbol{\rho_\pi}$	0.89	Author calculations	Weights assigned to inflation in interest rate
$\boldsymbol{\rho_m}$	0.82	Author calculations	Weights assigned to growth of money
$\boldsymbol{\rho_r}$	0.80	Author calculations	Weights assigned to interest rate of previous period
$\boldsymbol{\Phi_\eta^\pi}$	0.062	Author calculations	Weight assigned to inflation in reserve requirement
$\boldsymbol{\Phi_\eta^\eta}$	0.83	Author calculations	Weight assigned to reserve requirement at previous period
Government and Oil Sector			
$\boldsymbol{\Phi_B^g}$	0.1	Author calculations	Weight assigned to bond in government expenditure

$\boldsymbol{\Phi_t^g}$	0.25	Author calculations	Weight assigned to tax in government expenditure
$\boldsymbol{\Phi_{or}^g}$	0.55	Author calculations	Weight assigned to oil revenue in government expenditure
$\boldsymbol{\Phi_x^g}$	0.1	Author calculations	Weight assigned to other revenue in government expenditure
$\boldsymbol{\Phi_y^t}$	2.08	Author calculations	Weight of output in tax
$\boldsymbol{\Phi_x^y}$	1.54	Author calculations	Weight of other revenue in tax
Shock			
$\boldsymbol{\rho_A, \sigma_A}$	0.64, 0.01	Appropriate structural of model	Persistence/standard dev., productivity shock
$\boldsymbol{\rho_{rc}, \sigma_{rc}}$	0.65, 0.02	Author calculations	Persistence/standard dev., monetary shock
$\boldsymbol{\rho_{or}, \sigma_{or}}$	0.60,0.001	Author calculations	Persistence/standard dev., oil revenue

Source: Research Findings

6 Procyclical Effects of Regulatory Regimes

We now consider the effects of regulatory regimes as measured by the behavior of the repayment probability of a positive productivity shock, expansionary monetary policy shock, and positive oil revenue shock. We such as Agenor et al. (2012) report results for two different values of the elasticity of the repayment probability with respect to the capital loan ratio, $\varphi_2 = 0.0$ and $\varphi_2 = 0.5$. As is made clear below, this parameter change, by itself, is sufficient to let us illustrate the ambiguity in the procyclical effects of the two regulatory regimes.

Figures 1, 2 and 3 show the impulse response functions of some of the main variables of the model following a temporary, one percentage positive shocks. The results show that two different outcomes may occur, depending on the elasticity of the repayment probability with respect to the capital–loan ratioφ_2. In all of the figures, the behaviors of most of the variables do not differ much across regimes. This is because of the negative relation between the capital buffer and required capital; as a result, total capital under the two regimes is more closely related. However, by changing the parameters by more, we could magnify differences across regimes.

Effects are examined directly and indirectly. The direct effects will be explained after each chart. Indirect effects are explored through the repayment probability and bank's capital-loan ratio.

As shown in the Figures 1, 2 and 3, the initial drop (rise) in output (relative to its steady-state value) tends to lower (higher) the repayment probability, whereas the initial increase (decrease) in the collateral–loan ratio (due to the reduction (increase) in the real demand for loans) tends to raise it. The repayment probability falls (rises) (as one often observes in a recession (Boom)), thereby increase (decrease) the loan rate and marginal costs. The rise (fall) in the loan rate, by increasing (decreasing) the effective cost of labor, tends to further depress (raise) production.

However, there is also another effect, which operates through the bank capital–loan ratio and depends on the regulatory regime. Under Basel I, the bank capital–loan ratio does not change by much, because excess capital changes is very little (given our calibration) and, by definition, the risk weight σ_t^F is constant. There is therefore a negligible indirect effect on the repayment probability under this regime. By contrast, under Basel II, the initial drop (increase) in the repayment probability raises (drops) the risk weight and therefore raises actual and required capital. Because credit falls (increases), the bank capital–loan ratio rises (decreases) unambiguously, which implies an upward (downward) effect on the repayment probability, thereby mitigating the initial downward effect under that regime. The net effect is thus ambiguous in general and depends on the value ofφ_2. In Figures 1, 2 and 3 which corresponds to $\varphi_2 = 0.0$, the shocks lead to the conventional case where Basel II is more procyclical than Basel I, whereas in Figures 1 and 3 which corresponds to $\varphi_2 = 0.5$, the opposite occurs. Thus, Basel II is less Procyclical than Basel I in the sense that the drop (increase) in the repayment probability, the increase (decrease) in the lending rate, and the fall (raise) in output are all of a smaller magnitude.

Figure 1 shows monetary policy shocks effect. We assume the Central Bank increases policy interest rate r_t^c. This policy rate has two effects on banks. First because of the increasing in policy rate, lending rate increases, interest revenue increases and banks increase deposit rate while decrease deposit. Households benefit from savings and consumption increases first. Then, with increase in the interest rate on deposits, households prefer saving instead of consumption. The increase in deposit leads to a further increase in credit. Because of increasing in lending rate, cost of production increases and it leads to decreasing aggregate output but increasing inflation. With increase in credit, first physical capital increases and then with increasing in cost of production, physical capital decreases. Second, when output decreases, repayment probability falls and bank increases collateral-loan ratio. As it can be seen, Basel II with $\varphi_2 = 0.5$ has less Procyclical effect than Basel I.

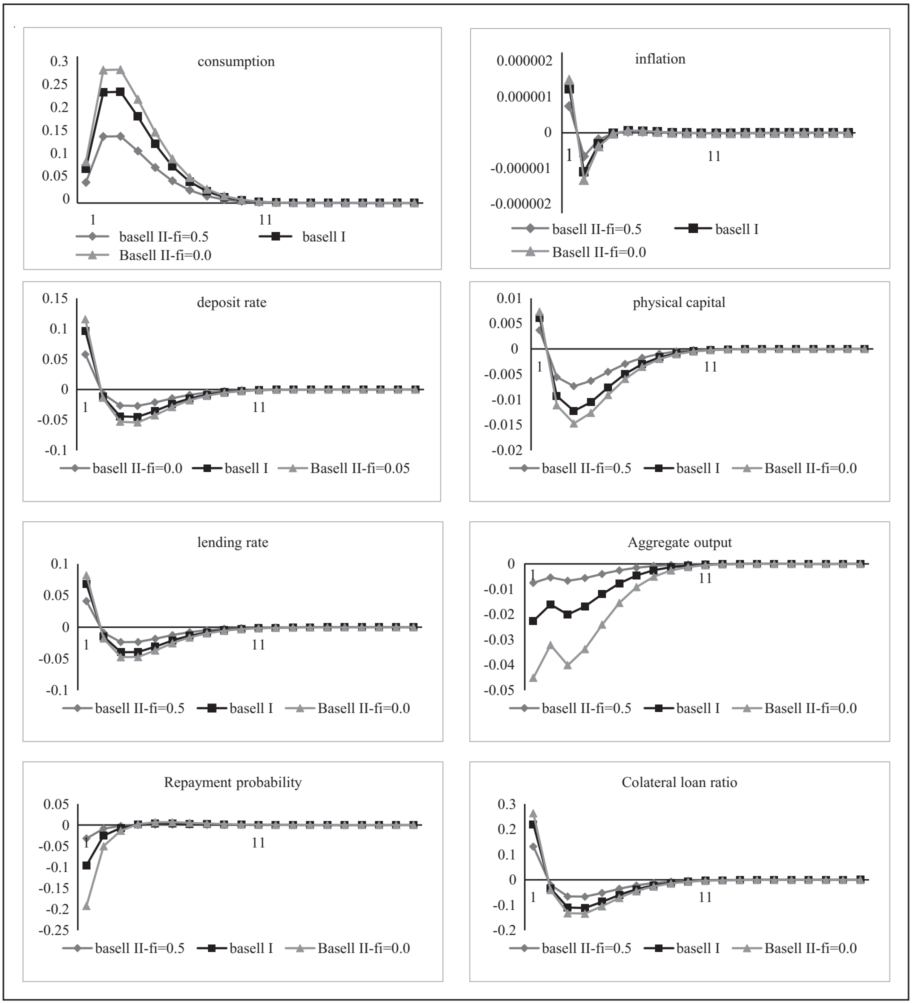

Figure 1. Monetary Policy Shocks
Source: Research Findings

Figure 2 shows the impacts of positive technology shock on Iran's economy. Since the production is more efficient, output rises. The Supply of goods increases, thus reducing the price of goods. The technology innovation reduces marginal costs and inflation. Households rise their saving and entrepreneurs borrow more. Because of the increased savings, the marginal product of labor increases so that the aggregate capital increases. The rising in consumption means a rising demand for goods, therefore raising inflation. Central bank raises loan rates.

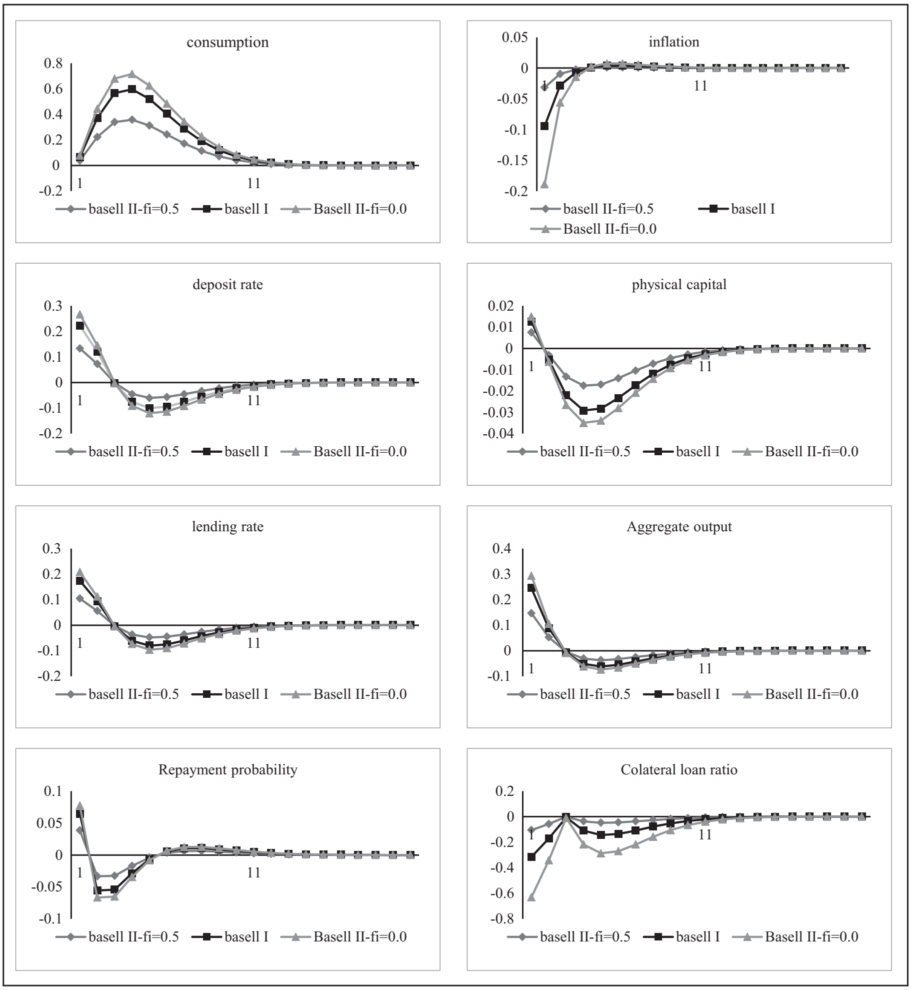

Figure 2. Positive Technology Shock
Source: Research Findings

In the presence of bank intermediary, the endogenous propagation mechanism is amplified because credit spreads benefits for entrepreneurs due to the greater availability of credit. Entrepreneurs borrow more and produce more. Because of raising production, inflation decrease. Aggregate output increase then repayment probability increases and banks need less collateral than before and collateral loan ratio decreases.

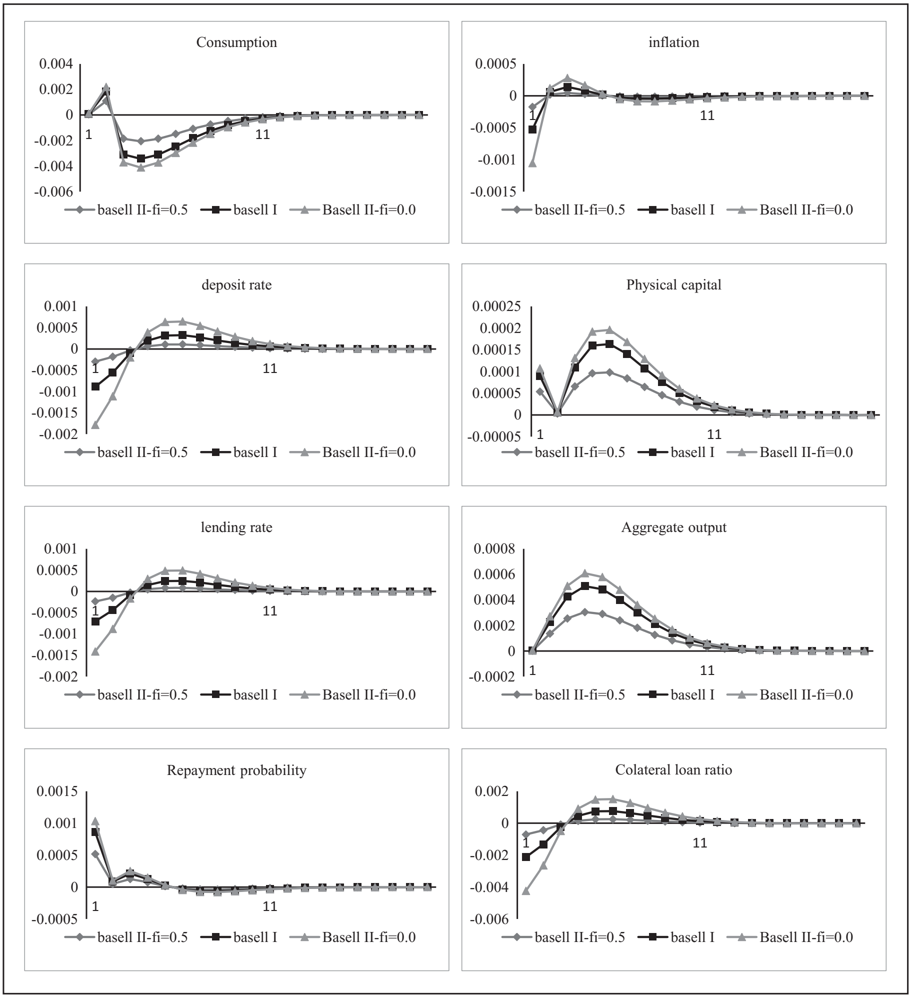

Figure 1. Oil Revenue Shock
Source: Research Findings

In Figure 3, we see the impulse response functions of the variables related to the oil revenues in terms of a standard deviation. With rising oil revenues, household consumption is on the rise. The production sector shows a slight increase. In other words, the increase in oil revenues will lead to the allocation of some resources to non-productive activities, which is largely due to the positive effects of increasing oil revenues on non-oil production. With rising oil revenues, government expenditure increases, which will reduce physical capital in private sector. Impulse response functions show, although the increase in oil revenues in the short run reduces inflation by channeling the overall output of the economy, but in the medium and long term, due to the transfer of oil shocks to the demand side, inflation in the economy is increasing. With decreasing inflation, Central Bank decreases deposit and lending rates. With increasing aggregate output, the ability to repay the facility increases and repayment probability increases. Then banks' requirement for collateral is reduced and collateral- loan ratio decreases.

7 Conclusions

In this paper like Agenor et al. (2012), the business cycle effects of bank capital requirements are examined by the Central Bank in a New Keynesian model with credit market imperfections, a cost channel of monetary policy, and a perfectly elastic supply of liquidity at the policy rate. In the model, which combines elements developed in Agenor et al. (2012), Basel I and Basel II regulatory regimes are defined. In the latter case, the risk weight is related directly to the repayment probability that is embedded in the loan rate that the bank imposes on borrowers. A bank capital channel is introduced by assuming that higher levels of capital (relative to the amount of loans) induce banks to screen and monitor borrowers more carefully, thereby reducing the risk of default and increasing the repayment probability.

Results show Basel regulation has procyclical effect. According to the results of the model and according to the realities of economy and banking system of Iran, in a recession, lending increases and credit risk increases and repayment probability is low. Despite that, capital adequacy will not increase. This confirms that risks are less counted in determining capital. This result is consistent with Khoshnod and Esfandiari (2018) findings.

In this paper 3 shocks are considered; monetary policy shock, technology shock and oil revenue shock. Results show that, in the absence of the bank capital channel, a Basel II regime is always more procyclical than a Basel I regime, as in the conventional, partial equilibrium. By contrast, if the elasticity of the repayment probability to the bank capital–loan ratio is sufficiently high, the Basel II regime may be less procyclical. The key reason is that, following a decrease in aggregate output, bank capital channel mitigates the drop in the repayment probability, due to the monitoring incentive effect.

Despite monetary policy shock, the decline in aggregate output under Basel I is more than the Basel II, and the repayment probability is also less under Basel I than Basel II. So, under Basel I, there is more need for collateral than

Basel II. Despite technology shock, increasing aggregate output under Basel II is more than Basel I and the repayment probability is less than Basel I. Therefore, under Basel II, there is more need for collateral than Basel I. Also oil shocks shows, under Basel II, decreasing in aggregate output is less than Basel I and the repayment probability is more than Basel I. So, under Basel II, there is less need for collateral than Basel I. Future work will consist of estimating the model's structural parameters, incorporating credit to households, extending the framework to an open economy model.

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