Iran. Econ. Rev. Vol. 24, No. 4, 2020. pp. 1025-1047

A Study of the Financial Instability and Banking Intermediaries by Using a DSGE Modeling Approach

Afsaneh Ghasemi[1], Beitollah Akbari Moghadam*[2], Hossein Tavakolian[3]

Received: 2018, November 4 Accepted: 2019, March 5

Abstract

This paper is to develop a quantitative monetary DSGE model with financial intermediaries and deals with the endogenously determined balance sheet constraints. Moreover, the present paper studies a DSGE model with financial intermediation as in Gertler and Karadi (2011), a monopolistically competitive banking sector to investigate the role of banks in the propagation of disturbances, and to assess the importance of shocks to the banking sector and to the financial system in explaining economic fluctuations in Iran. The model is estimated using Bayesian techniques. According to the findings, the banking sector attenuates the effects of demand shocks (i.e. monetary policy shock), strengthens the effects of supply shocks (i.e. technology shock) at the national level, and amplifies the transmission of shocks in Iranian economy. Furthermore, credit shocks in the banking system and financial shocks are the important sources of macroeconomic fluctuations in Iran. Results show that financial shock is more important in explaining the variation in the lending rate. The nominal deposit rate and financial leverage reduce by this shock and, as expected, the return equity capital rate reduces too.

Keywords: Financial Intermediaries, DSGE Model, Interest Rate Shock, Banking Industry, Productivity Shock.
JEL Classification: E62, E58, E32, E20, C11.

1. Introduction

The recent financial crisis in Iran made it clear that disruptions in financial markets could have considerable effects on both the dynamics

1. Department of Economics, Qazvin Branch, Islamic Azad University, Ghazvin, Iran.
2. Department of Economics, Qazvin Branch, Islamic Azad University, Ghazvin, Iran (Corresponding Author: b.akbari@qiau.ac.ir).
3. Faculty of Economics, University of Allameh Tabataba'i, Tehran, Iran (hossein.tavakolian@atu.ac.ir).

of the business cycle and on the underlying equilibrium growth path. In the dynamic stochastic general equilibrium (DSGE) literature, the relationships between financial and real sectors have mostly been neglected until recently. Over the last two decades beginning with Bernanke and Gertler (1989), economists began to introduce credit frictions into models, which allowed for borrowing and lending in equilibrium. Kiyotaki and Moore (1997), Carlstrom and Fuerst (1997), and Bernanke, Gertler, and Gilchrist (1999) then showed that these credit frictions could amplify the macroeconomic fluctuations induced by certain shocks. This is why the credit frictions are often referred to as the “financial accelerator”. These studies mainly focused on debt contracts among lenders and borrowers of the two groups under asymmetric information conditions. Gerali et al. (2008, 2010) consider a monopolistically competitive banking sector with a saving bank, a lending bank, and a wholesale bank in a DSGE model with collateral constraint, as in Iacoviello (2005). Using data for the Euro area, they show that the largest fraction of output fall in the Euro area is explained by shocks originating in the banking sector. Iacoviello (2011) introduces a banking sector in one bank and focuses on how financial shocks (repayment shocks) affect an economy with patient and impatient households. The financial intermediaries of these groups are linked to each other. Claiming collateral from borrowers causes financial friction, and this affects the loan amount. Regardless of the role played by banks and other financial institutions, past credit models focused on credit demand. Yet, the new financial models more accurately represent the financial crisis structure. In Gertler and Kiyotaki (2009), although there is a possibility of a financial shock, there is considered one type of shock that is not created in the financial sector, and it is the capital quality shock that Gertler designs, which imposes the implications of intergenerational factors on the leverage ratios. So that the decline in the banks’ capital affects the number of facilities and the deposits offered. Gertler et al (2016) explained the banks’ incentives to maintain excessive risk. This study will mainly focus on credit and lending channels. Based on the channel framework, due to the application of a contractionary monetary policy, access to banking resources becomes more difficult and the cost of financing small firms increases. By contrast, larger firms that have more access to other markets and financial instruments are less affected by the monetary policy consequences. Of course, it is believed that the mechanism of money transfer through the credit channel not only affects the demand for a loan through interest rate changes but also has the potential to affect the supply of bank credit in the market, followed by investment and consumption impact. Duncan (2017) showed that the bank's capital base is a major concern for several decades of capital regulation, and this level of capital is monitored by macroeconomic policymakers. As can be seen, in the above-mentioned studies, the effect of monetary policies with an emphasis on the banking sector has been examined. The model is successful in reproducing most of the salient features of the Iranian economy including key macroeconomic volatilities, autocorrelations, and correlations with output. Importantly, the impulse responses of key macro variables to different shocks show that intermediation of the banking sector vanished the real effects of aggregate shocks, particularly financial shocks, and, thus, helps stabilize the economy.

In this paper, we introduce a banking sector in a DSGE model to understand the role of banking intermediation and analyze how shocks that originate in credit markets are transmitted to the real economy. We are not the first to do this. Recently there has been increasing interest in introducing a banking sector in dynamic models, and to analyze economies where a plurality of financial assets, differing in their returns, is available to agents. But in these cases, banks operate under perfect competition and do not set the interest rates.

The remainder of this paper is organized as follows. In Section 2, the model is described. Section 3discusses the parameter calibration, and Section 4reports and discusses the empirical results. Section 5 concludes the paper.

2. Literature Review

Gertler and Kiyotaki (2009) used a model to evaluate the central bank performance using unconventional monetary policy to combat a simulated financial crisis. They interpreted the unconventional monetary policy as expanding central bank credit intermediation to offset a disruption of private financial intermediation. Within this study's framework, the central bank is less efficient than the private intermediaries at making loans, but it can elastically obtain funds by issuing riskless government debts. Unlike private intermediaries, it is not a balance sheet constrained. During a crisis, the balance sheet constraints on private intermediaries tighten, raising the net benefits from central bank intermediation. These benefits may be substantial even if the zero lower bound constraint on the nominal interest rate is not binding.

Hafstede and Smith (2012) showed the impact of shocks (both demand and supply shocks) originating from the financial side of the economy on the real macroeconomy. First, they showed that the inclusion of our banking sector mitigates (but does not negate) the impact of the credit friction on macroeconomic fluctuations by affecting both the magnitude and persistence of non-financial shocks. This is achieved by reducing the elasticity of the expected credit spread, based on the leverage ratio, and by presenting a positive interest rate spread. Secondly, they found that financial shocks, both on the demand and supply sides, could cause severe macroeconomic fluctuations with supply-side shocks to bank intermediation costs via bank production having the largest impact.

Merola (2014) used American economic data and a stochastic dynamic model to study the role of financial frictions in the 2008 financial crisis. She concluded that Bernanke’s accelerator theory did not affect the US economy in this period.

Carlstrom and Timothy (2016) studied the contract for optimum financial acceleration models of Bernanke et al. (1999) and compared it to the financial accelerator. The contract relates to the indexation of the overall return on capital, household consumption, and domestic financing. These three interactive profiles reduce the volatility of bank leverage and initial risk, suggesting that the Bernanke financial accelerator does not affect this contract.

Stephan et al. (2017), studying the relationship between financial markets and financial frictions by using time series data from the US, found that friction in the investment sector had a remarkable effect on significant economic shocks. Monetary policies can also be used to prevent a rise in bank leverage. But sometimes they conflict with macroeconomic policies; for example, a positive shock to government spending leads to higher inflation and it needs monetary policy. This will reduce the contraction, and lead to a reduction in bank leverage and, as a result, virtually impacts macroeconomic policy.

Palic (2018) showed that monetary policy shock has a positive initial impact on the interest rate and a negative initial impact on house prices and the output gap. Results indicated that the empirical impact of the monetary policy shock adequately reflects the impact of a monetary shock in the DSGE model with financial frictions.

Jiri (2018) showed that an increase of interbank default risk can generate a money market freeze. The subsequent flight-to-quality diverted funds from the risky interbank to the safer government bonds market causing a reduction of the credit supply and a supplementary monetary can reduce default risk and thus shifting financial intermediaries' preferences towards interbank lending. Finally, the monetary authority can avoid the accumulation of safe assets, partially alleviating the liquidity shortage and, to a lesser extent, dampen the drop in the real activity.

3. Research Methodology

The core theory is the monetary DSGE with nominal rigidities developed by CEE (2005) and SW (2007). To do this, we add financial intermediaries that transfer funds between households and non-financial firms. An agency problem debilitates financial intermediaries to obtain funds from households. We also assume an inconvenience to capital quality. In the absence of financial frictions, this shock creates only a modest decline in output as the economy works to replenish the effective capital stock. With frictions in the intermediation process, however, the shock creates a significant capital loss in the financial sector, which in turn induces tightening of credit and a significant downturn. There are five types of agents in this model: households, financial intermediaries, non-financial goods producers, capital producers, and monopolistic competitive retailers. The latter is in the model only to introduce nominal price rigidities. Besides, the central bank conducts both conventional and unconventional monetary policy. We now proceed to characterize the model’s basic ingredients.

3.1 Household

In each household, there are two types of individuals: workers and bankers. Workers supply labor and hand over their earned wages to the household. Each banker manages finances in terms of diary and transfers any earnings back to the household. The household thus effectively owns the intermediaries that are the bankers manage. However, in the deposits it holds, the fraction1-f of the household members is always workers and the fraction f are bankers. Over time, an individual can shift between the two careers. For example, a banker in this period stays banker in the next period with the probability ofθ, regardless of the history (how long they have been a banker). The average durability time for a banker in any given periods, thus, $\frac{1}{1-\theta}$. As it will become clear, we introduce a finite horizon for bankers to ensure that over time they do not reach the point where they can fund all investments from their capital. Thus, every period $(1-\theta)f$, bankers exit and become workers. A similar number of workers randomly become bankers, keeping the relative proportion of each type. Bankers, who exit, give the retained earnings to their household. The household, though, provides new bankers with some start-up funds, as will be described in the next sub-section. Let C_t be consumption, and $L_t$be family labor supply. Then, the household's preferences are given based on:

$$MaxU_t = \sum_{i=0}^{\infty} \beta^i [\ln(C_t - hC_{t+i}) - \frac{x}{1+\varphi} L_{t+i}^{1+\varphi} + \frac{k}{1+\sigma} M_{t+i}^{1+\sigma} \quad (1)$$

With $0 < \beta < 1, 0 < h < 1$, $\varphi > 0$, and the budget constrain:

$$C_t = W_t L_t + \pi_t + T_t + R_t B_t - B_{t+1} + M_t - M_{t-1} \quad (2)$$

With the logarithm of the first-order Taylor expansion of Equation 2, we obtain the equation of demand for money by the following way:

$$M_t = \frac{\varphi}{\sigma} C_t - \frac{R_t}{\beta} \quad (3)$$

Letϱ_t denote the marginal utility of consumption. Then, the household's first-order conditions for labor supply and consumption/saving are as following:

$$\varrho_t W_t = X L_t^{\varphi} \quad (4)$$

$$\varrho_t = (C_t - hC_{t-1})^{-1} - \beta E_t (C_t - hC_{t-1})^{-1} \quad (5)$$

$$E_t \beta \Lambda_{t,t+1} R_{t+1} = 1 \quad (6)$$

$$\Lambda_{t,t+1} = \frac{\varrho_{t+1}}{\varrho_t} \tag{7}$$

3.2 Capital Producing Firms

At the end of the period t, firms purchased capital goods and, after depreciation, performed a new investment.I_t Gross capital is created, and $I_{nt} = I_t - \delta(U_t)\xi_t K_t$Net equity is generated. The expected earnings for capital are as follows:

$$MaxE_t \sum_{\tau=t}^{\infty} \beta^{T-t} \Lambda_{t,\tau}\{(Q_t - 1)I_{nt} - f\left(\frac{I_{nt}+I_{ss}}{I_{nt-1}+I_{ss}}\right)(I_{nt} + I_{ss}) \tag{8}$$

where $f(1) = f^{'}(1) = 0, f^{"} > 0$, and $\delta(U_t)\xi_t K_t$ and the amount of capital has been renewed. Assuming that the market is full of competition and the net investment rate is the same for all producers, the first-order condition is as follows:

$$Q_t = 1 + f(0) + \frac{I_{nt}+I_{ss}}{I_{nt-1}+I_{ss}} f^{'}(0) - E_t \beta \Lambda_{t,t+1} \left(\frac{I_{nt}+I_{ss}}{I_{nt-1}+I_{ss}}\right) f^{'}(0) \tag{9}$$

3.3 Retail Firms

Final output Y_t is a CES composite of a continuum of mass unity of differentiated retail firms that use the intermediate output as the sole input. The final output composite is given through:

$$Y_t = [\int_0^1 Y_{ft}^{\frac{(\varepsilon-1)}{\varepsilon}} df]^{\varepsilon/1-\varepsilon} \tag{10}$$

$$Y_{ft} = (\frac{P_{ft}}{P_t})^{-\varepsilon} Y_t \tag{11}$$

ε is the drag of succession between commodities. For the household's minimization problem,P_t is the price index as follows:

$$P_t = [\int_0^1 P_{ft}^{1-\varepsilon} df]^{\frac{1}{1-\varepsilon}} \tag{12}$$

According to Calvo (1983), no retail changes its price unless it receives a random signal. It is possible to get a 1-γ pre-signal, so at only 1-γ, in each period, they change their prices. The rest of the firms continue to price following past inflation. Assuming that pricing is done firmly, firms will be able to set P* or the optimal price as follows:

$$MaxE_t \sum_{i=0}^{\infty} \gamma^i \beta^{\mathrm{i}} \Lambda_{t,t+1} [\frac{P_t^*}{P_{t+1}} \Pi_{k=1}^{i} (1 + \Pi_{t+k-1})^{\gamma_p} - P_{mt+i}] Y_{ft} \quad (13)$$

Where Π_t is the inflation rate from t-i to t . The first-order necessary conditions are given by E_t:

$$E_t = \sum_{i=0}^{\infty} \gamma^i \beta^{\mathrm{i}} \Lambda_{t,t+1} [\frac{P_t^*}{P_{t+1}} \Pi_{k=1}^{i} (1 + \Pi_{t+k-1})^{\gamma_p} - P_{mt+i}]\, Y_{ft} = 0 \quad (14)$$

$$P_{\mathrm{t}} = [(1 - \gamma)(\mathrm{P_t^*})^{1-\varepsilon} + \gamma(\Pi_{\mathrm{t-1}}^{\gamma_{\mathrm{p}}} \mathrm{P_{t-1}})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \quad (15)$$

The output is divided between consumption, investment, government consumption, and expenditures on government intermediation $\psi_{\mathrm{t}} \mathrm{Q_t} K_{\mathrm{t+1}}$.We assume that government expenditures are exogenously fixed at level G. The economy resource constraint is given by:

$$Y_{\mathrm{t}} = \mathrm{C_t} + \mathrm{I_t} + \mathrm{f}\left(\frac{\mathrm{I_{nt}} + \mathrm{I_{ss}}}{\mathrm{I_{nt-1}} + \mathrm{I_{ss}}}\right)(\mathrm{I_{nt}} + \mathrm{I_{ss}}) + \mathrm{G} \quad (16)$$

Government expenditures are financed by lump-sum taxes and government intermediation:

$$G + \psi_{\mathrm{t}} \mathrm{Q_t} K_{\mathrm{t+1}} = T + (R_{kt} - R_t) B_{gt-1} \quad (17)$$

Where government bonds, and B_{gt-1} and $\psi_{\mathrm{t}} \mathrm{Q_t} K_{\mathrm{t+1}}$ finance total government intermediated asset.

Monetary policy is characterized by the simple Taylor rule with interest rate smoothing. Here, i_{t} is the net nominal interest rate, i is the steady-state nominal rate, and Y_t^* is the natural (flexible price equilibrium level) output. Then:

$$i_{\mathrm{t}} = (1 - \rho)[\mathrm{i} + K_\pi \pi_t + K_y (logY_t - logY_t^*) + \rho i_{t-1} + \varepsilon_t \quad (18)$$

Where the smoothing parameter, $0 < \rho < 1$, ε_t is an exogenous shock to monetary policy, and the link between nominal and real interest rates is given by the following Fisher relation:

$$1 + \mathrm{i} = \mathrm{R_{t+1}} \frac{\mathrm{E_t P_{t+1}}}{\mathrm{P_t}} \quad (19)$$

We assume that the interest rate rule is sufficient to characterize the monetary policy. In a crisis period, the central bank injects credit spreads, in response to movements and based on the following feedback rule:

$$\psi_t = \psi + vE(logR_{kt+1} - logR_{t+1}) - (logR_k - R) \tag{20}$$

Where ϕ_t , is the steady-state fraction of its publicly intermediated assets, and $(logR_k - R)$ is the steady-state premium. Also, the feedback parameter is positive. According to this rule, the central bank expands credit as the spread increase relative to its steady-state value.

3.4 Oil Sector

The flow of oil is primarily dependent on the oil resources, and do not change by increasing the capital and labor. So, oil production is predetermined. Also, since oil prices are set at world markets, and Iranian crude oil exports are determined by OPEC, the surplus foreign exchange earnings from crude oil exports are considered as a first-order regression process as in the Equation19.

$$or_t = \rho_{or} or_{t-1} + (1 - \rho_{or})\overline{or} + \varepsilon_{or,t} \tag{21}$$

Whereor_t, is the actual oil flow during the period t, and $\overline{or}$is the stable level of oil revenues. Oil revenues from the export of oil are constant, and all the produced oil is exported at the global oil market prices. This revenue, which is usually obtained in dollars, is converted into Rials based on the exchange rate usually announced by Iran's central bank. In this research, oil revenues are considered as Rial.

3.5 Financial Intermediaries

Financial intermediaries lend funds obtained from households to non-financial firms. In addition to acting as specialists, which assists in channeling funds from savers to investors, they hold long-run assets and funds. These assets bring short-run liabilities. Besides, financial intermediaries in this model are meant to capture the entire banking sector, i.e investment banks, and commercial banks. Let N_{jt} be the amount of wealth–or net worth, which a banker/intermediary j has at the end of period t; $B_{jt+1}$is the deposits the intermediary obtains from households, $S_{jt}$is the quantity of financial claims on nonfinancial firms that the intermediary holds, and Qt is the relative price of each claim. The intermediary balance sheet is then given to the household deposits.

$$Q_t S_{jt} = N_{jt} + B_{jt+1} \tag{22}$$

During the period t, the real interest rate of R_{t+1} is paid at time t + 1, and B_{jt+1} is the same as the debt of financial institutions and N_{jt} of the funds. Financial institutions are obtained in each period. R_{k+1} and R_{t+1} are determined internally. Over time, the banker's capital is the difference between receiving and payments of debts.

$$N_{jt} = Q_t S_{jt} + R_{t+1} B_{jt+1} \tag{23}$$

$$N_{jt} = Q_t S_{jt} + R_{t+1} B_{jt+1} \tag{24}$$

An increase in banks' capital depends on the difference $R_{kt+1} - R_{t+1}$. $\beta^{i}\,\Lambda_{t,t+1}$ is the risk factor of a banker's tangible deduction at time t as compared to t + i receipts. Since financing for financial institutions is conducted with a rate of return below the rate of return on loans to households, this relationship is always positive and larger than the unit:

$$E_t \beta^{i}\,\Lambda_{t,t+1}(R_{kt+1} - R_{t+1}) \geq 0 \tag{25}$$

With perfect capital markets, the relation always holds with equality (the risk-adjusted premium is zero). However, with imperfect capital markets, due to the limits on the intermediary to obtain funds, the premium may be positive. As long as the intermediary can earn a risk-adjusted return, which is greater than or equal to the return, the household can earn on its deposits, and it pays for the banker to keep building assets until exiting the industry. Accordingly, the banker's objective is to maximize expected terminal wealth, given by:

$$(MaxE_t \sum_{i=0}^{\infty} \theta^{i}\,\beta^{i+1}\,\Lambda_{t,t+1+i}(N_{jt+1+i}) = MaxE_t \sum_{i=0}^{\infty} \theta^{i}\,\beta^{i+1}\,\Lambda_{t,t+1+i}[(R_{kt+1+i} - R_{t+1+i})Q_{t+i}S_{jt+1} + R_{t+1}N_{jt+1} \tag{26}$$

λ is the percentage of available funds from projects, transferred by the bankers to the households. However, the banker's expenses are the same as the cost of bankruptcy for enthusiastic borrowers who are interested in borrowing funds from the banker. Equations 27–29 indicate the process:

$$V_{jt} = V_j Q_t S_{jt} + \eta_t N_{jt} \tag{27}$$

$$\upsilon_t = E_t\{(1-\theta)\beta\Lambda_{t,t+1}(R_{kt+1} - R_t) + \beta\Lambda_{t,t+1}\theta X_{t,t+1}\upsilon_{t+1}\} \quad (28)$$

$$\eta_t = E_t\{(1-\theta) + \beta\Lambda_{t,t+1}\theta z_{t,t+1}\eta_{t+1} \quad (29)$$

where $X_{t,t+i} = \frac{Q_{t+1}S_{jt+1}}{Q_t S_{jt}}$ is the growth rate of assets between t and t + 1, and $Z_{t,t+i} = \frac{N_{jt+1}}{N_{jt}}$ is the growth rate of net trust. The variable υ_t is the expected dividend yield resulting from the expansion of the assets equal to $Q_t S_{jt}$ as one unit, provided that N_{jt} and η_t are constant. With the expected value A, unit is N_{jt}, provided that S_{jt} is constant. Assuming that there is financial friction in the financial market, lending capital will expand to where $\upsilon_t = 0$. The constraint of the financial institutions will be:

$$\eta_t N_{jt} + \upsilon_t Q_t S_{jt} \geq \lambda Q_t S_{jt} \quad (30)$$

If there is a two-way relationship, the bank's assets will have a positive relationship with the size of the capital.

$$Q_t S_{jt} = \frac{\eta_t}{\lambda - \upsilon_t} N_{jt} = \phi_t N_{jt} \quad (31)$$

φ is the ratio of private assets to the capital amount. With the persistence of N_{jt} and the expansion of S_{jt}, the banker's incentive increases to expand the leverage. Otherwise, the expansion of the asset equals costs. If $N_{jt} \geq 0$ and $0 < \upsilon_t < \lambda$, the leverage ratio raises. The net worth of each banker is calculated as follows:

$$N_{jt+1} = [(R_{kt+1} - R_t)\phi_t + R_{t+1}]N_{jt} \quad (32)$$

$$Z_{t,t+i} = \frac{N_{jt+1}}{N_{jt}} = (R_{kt+1} - R_t)\phi_t + R_{t+1} \quad (33)$$

$$= \frac{Q_{t+1}S_{jt+1}}{Q_t S_{jt}} = \left(\frac{Q_{t+1}}{Q_t}\right)\left(\frac{N_{jt+1}}{N_{jt}}\right) = \left(\frac{Q_{t+1}}{Q_t}\right)Z_{t,t+1} \quad (34)$$

Therefore, the demand for total financial intermediaries can be obtained from the sum of the demands of different individuals.

$$Q_t S_t = \emptyset N_t \quad (35)$$

S_t, is the total financial asset, and N_t is the total capital amount. N_t, is equal to the net value of the old and new bankers wealth, which is given in Equation 36:

$$N_t = \frac{n_*^e}{n} N_t^e + \frac{n_*^n}{n} N_t^n \tag{36}$$

The net wealth of bankers is equal to the earnings from assets in the past period and the growth rate of net wealth which is calculated by Equation 37:

$$N_t^e = N_{t-1}^e + Z_t + e_t^n \tag{37}$$

The net wealth of new banks is the same as the initial households', which is a percentage of total assets, and is calculated by Equation 38:

$$N_t^n = \xi lev_*(Q_t + K_t) \tag{38}$$

3.6 Credit Policy

In the previous sections, we showed how the total value of private assets was obtained. To govern the credit policy of the central bank, public debt securities issued by a risk-free interest rate are issued to institutions R_{kt+1}borrowed. To finance, the central bank pays a cost of t, and since it is usually proud to have debt, there will be no conflict with financial institutions' cash outflows from households. Therefore, by assuming that the central bank can provide government debt through private assets:

$$Q_t S_{gt} = \psi Q_t S_t \tag{39}$$

Where $\psi$is the percentage of government debt which is funded by the central bank and the government bonds. $B_{gt} = \psi Q_t S_t$is the net income, due to the financial intermediation at time t with $(R_{kt+1} - R_t)B_{gt}$.Then, Equation 40 changes as follows:

$$Q_t S_t = \phi N_t + \psi Q_t S_t = Q_{ct} N_t \tag{40}$$

Where Q_t is the leverage ratio of private and public assets. So that $Q_t S_t$ = 1 $Q_{ct} = \frac{1}{1-\psi_t} Q_t$, and $Q_t$is directly related to credit policies.

4. Research Results

The Bayesian approach employed here makes use of the likelihood function combined with the prior assumptions about model parameters, which then allows us to evaluate their posterior probability. First, the approximation of posterior mode is estimated, followed by a posterior simulation applying Metropolis-Hasting Markov Chain Monte Carlo (MH-MCMC) methods, based on Schorfheide (2000). Based on the posterior draws of the model parameters, point estimates of parameter vector can be obtained from the generated values by using various location measures, e.g. the mean or median. Similarly, measures of uncertainty follow computing the percentiles of the draws. One of the main advantages of adopting a Bayesian approach is that it facilitates a formal comparison of different models. Through their posterior marginal likelihoods, they allow us to compute Bays factors and the corresponding model probabilities. First, the distribution, mean, and standard deviation of the previous one should be considered so that the parameters can be determined. The initial mean and standard deviations of the parameters can be estimated by using the Bayesian method. Each parameter is selected based on its characteristics and density characteristics. The beta density example is the density with three parameters: mean, standard deviation, an upper limit, and down limit characterized. Therefore, to estimate the parameters that fall within a certain range of numbers, this density should be used. Hence, the Bayesian method is one of the best methods for parameter estimation. Many of these parameters were not estimated for the Iranian economy. Table 1 shows the results of the estimated parameters. Priorities in this paper are listed in Table 1. These priorities are either consistent with the previous literature or relatively obscure.

Table 1: Results of the Estimated Parameters

Parameter		**Priority**	
Definition	**Symbol**	**Mean**	**Reference**
Discount Factor	B	0.9622 (0.01)	Tavakolian and Komeyjani (2013)
Habit	H	0.5 (0.01)	Author Calculations
The Inverse Elasticity of Investment to the Price	η	1.728 (0.01)	Shahmoradiet al. (2011)
The Probability to Keep Fixed Prices	γ	0.5 (0.01)	Tavakolian and Komeyjani (2013)
The Price Indexation	γp	0.715 (0.01)	Tavakolian and Komeyjani (2013)

Parameter		Priority	
Definition	**Symbol**	**Mean**	**Reference**
The Probability to Stay as a Banker in the Next Period	θ	0.972 (0.1)	Author Calculations
Inverse Frisch Elasticity of Labor Supply	σ_L	2.17 (0.01)	Tavakolian and Komeyjani (2013)
Smoothing Parameter of Taylor Rule	ρ_r	0.909 (0.01)	Author Calculations
AR Process Parameter of Technology	ρ_a	0.764 (0.01)	Author Calculations
AR Process Parameter of Capital Quality	ρ_{eps}	0.66 (0.01)	Author Calculations
Inflation in Taylor Rule	κ_π	0.097 (0.01)	Farzinvash et al. (2016)
Output Gap in Taylor Rule	κ_y	0.031 (0.01)	Farzinvash et al. (2016)
Standard Deviation of Technology Shock	σ_a	0.01	Selected
Standard Deviation of Net Worth	σ_n	0.01	Selected
Standard Deviation of Interest Rate Shock	σ_r	0.01	Selected
Standard Deviation of Price Shock	σ_p	0.01	Selected
Standard Deviation of Quality Capital Shock	σ_ε	0.01	Selected

Source: Research Findings.

The prior density of the parameters along with their estimated based on the algorithm, Metropolis-Hastings are reported in Figure 1. The adaptation of the previous and the later density of some of the parameters in this diagram show that either the previous information about these parameters is completely correct or the data cannot be estimated by this parameter.

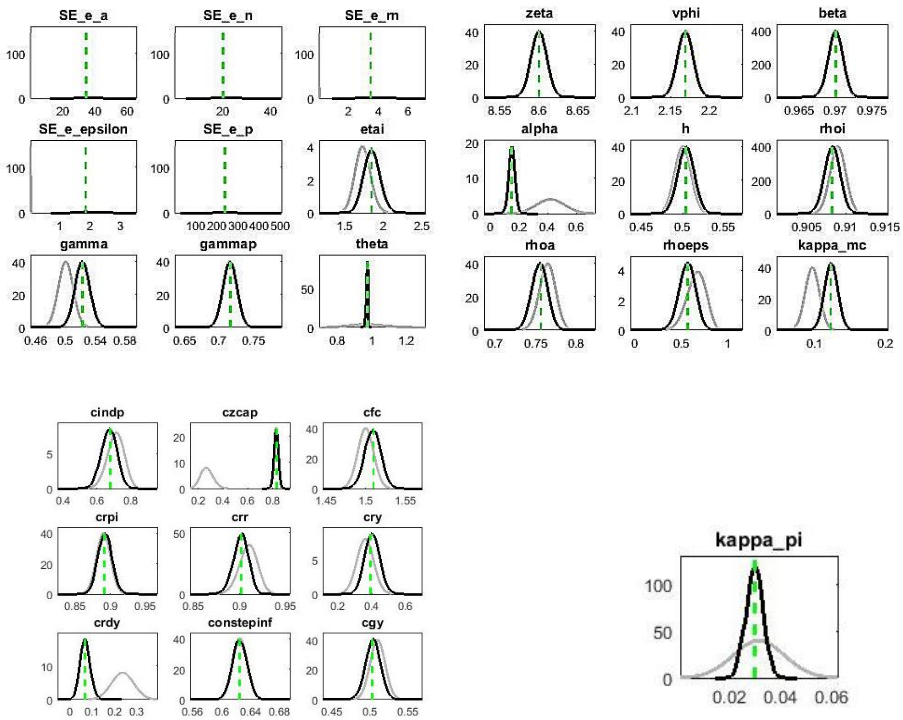

Figure 1: Prior and Posterior Estimates of Parameters

5. Impulse Response

Before simulating and analyzing the instantaneous response functions of the model, it is necessary to calculate structural parameters and stable values of the model variables. In this paper, the stable values of variables are calculated by using the seasonal data from1999 to 2017 in Iran. We analyze the dynamic responses of key macroeconomic variables to the financial shocks which are originated in the banking sector. Figures 1 and 2 show the impulse response to the interest rate and productivity shocks, respectively. Figure 3 indicates the responses to financial shocks and intermediaries, and Figure4illustrates the responses to price markup shocks. Each response is expressed as the percentage of a variable deviation from its steady-state level.

5.1 Impulse Response to Interest Rate Shock

Figure 2 shows the responses to a 1-percent positive technology shock. Following this shock investment, employment, and inflation rate decrease, the willingness to deposit raises and, consequently, the nominal deposit rate decreases. The positive shock effect of the deposit rate is fully adjusted, and variables return to their steady-state. Figure 2 also shows that an easing monetary policy shock moves the deposit and prime lending rates in opposite directions: the deposit rate decreases slightly but persistently; while the prime lending rate rises on impact, before falling below its steady-state value. The bank leverage ratio falls on impact before increasing one quarter later. The probability of defaulting on interbank borrowing increases after a positive monetary policy shock, while the supply of interbank lending decreases sharply on impact before dropping persistently below its steady-state level. It should be noted that in the graphs below, r is the interest rate, y national production-consumption, I, investment, l labor, q volume of capital, n net asset value of financial intermediaries, pi inflation rate, m money volume, rk interest rate, and erk interest rate spread.

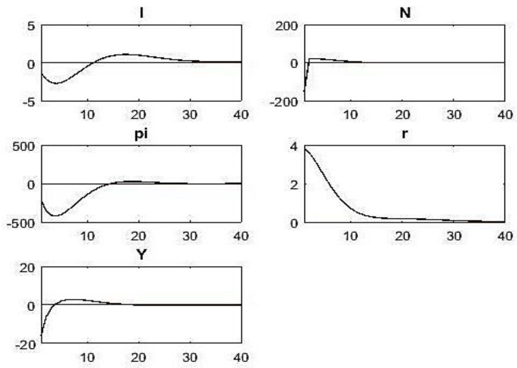

Figure 2: Impulse Response to Interest Rate

5.2 Impulse Response to Technology Shock

Figure 3 shows that, following a positive technology shock, the bank leverage ratio decreases on impact before moving persistently above its steady-state level. Also, bank capital holding increases persistently and for a longer-term. We note that, following a positive technology shock, the deposit rate declines slightly; while the prime lending rates jump on impact before declining after a quarter. This shock gradually increases output and consumption; while the net worth, the policy rate, and the inflation rate decline. Following this shock, the lending banks reduce their prime lending rate to accommodate the impact of this expansionary monetary shock. The shock also causes a substantial decline in the bank capital; because banks prefer to rely on cheaper funds from the central bank. This, in turn, reduces the marginal cost of loan-producing.

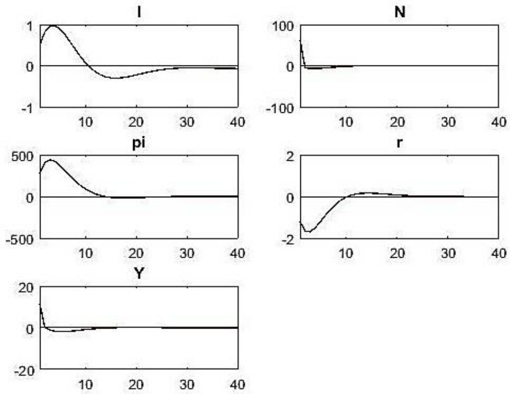

Figure 3: Impulse Response Technology Shock

5.3 Impulse Response to Net Worth

Figure 4 shows the impulse responses to a 1 percent positive financial intermediation shock. It is a positive shock to loan production, which leads to a credit supply rise without varying the inputs in the loan production function. Following this shock, loans rise on impact but fall persistently a few quarters later. On the other hand, the output, the investment, and the net worth respond positively to this shock. Nevertheless, inflation and policy rate decrease sharply. It should be noted that the external finance premium and the deposit and lending rates decline as a result of the shock. The instantaneous decline rate of prime lending is larger than that of the policy. This decrease in the spread affects the surplus loan supply generated by the positive financial intermediation shock.

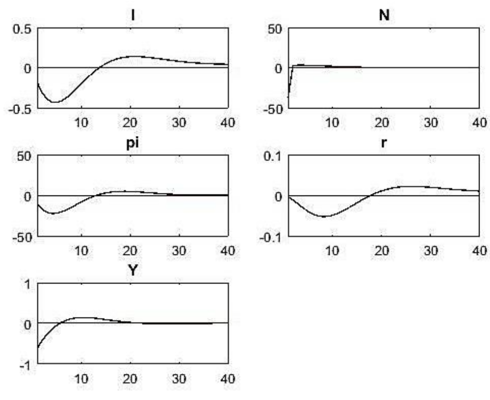

Figure 4: Impulse Response to Net Worth

5.4 Impulse Response to Price Markup Shock

The corresponding IRFs are illustrated in Figure5. The markup shock naturally induces an increase in the markup, which is associated with an inflation rise as well as a fall in real output and real wages. As expected, positive shock mark-up price has a significant negative effect on investment, consumption, and domestic cost in the short-run.

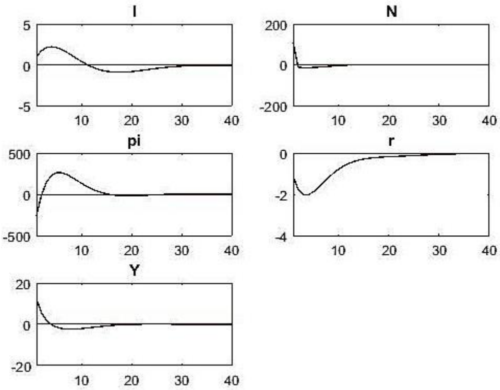

Figure 5: Impulse Response to Price Shock

6. Conclusion

After the Great Recession, the DSGE literature extensively focused on the links between financial and real sectors. Among the different contributions on DSGE models to characterize the banking sector, we followed Gertler and Karadi (2011). Such models provide a better understanding of the role of financial intermediation in the transmission and propagation of the real impacts of aggregate shocks and help evaluate the importance of financial shocks which are originated in the banking sector as a source of business cycle fluctuations. We also considered the contribution of shocks originated in the banking system as well as the importance of financial shocks to economic activity. We found that banks attenuated the effects of demand shocks (monetary policy shocks), and strengthened the effects of supply shocks (technology shocks). Moreover, banks amplify the transmission of shocks across these two issues. Shocks originating in banks are found to have a significant impact on the economic activities when considering the model with banks. Therefore, the banking channel is an important facet of the dynamics of the economy. Results show that:

1. When facing a positive shock to net worth, households consume more and withdraw deposits from banks. According to the balance sheet identity, a decline in deposits leads to a large drop in loans to entrepreneurs. With the reduced loans, entrepreneurs have to accumulate less capital, so that aggregate output falls, then consumption falls. The labor demand of households will also respond to the fall in output. The households save less because of the reduced savings. The marginal product of labor falls, and then the output declines. Inflation rises in response to the drop in output.
2. As expected, the monetary policy and macroprudential policy could sometimes conflict with each other. In particular, an interest rate shock leads to lower inflation, wage, labor, consumption, and deposit rate, suggesting a need to tighten monetary policy, but to lower bank-led deposit rate leverage, suggesting a possible need to loosen macro-prudential policy.
3. In a positive technology shock, the production is more efficient, and output rises. Thus, the goods price reduces. The technology innovation reduces marginal costs and inflation, which causes a drop in the deposit rate. Meanwhile, households and entrepreneurs increase their consumptions.
4. A positive price markup shock, because of the increasing market power, production, and net worth, decreases, and banks decrease the deposit rate, which leads to a decrease in deposits. Besides, households increase consumption and decrease savings. A fall at deposit leads to a further decrease in credit. As a result, investment and output decrease, production cost increases, and the inflation rate decreases.

Future work will consist of estimating the model’s structural parameters, incorporating credit to households, extending the framework to an open economy model, and capital requirement regulations.

References

Bernanke, B. (1983). Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression. *American Economic Review, 73*(1), 257-276.

Bernanke, B., & Mark, G. (1989). Agency Costs, Net Worth and Business Fluctuations. *American Economic Review*, *79*(1), 14-31.

Bernanke, B., Gertler, M., & Gilchrist, S. (1999). The Financial Accelerator in a Quantitative Business Cycle Framework. In J. B.Taylor and M. Woodford (Eds.), *Handbook of Macroeconomics*. Amsterdam: North-Holland.

Carlstrom, Ch. T., Timothy, S. F., & Paustian, M. (2016). Optimal Contracts, Aggregate Risk, and the Financial Accelerator. *American Economic Journal: Macroeconomics*, *8*(1), 119-147.

Christiano, L., Eichenbaum, M., & Evans, C. (2005). Nominal Rigidities and the Dynamics Effects of a Shock to Monetary Policy. *Journal of Political Economy*, *1*(113), 1-45.

Christiano, L. J., Trabandt, M., & Walenti, K. (2011). Introducing Financial Frictions and Unemployment in to a Small Open Economy Model. *Journal of Economic Dynamics and Control*, *35*(12), 1999-2041.

Damjanovic, T., Damjanovic, V., & Nolan, Ch. (2017). Default, Bailouts and the Vertical Structure of Financial Intermediaries. *Working Paper,* Retrieved from http://oxfordre.com/economics/abstract/10.1093/acrefore/9780190625979.

DeJong, D. N., & Dave, C. (2007). Structural Macro Econometrics. *Princeton University Press*, Retrieved from, https://press.princeton.edu/titles/9622.html.

Duncan, A., & Nolan, Ch. (2017a). Disputes, Debt and Equity. University of Glasgow Economics *Discussion Paper*, Retrieved from https://www.kent.ac.uk/economics/documents/research/papers/2017/1719.pdf.

---------- (2017b). Financial Macroeconomics with Complete Business Cycle Risk Markets. *Working Paper*, Retrieved from https://www.kent.ac.uk/economics/documents/research/papers/2017/1719.pdf.

Giri, F. (2018). Does Interbank Market Matter for Business Cycle Fluctuation? An Estimated DSGE Model with Financial Frictions for the Euro Area. *Economic Modeling*, *1*(75), 10-22.

Gertler, M., & Kiyotaki, N. (2015). Banking, Liquidity, and Bank Run in an Infinite Horizon Economy. *American Economic Review, 105*(7), 2011–2043.

---------- (2009). Financial Intermediation and Credit Policy in Business Cycle Analysis. *Handbook of Monetary Economics*, *3*(53), 547-599.

Gertler, M., Kiyotaki, N., & Prestipino, A. (2016). Wholesale Banking and Bank Runs in Macroeconomic Modeling of Financial Crises. In J. B. Taylor and H. Uhlig (Eds.), *Handbook of Macroeconomics* **(**2). North-Holland: Elsevier.

Hafstead, M., & Smith, J. (2012). Financial Shocks, Bank Intermediation, and Monetary Policy in a DSGE Model. *Stanford University*, *Working Paper,* Retrieved from https://pdfs.semanticscholar.org/7e70/af7c9abce56cf0a4f7cac2ea81bd62af00f7*pdf***.**

Iacoviello, M. (2005). House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle**.** *American Economic Review, 95*(1), 739-764.

Iacoviello, M., & Neri, S. (2010). Housing Market Spillovers: Evidence from an Estimated DSGE Model. *American Economic Journal: Macroeconomics*, *2*(2), 125-64.

Kiyotaki, N., & Moor, J. (1997). Credit Cycles. *Journal of Political Economy*, *105*(2), 211-248.

Merola, R. (2014). The Role of Financial Friction during the Crisis: an Estimated DSGE Model. *Dynare Working Paper Series*, Retrieved from www.dynare.org/wp-repo/dynarewp033.pdf.

Palic, I. (2018). The Empirical Evaluation of Monetary Policy Shock in Dynamic Stochastic General Equilibrium Model with Financial Frictions: Case of Croatia. *International of Engineering Business Management*, *10*(1), 1-11.

Stephen P. M., Varadi, A., & Yashiv, E. (2017). The Interaction of Financial Frictions and Labor Market Frictions in a DSGE Model. *Working Paper*, Retrieved from www.patrickminford.net/emf/emf_2017/Frictions%20Working%20Paper.pdf.

Smets, F., & Wouters, R. (2007). Shocks and frictions in U.S. Business Cycles: A Bayesian DSGE Approach. *American Economic Review*, *97*(3), 586-606.

Appendix:

The Results of MCMC Test