Journal of Money and Economy
Vol. 11, No. 3, Summer 2016
pp. 283-303

Implementation of Value-Added Tax on Iran Banking Services: An Application of DSGE Model

Ahmad Gholami* **Hossein Abasinejad†**

Received: 9 Aug 2017 Approved: 04 Sep 2018

In the Value-Added Tax (VAT) system some goods and services, such as banking services, are exempted from taxes. Based on theoretical foundations, exempt treatment leads to several distortions and inefficiencies in the economy. In order to understand the importance of exemption as well as the fundamental role of financial intermediaries on macroeconomic fluctuations and economic shocks, a Dynamic Stochastic General Equilibrium (DSGE) model is designed. This model provides an empirical analysis for policy simulations with consideration of VAT impacts on financial services under different scenarios. Accordingly, the values of model parameters are estimated via calibration method. Also the model accuracy is evaluated by Brooks & Gelman test and impulse-response functions. Simulation results of the policy exercise suggest that shifting from exemption to full taxation, reduces the costs for banks, and increases banks' free resources leading to higher investment and output through more bank loans.

Keywords: VAT, Banking Services, Exempt Treatment, Dynamic Stochastic General Equilibrium
JEL Classification*:* H20, H25, H30, E52, E58

1 Introduction

Value-added Tax is one of the attractive ways for governments to raise their revenues. This tax is levied on all sales, including wholesale and retails, and at the same time it allows firms to charge VAT on inputs. In practice, most goods and services are not subject to the standard rates of value added tax, and some of them are exempted from paying VAT. Banking services is one example that has been exempted from paying VAT in Iran. Under this treatment, banks pay non-recoverable VAT on their inputs but do not charge VAT on their outputs.

This treatment increases banks costs and reduces their resources to create more loans. In Iran, despite the development of financial markets and various formal and informal institutions, the banking system continues to play a major

* Facualty of Economics, University of Tehran, Iran; ahmad.gholami39@gmail.com (Corresponding Author)
† Facualty of Economics, University of Tehran, Iran; habasi@ut.ac.ir

role in financing and depositors mainly rely on bank deposits and money market instruments, such as bonds. Hence, public and private investment decisions and household consumption behaviors are closely related to operation of banking system. This study investigates the fluctuations of business cycles in Iran as well as the impact of shocks generated by value added tax on macroeconomic variables, by using a Stochastic Dynamic General Equilibrium (DSGE) Model with the banking sector added to it and consideration of VAT on banking services. Finally, as a policy exercise, simulations are carried out moving from exemption to full taxation.

In the following section, a literature review on taxing financial institutions under VAT is explained. Section 3 presents model based on the macroeconomic structure of Iran and focuses on the banking sector. Section 4 estimates model parameters**.** The simulation results of the monetary shocks, as well as the effects of the value added tax shock, are presented in two scenarios of no tax coverage and the full coverage in Section 5, and finally, Section 6 concludes.

2 Theoretical Literature And Research Background

2.1 Theoretical Literature

Value-added tax is a kind of tax on sales of goods and services, which is applied during the stages of import, production, distribution and consumption at a constant tax rate (non-progressive) and ultimately, final consumers pay it. Banking services are exempt from VAT in most countries of the world for technical reasons. The value added that not subject to tax is the difference between the interest rate on loan and the interest rate paid to depositors. Note that, although banks purchases from other firms for the provision of services are included VAT, they cannot claim it from their customers. Since interest rates in Iran are arbitrarily determined and are exogenous, banks cannot transfer their taxes to their customers through higher interest rates on loans. Therefore, bank costs have increased and its liquidity has decreased so the bank ability to pay loan is limited. In the period of recession, firms' accessibility to domestic resources reduces and they forced to finance from outside which increases their cost and leads to worse conditions. According to Bernanke and Gertler (1995), economic shocks spread through the effects of borrowers' liquidity flows. A liquidity shock reduces the ability of firms to finance investment projects and increases cost of external financing especially for new investments. After investment decrement in economic activity and also decrement in cash flow in subsequent projects, the effects of the initial

shock are repeated and distributed in economy. In order to understand the importance of the relationship between business cycle in Iran and banks facilities, their correlation has been reviewed during 1986-2015. For this purpose, the effects of prices on the variables have been adjusted using the GDP moderator index. Then, using the Hodrick-Prescot filter, the logarithm of the variables are detrended and their cyclical components are obtained.

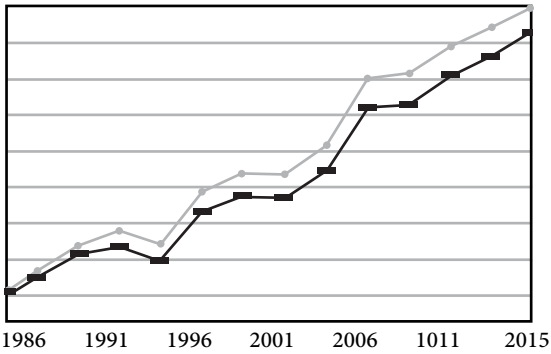

Figure 1. Cyclical part of GDP and bank real loans. *Source*: Authors' Findings.

In figure 1, the black line represents the cycles of loans and the gray line is cycles of output. As it is shown, bank facilities in most economic periods have the same behavior with business cycles.

2.2 Research Background

In the following, some previous studies that were concentrated on DSGE model in banking sector and considered the effects of VAT exempt treatment on the bank behavior are investigated.

In the study of Bahrami and Qureshi (2011), a dynamic stochastic equilibrium model has been designed to explain monetary policy in Iran's economy in which monetary policymaker is able to decide on one of the two objectives of controlling the inflation rate or controlling the exchange rate. The Central Bank tools for achieving these two goals are controlling the credits and intervening in the foreign exchange market. The results of the model, after calibration of the parameters, indicate that in case of oil revenue shocks, the inflation targeting scenario tends to fluctuate less in consumption, non-oil production, employment, inflation rate and stock of money. Also, in the event of a technological shock, fluctuations in consumption, employment, and money stock are not significantly different in both scenarios, but the

inflation targeting scenario creates less fluctuations in non-oil production and inflation rate.

Pioneer models in introducing banking sector in DSGE models are presented by Cristiano and et al (2007), Goodfriend and McCallum (2007) and Gertler and Kiyotaki (2009). Christiano, Motto and Rostagno (2007), using the error prediction criterion, assessed their model in two economies of the United States and European region and obtained different results for different macroeconomic variables. The most important result of the model is that the financial friction shock is one of the main drivers in the business cycle of the model.

Goodfrinds and McCallum (2007) model, based on Gertler (2009) and Bernanke's methodology, have modeled a competitive banking sector that supply diverse assets with different returns. The major activity of banks is creating loans, bank deposits and risk-free bonds. Creating loans in this model depends on the amount of bail and the cost of monitoring the loans. In this model, there are two types of financial shocks that are the main drivers of macroeconomic variables. One causes the capital to be more effective in making the facility and the other increases the efficiency of the facility. The results of Goodfriend and McCullum (2007) show that by using money and banking in the model, in a steady state, general variables and interest rates are matched with data of United States. This model has been successful, especially in the steady state, in adapting business hours, capital ratio, inter-bank rate and external collateralized financing costs.

Fakhr Hosseini et al. (2012) using new Keynesian dynamic stochastic general equilibrium model have studied the various impulse-responses of technology, money, oil and government expenditures. The results indicate that the impulse-response functions of inflation and non-oil production increases against all impacts but technological impact.

In the study of Shahmoradi and Sarem (2013), using dynamic stochastic general equilibrium model, the optimal monetary rule for the Central Bank is derived by considering four equations of total demand, total supply, oil price, and Taylor's relation on the monetary transmission mechanism. Their results indicate that the growth rate of money does not affect the production gap and is completely reflected in inflationary expectations.

Yilmaz (2013), using the general equilibrium approach, briefly examines the effects of tax exemption on the banking sector. The results show that the price of financial intermediation is higher under exempt treatment relative to both alternative cases (e.g. full taxation or partial recovery). This forces some

firms out of the market and shrinks the aggregate demand for the products of the remaining firms, which lowers overall welfare and tax revenues.

Buettner & Erbe (2014), using a general equilibrium approach, have examined the effects of tax exemption on consumer demand and demand for intermediary inputs for financial services, and estimated tax revenue and deadweight loss for Germany. Their results show that by moving to full taxation of financial services, the tax revenue will increase by 1.7 billion euros and GDP increases (as a benchmark of welfare) by one billion euros.

3 Designing DSGE Model

This section briefly introduces the model. The structure of the model is developed using Christiano & Motto (2010), Gerali et al. (2010), Yilmaz (2013), and has been expanded with regard to the banking sector and the imposition of value added tax on their services. The model includes the household sector, the final goods producing firms, the intermediate goods sector, banks, the government, the oil-production sector and the monetary authority. What distinguishes this study from other studies, is the introduction of value added tax on the bank profit function which has implicit and explicit effects on macroeconomic variables.

3.1 Households

A representative consumer maximizes discounted expected lifetime utility

$$E\sum_{t=0}^{\infty}\beta_P^t\varepsilon_t^z[\log(c_t(i)-a^p\,c_{t-1})-\frac{l_t(i)^{1+\emptyset}}{1+\emptyset}-\frac{\varepsilon_t^m}{1-\sigma_m}(\frac{M_t^i}{P_t})^{1-\sigma_m}] \quad (1)$$

The utility of households depends on consumption, consumption of the past period and hours of work. The parameter a^p shows consumption habits of the household. $\emptyset$ denotes inverse of the labor relative to the actual wage and σ_m denotes inverse of the real balance of the money relative to the interest rate, ε_t^z denotes the shock of intertemporal preferences and is assumed to be distributed normally and has a first order autoregressive process and the autoregressive coefficient and its standard deviation are respectively ρ_z and σ_z.

Also ε_t^mdenotes money demand shock preferences and is assumed to be distributed normally and has a first order autoregressive process and the autoregressive coefficient and its standard deviation are respectively ρ_m and σ_m.

The household budget constraint is as follows:

$$c_t + d_t(i) \leq W_t l_t(i) + \frac{(1+r_{t-1}^d)}{\pi_t} d_{t-1}(i) + T_t \quad (2)$$

That d_t is household current deposit and $\frac{(1+r_{t-1}^d)}{\pi_t}$ is interest earning of past deposit and π_t represents the inflation rate and is defined as $\frac{P_t}{P_{t-1}}$ and T_t represents household earnings which includes the distributed benefit of the firms and the bank.

Also, the investment is added to the initial capital stock of $k_{t-1}$and will be created the capital stock at the beginning of the next period (the end of the current period). As Burriel et al. (2010), in terms of the cost of investment adjustment, the process of capital accumulation is determined by relation (4).

$$\mathrm{k_t} = (1-\delta_\mathrm{k})\mathrm{k_{t-1}} + \left(1 - \mathrm{S}\left(\frac{\mathrm{i_t}}{\mathrm{i_{t-1}}}\right)\right)\mathrm{i_t} \quad (3)$$

3.2 Final Goods Producers

There is a representative firm that purchases the differentiated goods supplied by the intermediary firms and by combining them produce the final goods and sell for final consumption. Final output y_t is produced using the technology by a perfectly competitive firm:

$$\mathrm{y_t} = \left[\int_0^1 (\mathrm{y_t(i)})^{\frac{\theta-1}{\theta}} \mathrm{di}\right]^{\frac{\theta}{\theta-1}} \quad (4)$$

The final goods producer, which operates in competitive conditions, tries to determine the price of differentiated intermediary goods in a manner that maximizes its profit:

$$\underset{\mathrm{y_t(i)}}{\mathrm{Max.}}: \quad \mathrm{P_t y_t} - \int_0^1 \mathrm{P_t(i) y_t(i) di} \quad (5)$$

By imposing a competitive condition and a zero profit, the demand for each intermediate good as well as the price of the final product is determined in (6) and (7).

$$y_t(i) = \left(\frac{p_t(i)}{p_t}\right)^{-\theta} y_t \tag{6}$$

$$y_t(i) = \left(\int_0^1 (\mathrm{P_t(i)})^{1-\theta} \mathrm{di}\right)^{\frac{1}{1-\theta}} \tag{7}$$

3.3 Intermediate Goods Sector

These firms with combination of labor and capital produce intermediate goods via following technology

$$y_t^E(\mathrm{i}) = a_t^E k_{t-1}^E(i)^{\alpha} l_t^E(i)^{1-\alpha} \tag{8}$$

That a_t^E shows productivity of factors of production and has a first order autoregressive process that the autoregressive coefficient and its standard deviation are respectively ρ_a and σ_a.

$$a_t^E = \rho_a a_{t-1}^E + (1-\rho_a)\overline{a^E} + \varepsilon_{a^E,t} \quad , \rho_a \epsilon (0,1) \tag{9}$$

And loan demand function is

$$lo_{it}^d = \partial\left(P_{it} r_t^k {K_{it}}^E + P_{it} W_t {L_{it}}^E\right) \tag{10}$$

At the beginning of the period each firm receives $\mathrm{lo_{it}^d}$ from the bank and finance ∂ percent of cost of capital and labor and at the end of the period, it will repay the loan with rate of r_t^l. As Rotenberg (1982) assumes that each intermediary firm has the following adjustment cost:

$$PAC_t^i = \frac{\varphi_f}{2}\left(\frac{P_{it}}{(\bar{\pi})P_{it-1}} - 1\right)^2 Y_t \tag{11}$$

Which $\varphi_f > 0$ is cost adjustment parameter, $\bar{\pi}$ is inflation rate in steady state and Y_t is total production.

In the next step, the monopolistically competitive firm, with regard to market demand, chooses the price of its product in such a way as to maximize its profit

$$\pi_{it}^f = P_{it} Y_{it} - P_t mc_t Y_{it} - PAC_t^i \tag{12}$$

In this study, we use the Calvo method (1983) to adjust prices. Thus, it is assumed that γ percent of firms in each period are not able to adjust the new price and thus keep their prices constant during the period and others can determine the optimal price of their product according to their demands. Therefore, the price index P_t can be written as:

$$P_t = \left[(1-\gamma)(p_t^*)^{1-\theta} + \gamma(P_{t-1})^{1-\theta}\right]^{\frac{1}{1-\theta}} \quad (13)$$

3.4 Banks

Banks have a fundamental role in the model because they intermediate in all financial transactions. Household savings is the only bank deposit which passed through to intermediary firms as loans.

The main point to introduce banks in the model is the monopolistic competitive environment in which banks operate. Banks enjoy market power in their intermediary activities and this power allows them to adjust the interest rates on loans and deposits and during economic shocks[1]. These conditions give us the opportunity to examine how different rates of interest transfer various shocks (especially monetary shock).

The second key point in the study is tracking records of banks from their balance sheets. In other words, banks can finance their loans either through deposits or through their own funds.

$$lo_t = (1 - \mathrm{rr_t})\mathrm{d_t} + \mathrm{k_t^B} + \mathrm{d_t^c} \quad (14)$$

Like Gerali et al. (2010), we assume that the capital of banks is derived from the accumulation of profit and the capital of the previous period as bellow:

$$k_t^B = (1-\delta_{kB})k_{t-1}^B + \pi_t^B \quad (15)$$

There is an optimal capital-to-asset ratio for banks which is considered as a leverage. So the capital of banks has a key role in determining the supply of credit. When banks' profits decline, this prevents the increasing of new capital and reduces the amount of bank loans. One thing that creates this situation is an increase in value added tax.

In exemption condition, bank pays VAT on its inputs but cannot charge its customers for it, so the bank's cost will increase. Since interest rate is an exogenous variable in Iran and bank does not have a role in determining it, bank cannot transfer its cost through charging higher interest rates on borrowers. Therefore, It can only increase the loan's interest rate up to the limit set by the Central Bank.

[1] As the interest rate in Iran is determined exogenously by the Central Bank and the money and credit council, banks will make adjustments at rates below the specified rate

Increasing the interest rate leads to a reduction of market power and competitiveness of the bank. As a result, increasing tax decreases bank's resources so bank reduces the amount of bank facilities.

Through process of propagation, reducing the amount of credit creates range of changes that affect the economy. This paper investigates the effects of these disorders.

According to Cristiano et al. (2010) and Lucas (1990), assumed that banks give liquidity services using labor, capital and free stocks with the following technology:

$$\frac{lo_t}{P_t} = a_t((K_t^B)^{\alpha}(l_t^B)^{1-\alpha}))^{£_t}(\frac{E_t^r}{P_t})^{1-£_t} \quad (16)$$

That lo_t is bank loan, a_t is technology shock, $£_t$ demand shock to bank's free resources.

Banks use a series of inputs to provide their services, which are supplied by sources inside and outside the bank. For example; legal contracts, collection services for liquidity management, various types of IT services such as computer systems, software packages, and online payment systems are examples of services that banks provide from outside. These lead to the imposition of an additional cost (other than actual costs of the inputs) for the bank. Such treatment, in principle, creates an incentive to produce these services in-house, resulting in a "self-supply bias" (e.g. see McKenzie and Firth (2011)).

Supposed bank have a proportion of resources (θ) and provide the rest from outside of the bank. The representative bank receives the deposit D_t from the households. The rate of return that the bank pays to depositors is r_t^d and r_t^l is the loan rate that receives from firms.

Banks face default rates δ_t for repayment of loans, so the bank receipts in each period is $(1-\delta_t)\left(1+r_t^l\right)lo_t$. It is also assumed that in the event of a shortage of resources, the bank borrow from the Central Bank D_t^c and the Central Bank consider the penalty rate r_t^c to avoid unnecessary borrowing. Banks always need to maintain a percentage of deposits as required reserves, so the surplus reserves used as inputs are as follows.

$$E_t^r = M_t^b - rr\ D_t \quad (17)$$

In the case of the implementation of the value added tax, the tax is levied on the difference between the interest rate received from the borrowers and

the rate of interest paid to depositors $\left(r_t^l - r_t^d\right)$. Therefore, the bank's profit function is expressed as follow:

$$\pi_t^b = (1-\delta)\left(1+r_t^l\right)lo_t - \left(1+r_t^d\right)\mathrm{D}_t + \left(1+R_t^b\right)B_t + M_t^b - B_{t+1} - (1+\mathrm{r_t^c})\mathrm{D_t^c} - \frac{\kappa_{kB}}{2}\left(\frac{\mathrm{k_t^B}}{\mathrm{l_t}} - v^B\right)^2 \mathrm{k_t^B} - \left(1+r_t^d\right)\left[P_t r_t^k K_t^b + W_t l_t^b\right] - \tau(1-\rho_b)(1-\theta)[P_t r_t^k K_t^b + W_t l_t^b] - \tau\rho_b(1-\delta)\left(r_t^l - r_t^d\right)lo_t \quad (18)$$

That v^B is optimal ratio of capital to the bank's asset or the minimum ratio of capital adequacy. Banks are required to maintain the minimum capital adequacy ratios declared by the Central Bank and, if they are breached, incur an adjustment cost κ_{kB}. Tax coverage rate is displayed with ρ_b and its value is between 0 and 1. That $\rho_b = 0$ represents the tax exemption and $\rho_b = 1$ express the full tax coverage. According to profit function, when the bank services are exempt from VAT,$\rho_b = 0$, banks pay tax as $\tau(1-\theta)\left[P_t r_t^k K_t^b + W_t l_t^b\right]$ for the purchase of inputs so their profits are reduced by the amount of this tax, and, on the other hand, when full tax coverage applied, $\rho_b = 1$, they do not pay this tax but in contrast pay $\tau.\rho_b(1-\delta)\left(r_t^l - r_t^d\right)lo_t$ .Given the rate of return and the price of the factors of production, bank maximizes its profit according to relations (14), (15), (16) and (17).

3.5 Government and Oil Sector

Since oil production is primarily dependent on the country's oil reserves and cannot be changed by increasing the capital and labor, so it is externally determined. Oil prices are set at world markets and exchange earnings from export of oil is calculated from expression (18) as a first-order regression process.

$$or_t = \rho_{or}.or_{t-1} + (1-\rho_{or})\overline{or} + u_t^{or} \qquad , u_t^{or} \sim N(0, \sigma_{or}^2) \quad (18)$$

That $\mathrm{or_t}$ is the product of the world oil price times the amount of oil exports. Part of the oil revenues (χ) is allocated to the government, and the rest (1-χ) is the share of the Oil Company and national development fund. The government finances its expenses ($\mathrm{G_t}$) through taxes ($\mathrm{Ta_t}$), bonds ($\mathrm{B_t}$), oil revenue ($\mathrm{or_t}$)and other revenues. Government budget constraint is set to the real prices as follow:

$$G_t + \left(1 + R^b_{t-1}\right)\frac{B_{t-1}}{\pi_t} = or_t + B_t + Ta_t + other_t \quad (19)$$

And tax revenue is sum of the consumption tax, tax on return on capital and value added tax which is stated as follow:

$$Ta_t = t_w w_t l_t + t_k P_t K_t + vat \quad (20)$$

That VAT is:

$$vat = \tau(1-\delta)P_t y_t + \rho^b_t \tau(1-\delta)\left(r^l_t - r^d_t\right)lo_t + \in_{vat,t} \quad , \in_{vat,t} \sim N(\cdot, \sigma^2_T) \quad (21)$$

And ρ^b_t represents value added tax coverage on the activity of banks and takes a value between zero and one. The zero value represents tax exemption and one is full coverage. ε^z_t represents shock of the value added tax and assumed to be distributed normally and has an autoregressive first order process that the self-explanatory factor and its standard deviation are respectively ρ_T and σ_T.

3.6 The Central Bank

The Central Bank is the monetary authority of the country and is one of the major economic policymakers. In the country, the bank's interest rate is controlled by the Central Bank and the Money and Credit Council. The gross growth rate of money in the period t is defined as follows:

$$\mu_t = \frac{M_t}{M_{t-1}}$$

In addition to the changes caused by the autonomous decisions of the monetary authority on the growth rate of money, shocks to oil revenues also affect the growth rate of money.

$$\mu_t = \omega_\mu \mu_{t-1} + \left(1 - \omega_\mu\right)\bar{\mu} + \omega_{or}\varepsilon_{or} + \varepsilon_\omega \quad (22)$$

That ε_ω, is money supply shock and has a normal distribution with zero mean and standard deviation; σ_ω. When ω_{or} is zero, monetary policy is completely exogenous and only applied on the basis of the Central Bank decisions and is independent of the fluctuations in oil revenues.

3.7 Market Clearing

Market clearing implies that sum of non-oil production and the value added from the sale of oil and tax revenue is equal to sum of consumption, investment and government expenditures.

$$Y_t + e_t.or_t + Ta_t = C_t + I_t + G_t \quad (23)$$

4 Estimating Model Parameters

The model described in this paper, with the first-order conditions of households, firms, banks, as well as the behavioral functions of the government, the Central Bank and the oil sector, and also the market conditions and various market shocks, consists of 26 equations and 26 variables that are unknown. First, the extracted equations from first-order optimization conditions are linearized using the Uhlig (1999) method.

DSGE-based studies typically use calibration method in which the estimated parameters of the previous studies are placed in the model and the model is simulated and solved. Since the structure of the models are different, and some parameters are not estimated for Iran's economy, it is better to estimate some of the parameters for the model. The Bayesian method is used to estimate the parameters. Data used for estimation are for the period of 1986 to 2015.

In order to determine the model parameters, first the prior mean distribution and standard deviation for each of the parameters are specified. Parameters are calibrated in a way that reflects the characteristics of Iran's economy during the mentioned period. For this purpose, some of the parameters have been initialized base on previous studies, while others are estimated using the econometric method. Some parameters, such as the percentage of inputs that the bank purchases from external sources (θ), and the tax coverage rate are selected according to different scenarios. In table (1) the results of the posteriors estimations of the indexes and the standard deviation of them are depicted.

Table 1
Calibrated Parameters

Parameter	Description	Value
$\boldsymbol{\beta}$	Discount rate	0.9754
$\boldsymbol{a^p}$	Habit persistence parameter	0.025
$\emptyset$	Inverse elasticity of labor supply	2.94
$\boldsymbol{\alpha}$	Power on capital in production function	0.46
$\pounds_t$	Power on Excess Reserves in Deposit Services Technology	0.92

Source: Authors' Findings.

To verify accuracy of the Bayesian method, two single-variable and multivariate diagnostic tests of Brooks & Gelman (1998) are used. On the basis of the single-variable test, in-sample and inter-sample variance of all the parameters converge to each other and eventually converge to a constant value and since the multivariate analysis of the in-sample and inter-sample variance also converge to a constant value, it can be concluded that the results from the estimation of the Bayesian method are acceptable. Also, method of matching the calculated faces for each parameter is consistent with the maximum logarithm of the posterior density and indicates the accuracy of the estimates.

Using the estimated parameters in the previous section the model is simulated and solved and further the effects of different shocks and their results are discussed.

We estimate the parameters that affect the dynamics of the model and calibrate those determining the steady state in order to obtain reasonable values for some key steady-state values and ratios. Table 1 reports the values of the calibrated parameters.

Table 2 reports the posterior mean and 95% confidence intervals for the structural parameters, together with the mean and standard deviation of the prior distributions. Draws from the posterior distribution of the parameters are obtained using the random walk version of the Metropolis algorithm. We run 10 parallel chains, each has length of 100,000. The scale factor was set in order to deliver acceptance rates between 10 and 20 percent. Convergence was assessed by means of the multivariate convergence statistics taken from Brooks and Gelman (1998).

Table 2
Prior and Posterior Distribution of the Structural Parameters

Prior Distribution				Posterior Distribution		
Parameter	Distr.	Mean	St.Dev	St.Dev	2.5 Percent	97.5 Percent
γ	Beta	0.511	0.03	0.023	0.481	0.522
δ_{kB}	gamma	0.183	0.052	0.043	0.162	0.191
si	gamma	6.3	0.026	0.24	5.6	6.6
σ_m	gamma	0.05	0.048	0.049	0.042	0.055
ρ_z	Beta	0.66	0.032	0.042	0.56	0.71
ρ_a	Beta	0.764	0.05	0.1	0.663	0.782
ρ_T	Beta	0.82	0.043	0.058	0.76	0.93
ρ_m	gamma	0.79	0.01	0.021	0.66	0.94
ρ_r	gamma	0.81	0.012	0.018	0.64	0.97
ρ_{inf}	gamma	0.89	5	6.2	0.69	1.1
ρ_y	gamma	0.36	0.18	0.12	0.23	0.44
ρ_{or}	Beta	0.249	0.06	0.093	0.203	0.303
$\rho_{\text{£}}$	Beta	0.571	1.2	1.9	0.467	0.608
φ_f	Beta	4.37	0.14	0.21	3.88	5.12

Source: Authors' Findings.

5 Simulation Results of the Model

Using the results obtained from simulation of the model, the effects of different shocks on macroeconomic variables are investigated. In this Section the dynamics of the linearized model using impulse responses investigated.

5.1 Technology Shock

Productivity improvement of firms, leads to an increase in investment and demand for bank loans by firms, resulting in an increase in the production of firms. Productivity improvement of banks leads to increase in supply of banking facilities, increased in production's factors earnings, such as wages and capital returns, and since households are the main sources of production, their consumption and deposits in banks will increase.

The dotted line shows the baseline model, that is VAT exemption, and the VAT rate is τ*=10%*. The long solid line corresponds to the relative coverage of the tax $\rho_b = 50\%$ and the continuous line shows the full tax coverage status of $\rho_b = 100\%$ .As shown in the diagrams below, technology shock leads to an increase in production, investment, consumption and supply of loans, and as the tax coverage increases, this effect intensifies. As shown in the diagrams below, moving from the exemption to full taxation the result of improved technology is more efficient.

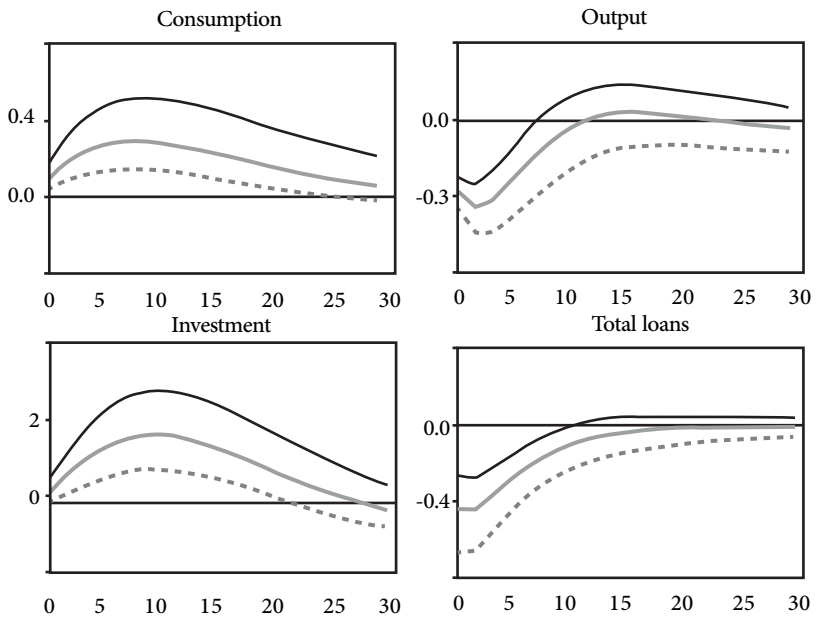

Figure 2. Impulse response functions of technology shock. *Source*: Authors' Findings.

5.2 Monetary Policy Shock

The contraction of monetary policy leads to a decrease in production levels and total demand in the economy. The capital stock and investment in the economy shrink due to the increase in interest rates. With declining consumption levels due to negative shocks, demand for bank deposits decreases, which limits banks in loan supplying. On the other hand, with higher external financing costs due to the increase in interest rates on bank facilities, the demand for loans by firms also decreases.

In Figure 3, the continuous line is the benchmark model (exemption). The dotted line, is relative tax coverage and the dash line is the full coverage of the value added tax.

As shown in full tax coverage condition, the effect of monetary shocks is small because in this case, banks having more free resources than exemption case, can compete with other banks through decreasing the interest rates on loans which will partly offset the effect of the initial increasing in interest rates (created by contractionary monetary policy).

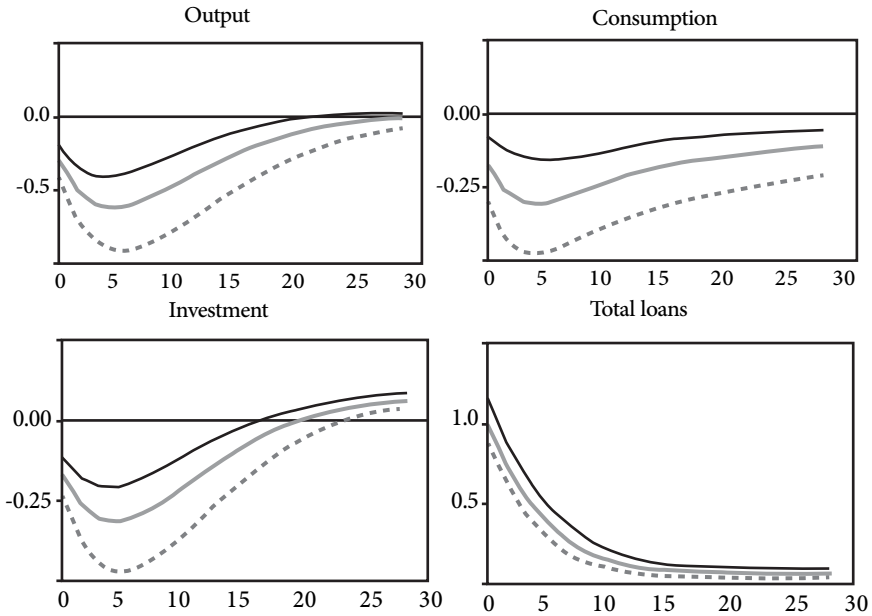

Figure 3. Impulse response functions of monetary policy shock. *Source*: Authors' Findings.

5.3 Impulse Response Functions to Increase in the VAT Rate

In this section, increasing of value added tax rate from 10% to 15% and then to 20% is examined. To this end, two different scenarios are considered. In the first scenario, tax coverage is zero ($\rho_b = 0$) so the bank cannot claim the tax that it pays to buy its inputs. (Figure 4) In the second scenario, (Figure 5) the coverage of the VAT is equal to one ($\rho_b = 100$).

In other words, in the first scenario banking services are exempt from VAT but in the second scenario bank facilities are fully subjected to VAT. In this case, the banks receive input credits for VAT paid on their inputs. In figure 4, blue line shows the tax exemption and the VAT rate is 10%. For green and red dotted lines, VAT rates are 15% and 20% respectively.

As shown in figure 4, under exemption, increasing in value added tax rate has led to a reduction in bank reserves and, consequent reduction in concessional loans and investment and, as a result, output decreases.

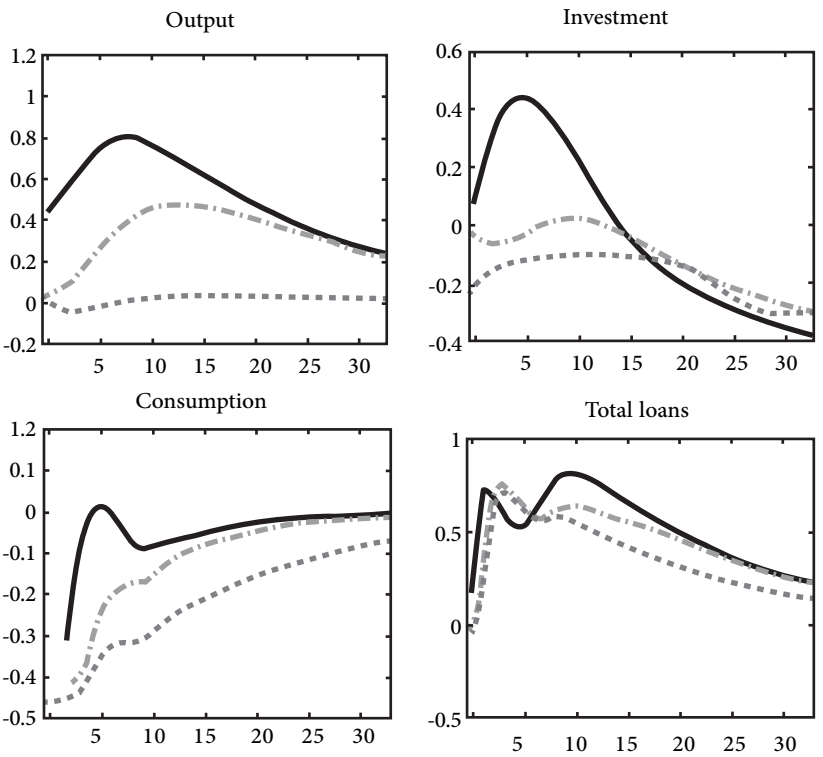

Figure 4. Increase in VAT rate in exemption conditions. *Source*: Authors' Findings.

In the second scenario (full taxation), banks receive input credits for VAT paid on their inputs. Bank's cost has dropped and it can lower the prices of services (for example, the decline interest on loans), therefore, demand for bank loans increases and on the other hand, bank is able to offer more loans as a result of having more resources. So supply of loans increases which increases investment and ultimately total production and consumption will increase. In figure 5, tax rate in blue line is 10%, green line is 15% and red line is 20%.

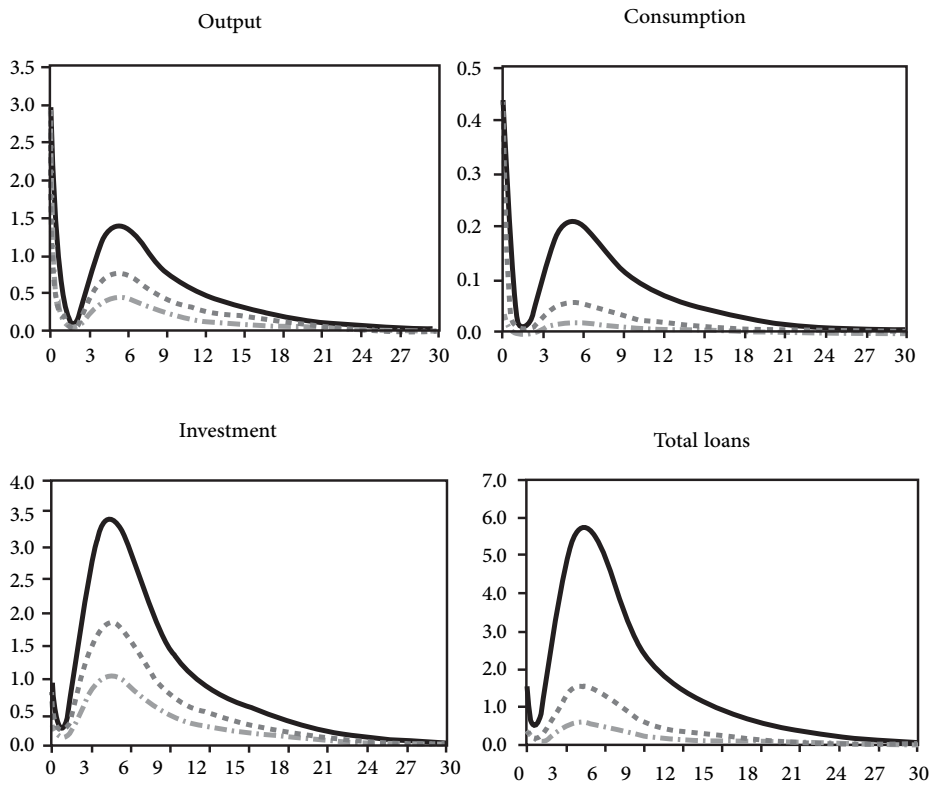

Figure 5. Increase in VAT rate and full taxation conditions. *Source*: Authors' Findings.

5.4 Impulse-Response Functions to Government VAT Income Shock

This section examines the increase in government revenue from the value-added tax. Two scenarios are considered for this purpose. In the first scenario, banking services are exempt from VAT, and in the second scenario, the full coverage of the VAT on banking services is considered. Note that in both scenarios the VAT rate is equal to 10%.

Increasing in tax revenue raises the public spending, so increases the production, consumption and saving. With increasing in saving, household deposits rises which increases loans. The dotted line represents the first scenario, tax exemption, and the blue line represents the second scenario that banking services are fully subject to value added tax. Bank can claim the tax paid on inputs so its cost is reduced. By reducing the bank's cost, it can

compete with its rivals by lowering interest rates on loans. The decline in the interest rate on loans leads to increase in loan demand, and as a result, investment will increase. As investment increases, production and subsequent consumption increase and thus intensify the initial effects.

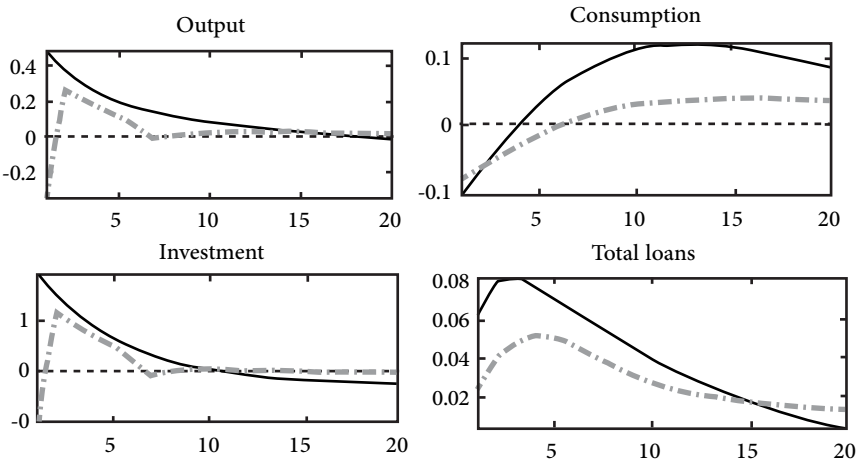

Figure 6. Impulse-response to VAT income shock. *Source*: Authors' Findings.

6 Conclusion

For some technical and distribution reasons, some goods and services, such as banking services, are exempt from value-added tax. This study aims to model the application of VAT on Iran banking services in the framework of a DSGE model**.** For this purpose, banking sector added to the DSGE model with consideration of value added tax on the banks services. Then the transmission of various shocks that the banks' activities may have on the other economic agents and macroeconomic variables are examined. In this model, the bank has a central role. The value added tax levied on the difference between interest rate paid to depositors and interest rate charged on loans as value added created by the bank. Then, the sudden changes in the resources of the bank and its consequences on other macroeconomic variables have been examined. In the utility function, instead of taking into account the total cash available in the economy we entered money that retained by household to avoid double-counting of liquidity in the economy.

In order to understand the importance of VAT exemptions on the macroeconomic fluctuations as well as the role of financial intermediaries on economic shocks, annual economic indicators of Iran during the period 1986-

2015 used. We investigated the response of macroeconomic variables to monetary shocks and impacts of VAT changing from exempt status to full taxation. In order to extract the value of the model parameters, the calibration and the Bayesian method are used and finally, using the Brooks & Gelman test and impulse-response functions the accuracy of model is evaluated.

The results show that imposing value added tax on banks services through reducing their costs will lead to increasing in bank resources and lending power. Therefore the supply of credits, investment and production will increase. The simulation results show that with the transition from the exempt status to complete banking services taxation, the amount of bank facilities has increased and conditions for increasing investment and increasing production are provided.

The effects of shocks indicate the importance of banking resources in influencing macroeconomic variables. With lacking resources, the bank faces liquidity risk and cannot respond to withdrawal, so supply of credit reduces. In this case, the bank will have to borrow from the Central Bank, which affects the monetary base. Therefore, moving from tax exemption to full taxation is a better horizon for the economy because of increasing investment, production and consumption.

The results of the impulse-response functions indicate that moving from exemption to full taxation, macroeconomic variables such as production, investment and consumption improve and this is an indication of the ineffectiveness of the tax exemption for banking services.

References

Bahrami, J., & Qureshi, N. S. (2011). Analysis of Monetary Policy in the Iranian Economy Using a Dynamic Stochastic General Equilibrium. *Economic Modeling Quarterly*, 5(1), 1-22.

Bernanke, B. M., & Gertler, M. (1995). Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives*, 9(4), 27-84.

Bernanke, B., Gertler, M., & Gilchrist, S. (1999). The Financial Accelerator in a Quantitative Business Cycle Framework. *Handbook of Macroeconomics*, edited by John B.

Brooks, S., & Gelman, A. (1998). General Methods for Monitoring Convergence of Iterative Simulations. *Journal of Computational and Graphical Statistics*, Vol. 7, No. 4 (Dec., 1998), 434-455.

Buettner, T., & Erbe, K. (2014). Revenue and welfare effects of financial sector VAT exemption. International Tax and Public Finance, 21(6), 1028-1050.

Burriel, P., Fernández-Villaverde, J., & Rubio-Ramírez, J. F. (2010). MEDEA: A DSGE Model for the Spanish Economy. SERIEs, 1(1-2), 175-243.

Calvo, G. A. (1983). Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics*, Sept, Vol. 12, No. 3, 983–998.

Christiano, L. J., Motto, R., & Rostagno, M. (2007). Shocks, Structures or Policies? The Euro Area and the US after 2001. *Journal of Economic Dynamics and Control*, Vol. 32(8) (August): 2476-2506. Cycle mimeo, European Central Bank and Northwestern University.

Christiano, L., Motto, R. & M. Rostagno. (2010). *Financial Factors in Business Cycle.* mimeo, European Central Bank and NorthWestern University.

Christiano, L., Motto, R., & Rostagno, M. (2008). Shocks, Structures or Monetary Policies? The Euro Area and US After 2001. *Journal of Economic Dynamics and Control*, 32(8), 2476-2506.

Fakhr Hosseini, S. F.; Shahmoradi, A., & Ehsani, M. A. (2012). Price and Wage Stickiness and Monetary Policy in Iranian Economy. *Quarterly of Economic Research*, 12(1), 1-30.

Gerali, A.; Neri, S., & Sessa, L. (2010). Credit and Banking in a DSGE Model of the Euro Area. *Journal of Money, Credit and Banking*, 42(1), 107-141.

Gertler, M., & Kiyotaki, N. (2009). Financial Intermediation and Credit Policy in Business Cycle Analysis. in preparation for the Handbook of Monetary Economics.

Goodfriend, M., & McCallum, B. T. (2007). Banking and Interest Rates in Monetary Economics. *Journal of monetary Economic*, 54(5), 1480-1507.

Lucas Jr, R. E. (1990). Liquidity and interest rates. *Journal of Economic Theory*, 50(2), 237-264.

McKenzie, K. J., & Firth, M. (2011). *The GST and Financial Services: Pausing for Perspective*. The School of Public Policy.

Rotenberg, J. J. (1982). Sticky Prices in the United States. *Journal of the Political Economy*, 90, 1187-1211.

Shahmoradi, A., & Sarem, M. (2013). Optimal Monetary Policy and Inflation Targeting in Iran. *Journal of Economic Research*, Vol. 48, No. 2, Summer 2013, 25-42.

Taylor, J., & Williams, J. (2010). Simple and Robust Rules for Monetary Policy. In B. Friedman and M. Woodford (Eds.). *Handbook of Monetary Economics*, Amsterdam: North-Holland.

Uhlig, H. (1999). A Toolkit for Analyzing Nonlinear Dynamic Rational Expectations Models Easily. *Computational Methods for the Study of Dynamic Economics*, 150-200.

Yilmaz, F. (2013). *VAT Treatment of Financial Institutions: Implications for the Real Economy*. Department of Economics University of Calgary (Job Market Paper).