Fixed-Rate Loans and the Effectiveness of Monetary Policy

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I thank Joon Myoung Woo, Jongwook Park and the anonymous reviewer for their valuable comments. I am also grateful to Wook Sohn, Hwankoo Kang, Sungju Song and seminar participants at the Bank of Korea. All errors are mine.

Contents

Fixed-Rate Loans and the Effectiveness of Monetary Policy

Fixed-rate loans may contribute to financial stability because they lower the volatility of interest rates. This reduced volatility of interest rates, however, may undermine the effectiveness of monetary policy. Fixed-rate loans, also, may change the steady-states of economy because fixed interest rates are usually higher than variable interest rates, which can alter incentives of borrowers for loans. This paper tests how fixed-rate loans affect the steady-states of economy and the effectiveness of monetary policy, using the DSGE model.

The steady-states in the economy are shown to vary in the ratio of fixed-rate loans. When the ratio of fixed-rate loans rises, borrowers bear more burden of interests because fixed interest rates are higher than variable interest rates. Therefore, borrowers reduce their loans, which lead into decreased weight of financial sector in the economy. Total output, however, remains almost unchanged regardless of the ratio of fixed-rate loans because households increase labor supply to compensate for their financial losses. The similar phenomenon happens when the mark-up of fixed interest rates over variable interest rates increases.

Effects of fixed-rate loans on monetary policy turn out to be different in financial economy and real economy. Financial economy variables, such as interest rates and loans, respond differently to monetary policy shocks when the ratio of fixed-rate loans increases. These differences, however, are offset by each other within financial economy and not transmitted to real economy. That is, real economy variables, such as output, consumption, and price, react virtually the same to monetary policy shocks regardless of the ratio of fixed-rate loans. The same results occur when I vary the mark-up of fixed interest rates or the stickiness of fixed interest rates

Keywords: Fixed-rate loans, Monetary policy, DSGE model, Financial stability, Interest rate stickiness

JEL Classification Numbers: E43, E44, E52, E58

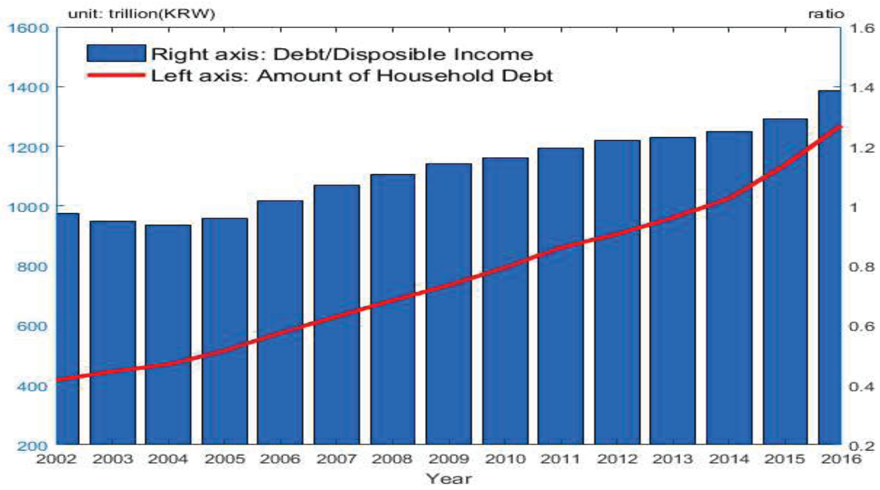
Ⅰ. Introduction

Loans can be divided into two types, fixed-rate loans and variable-rate loans, with regard to the way of charging interests. Fixed-rate loans have the constant interest rates till the expiration of loans while variable-rate loans have changing interest rates every period. Fixed-rate loans win the majority in the U.S., Germany and France while variable-rate loans take the great parts in the U.K., Australia and Spain (Rubio, 2011).

To the best of my knowledge, there is no clear explanation on why a country prefers fixed-rate loans to variable-rate loans, and vice versa. It seems clear, however, that fixed-rate loans have the advantage in financial stability over variable-rate loans. If a credit crunch occurs in financial markets, interest rates begin to soar and asset prices plunge. In this situation, households even with solid financial positions are likely to be forced into insolvency due to higher interest rates and no rolling-over. This exacerbates financial market distress further. Households with fixed-rate loans, however, do not have to take any additional interest rate risks regardless of financial market conditions. Furthermore, fixed-rate loans usually have long maturity. Therefore, the propagation of financial crisis into households can be prevented to some degree if fixed-rate loans have great importance in economy.

Korea is the example of using fixed-rate loans as a measure for financial stability. For over a decade, household debts have been one of the main concerns for Korea economy. Contrary to many advanced countries, who experienced household-debt reduction in the aftermath of Global Financial Crisis, household debts in Korea continue to increase as shown in Figure 1. As of the end of 2016, the amounts of household debts in Korea come up to 1.3 quadrillion KRW, which is 3.0 times as in 2002. The ratio of household debt over disposable income also rose to 1.39 in 2016 from 0.97 in 2002. According to OECD data, Korea ranks at the 4th, following Greece, Swiss and Slovakia in a rise in the ratio of household debt over disposable income for the period of 2008-2015.

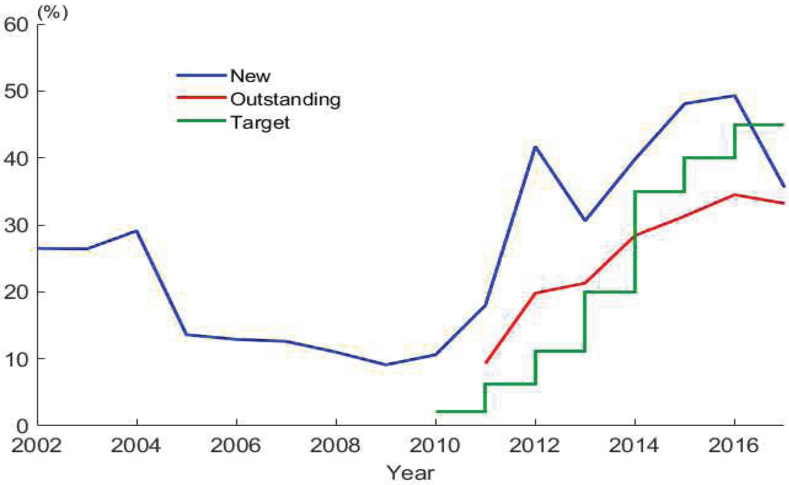
Figure 1. Household Debts in Korea



Korea government, therefore, adopted several measures to prevent the accumulation of household debts from impairing financial stability. Raising ratio of fixed rate loans is one of these policy measures.

Financial authorities in Korea announced the target ratio of fixed-rate loans in 2011 for the first time. The ratio is aimed at housing mortgage loans. At first, the target ratio was 2.1% by the end of 2011 and 30.0% by the end of 2016. The target ratio continues to rise and arrives at 47.5% by the end of 2018 as of Apr 2018. Figure 2 shows the actual ratio of the fixed-rate loans over total housing mortgage loans together with the target ratio in Korea. The actual ratio of both new and outstanding fixed-rate loans has been increasing since 2010s. The actual ratio of fixed-rate loans amounts to 49.3% for new housing mortgage loans and 34.5% for outstanding housing mortgage loans in 2016 even though these ratios drop to 35.6% and 33.2% in 2017. As seen from the Figure, the actual ratios and the target ratio comove very closely. Therefore, it could be argued that the target ratio set up by financial authorities exert important influences in raising the actual ratio of fixed-rate loans in Korea.

Figure 2. Ratio of Fixed-Rate Loans in Korea



It is claimed, however, that increases in fixed-rate loans may undermine effectiveness of monetary policy. Usually, the central bank can only set the short-term interest rates(=policy rates). These short-term interest rates spill over to long-term interest rates via financial markets. For the monetary policy to be effective, therefore, term structure of interest rates should be closely linked to policy rates. Interest rates in fixed-rate loans, however, remain unchanged till due date regardless of monetary policy stance. As fixed-rate loans increase, therefore, interest rates in financial markets become more insensitive to monetary policy. The more fixed-rate loans, the less effective monetary policy.

Rubio (2011) argues that monetary policy is less effective to fixed-rate borrowers than variable-rate borrowers. This is because interest rates of the former are not influenced by changes in monetary policy. As the ratio of fixed-rate borrowers increases, responses of overall lending interest rates to monetary policy shocks become smaller, which weakens effects of monetary policy. Auclert (2017) insists that a fall in interest rates is less effective to boost consumption when households have fixed-rate financial assets and liabilities with a negative duration gap[1]. Since households have fixed-rate financial assets and liabilities, interests households receive or pay remain unchanged. This means households have opportunity profits of interests from their assets and opportunity costs of interests from their liabilities when the central bank lowers policy rates. Under a negative duration gap, opportunity costs of interests become bigger than opportunity profits of interests. In this situation, expansionary monetary policy rates may tighten consumption of households with a negative duration gap, so monetary policy can be less effective.

Fixed-rate loans may also have effects of reallocating financial gains among economic agents. Fixed interest rates are usually higher than variable interest rates.[2] This is because financial intermediaries want compensation for giving up reoptimizing interest rates. As the ratio of fixed-rate loans rises, therefore, borrowers bear more burden of interests and have incentives to decrease loans, but financial intermediaries come to have more interest profits. Financial gains, therefore, would be transferred from borrowers to financial intermediaries in the ratio of fixed-rate loans. The same phenomenon will happen if gaps of interest rates between fixed-rate loans and variable-rate loans is widening.

The aim of this paper is to test how fixed-rate loans affect the steady-states of economy and the effectiveness of monetary policy, using the DSGE model. The model of this paper is similar to Rubio (2011). However, my model is differentiated from that of Rubio (2011) in following ways. Firstly, Rubio (2011) assumes two types of borrowers, fixed-rate borrowers and variable-rate borrowers. Fixed-rate borrowers are only able to borrow fixed-rate loans and variable-rate borrowers are only able to borrow variable-rate loans. In my paper, borrowers are assumed to take out both types of loans at the same time. The ratio of fixed-rate loans is decided by financial authorities. Secondly, Rubio (2011) assumes infinite maturity of fixed-rate loans. In practice, however, it is usual that fixed-rate loans have finite maturity. To reflect this reality, I let some

1) A negative duration gap means the durations of liabilities is longer than the duration of assets.

2) Fixed interest rates in Korea are usually set higher than variable interest rates.

portion of fixed-rate loans renewed every period with updated interest rates. Thirdly, Rubio (2011) assumes fixed interest rates are average of current and future variable interest rates. This implies that variable interest rates have the same steady-state as fixed interest rates. It is usual, however, that fixed interest rates are higher than variable interest rates. Therefore, I assume fixed interest rates are determined at variable interest rates multiplied by mark-up, which is greater than 1.

Analysis of steady-states shows that fixed-rate loans have reallocating effects. As the ratio of fixed-rate loans or the mark-up of fixed interest rates rises, borrowers pay more interests and reduce the level of loans. To make up for these losses, borrowers increase their labor supply. Thus, total output stays at almost the same level.

According to impulse responses, however, fixed-rates loans turn out not to affect the effectiveness of monetary policy on real economy. Financial economy variables, such as interest rates and loans, responds differently to monetary policy shocks as the ratio and maturity of fixed-rate loans and the mark-up of fixed interest rates changes. However, these differences are offset each other within financial economy and are not transmitted to real economy. Therefore, real economy variables, such as output, consumption, and price, react virtually the same to monetary shock without regard to conditions of fixed-rate loans.

The above results differ from those in Rubio (2011) who claims that effects of monetary policy on real economy vary in the ratio of fixed-rate loans. I think these opposing results mainly come from assumption of interconnection between fixed-rate and variable-rate loans. In Rubio (2011), fixed-rate loans are strictly separated from variable-rate loans. Therefore, there is no interconnectedness between fixed-rate loans and variable-rate loans. This severance make different responses of financial variables spill over to real economy. In my model, however, borrowers can take out both types of loans simultaneously, so decisions on variable-rate loans and fixed-rate loans are closely linked each other. This interconnectedness makes opposing impulse responses of financial variables offset each other within financial economy and the effectiveness of monetary policy on real economy unchanged.

This paper is organized as follows. Section 2 shows the model used in the paper and Section 3 explains parameters. Section 4 and Section 5 analyse steady-states and impulse responses in fixed-rate loans, respectively. Section 6 concludes.

Ⅱ. Model

The model in this paper is based on Iacoviello (2005) and Iacoviello (2015) and also very similar to Rubio (2011). The model, however, is differentiated from existing ones as follows. Loans are divided into variable-rate loans and fixed-rate loans. Fixed interest rates are higher than variable interest rates. A certain portion of fixed rate loans are renewed every period. Also, investment and housing production are absent from the model to focus on effects of fixed-rate loans on households.

1. Savers

Savers supply labor $n_{s,t}$ to labor unions and receive real wholesale wages $w^u_{s,t}$. They have real deposits $d_{s,t}$ at financial intermediaries with nominal interest rates $R_{s,t}$. Savers consume final goods $c_{s,t}$. Savers purchase new housing $h_{s,t}$ and sell previous housing $h_{s,t-1}$ at real price $q_{h,t}$.

Savers maximize utility from final good consumption, housing and leisure. Then, utility maximization of savers is given by,

$$Max_{c_{s,t},\, h_{s,t},\, n_{s,t},\, d_{s,t}} E_t \sum_{t=0}^{\infty} \beta_s^t [\ln(c_{s,t} - b_s c_{s,t-1}) + j_s \ln h_{s,t} + \tau_s \ln(1 - n_{s,t})],$$

$$s.t.\quad c_{s,t}+q_{h,t}h_{s,t}+d_{s,t}=w_{s,t}^{u}n_{s,t}+R_{s,t-1}\frac{d_{s,t-1}}{\pi_t}+q_{h,t}h_{s,t-1}+\Xi_{s,t} \tag{1}$$

where E_t denotes expectation operator and π_t implies inflation rates. $\Xi_{s,t}$[3] is dividends from wholesaler and labor union to savers. b_s is the degree of external habit formation in consumption. j_s and τ_s show the preference for housing and leisure.

The F.O.C.s are given by,

$$\frac{j_s}{h_{s,t}}=\frac{q_{h,t}}{c_{s,t}-b_s c_{s,t-1}}-\beta_s\frac{E_t\{q_{h,t+1}\}}{E_t\{c_{s,t+1}-b_s c_{s,t}\}}, \tag{2}$$

$$\frac{\tau_s}{1-n_{s,t}}=\frac{w_{s,t}^{u}}{c_{s,t}-b_s c_{s,t-1}}, \tag{3}$$

$$\frac{E_t\{c_{s,t+1}-b_s c_{s,t}\}}{c_{s,t}-b_s c_{s,t-1}}=\beta_s\frac{R_{s,t}}{E_t\{\pi_{t+1}\}}. \tag{4}$$

2. Borrowers

Borrowers supply labor $n_{b,t}$ to labor unions and receive real wholesale wages $w_{b,t}^{u}$. Borrowers consume final goods $c_{b,t}$. Borrowers purchase new housing $h_{b,t}$ and sell previous housing $h_{b,t-1}$ at real price $q_{h,t}$. Borrowers have two types of loans, real variable-rate loans $l_{vb,t}$ and real fixed-rate loans $l_{fb,t}$ whose nominal interest rates are given by $R_{vb,t}$ and $R_{fb,t}$, respectively.

Fixed interest rates are assumed to be higher than variable interest rates. Variable-rate loans should be smaller than a certain fraction m_{vb} of fixed-rate loans. This constraint is imposed by financial authorities for financial stability purposes. When the maximum limit of variable-rate loans is exhausted, therefore, borrowers have no choice but to use fixed-rate

3) $\Xi_{s,t}=(1-p_t^{w})y_t+(w_{s,t}-w_{s,t}^{u})n_{s,t}$, see Section Ⅱ.5 for details.

loans despite of their higher interest rates. Detailed explanations on two types of loans and their interest rates will be given in Section II.3. Loans plus interests can not exceed a certain fraction m_b of housing value at the following period.

Borrowers maximize utility from final good consumption, housing and leisure. Then, utility maximization of borrowers is given by,

$$Max_{c_{b,t},\, h_{b,t},\, n_{b,t},\, l_{vb,t},\, l_{fb,t}} E_t \sum_{t=0}^{\infty} \beta_b^t [\ln(c_{b,t} - b_b c_{b,t-1}) + j_b \ln h_{b,t} + \tau_b \ln(1 - n_{b,t})],$$

$$s.t.\quad c_{b,t} + q_{h,t} h_{b,t} + \frac{R_{vb,t-1}}{\pi_t} l_{vb,t-1} + \frac{R_{fb,t-1}}{\pi_t} l_{fb,t-1} = w_{b,t}^u n_{b,t} + l_{vb,t} + l_{fb,t} + q_{h,t} h_{b,t-1} + \Xi_{b,t}, \tag{5}$$

$$l_{vb,t} + \frac{R_{fb,t}}{R_{vb,t}} l_{fb,t} \le E_t \left\{ m_b q_{h,t+1} \frac{\pi_{t+1}}{R_{vb,t}} h_{b,t} \right\}, \tag{6}$$

$$l_{vb,t} \le m_{vb} l_{fb,t}, \tag{7}$$

where $\Xi_{b,t}$[4] is dividends from labor union to borrowers. b_b is the degree of external habit formation in consumption. j_b and τ_b show the preference for housing and leisure.

Then, we have the following F.O.C.s.

$$\frac{j_b}{h_{b,t}} = \frac{q_{h,t}}{c_{b,t} - b_b c_{b,t-1}} - \beta_b \frac{E_t\{q_{h,t+1}\}}{E_t\{c_{b,t+1} - b_b c_{b,t}\}} - \lambda_{b,t}^h m_b E_t\{q_{h,t+1}\} \frac{E_t\{\pi_{t+1}\}}{R_{vb,t}}, \tag{8}$$

$$\frac{\tau_b}{1 - n_{b,t}} = \frac{w_{b,t}^u}{c_{b,t} - b_b c_{b,t-1}}, \tag{9}$$

$$\frac{1}{c_{b,t} - b_b c_{b,t-1}} = \lambda_{b,t}^h + \lambda_{b,t}^{vb} + \frac{\beta_b}{E_t\{c_{b,t+1} - b_b c_{b,t}\}} \frac{R_{vb,t}}{E_t\{\pi_{t+1}\}}, \tag{10}$$

$$\frac{1}{c_{b,t} - b_b c_{b,t-1}} = \lambda_{b,t}^h \frac{R_{fb,t}}{R_{vb,t}} - \lambda_{b,t}^{vb} m_{vb} + \frac{\beta_b}{E_t\{c_{b,t+1} - b_b c_{b,t}\}} \frac{R_{fb,t}}{E_t\{\pi_{t+1}\}}, \tag{11}$$

4) $\Xi_{b,t} = (w_{b,t} - w_{b,t}^u) n_{b,t}$, see Section Ⅱ.5 for detail.

where $\lambda_{b,t}^{h}$ and $\lambda_{b,t}^{vb}$ represent Lagrange multiplier for Equation 6 and 7, respectively.

3. Financial Intermediaries

Financial intermediaries accept deposits $d_{s,t}$ with interest rates $R_{s,t}$ from savers and lend variable-rate loans $l_{vb,t}$ and fixed-rate loans $l_{fb,t}$ with interest rates $R_{vb,t}$ and $R_{fb,t}$ borrowers. While variable interest rates are reset every period, fixed interest rates remain the same till expiration. The maturity of fixed-rate loans, however, are not infinity. Instead, a certain portion of fixed-rate loans $(1-\theta_{fb})$ should be renewed with updated interest rates $R_{fb,t}^{*}$. Then, the average duration of overall fixed-rate loans becomes $\frac{1}{1-\theta_{fb}}$. Average interest rates for overall fixed-rate loans, $R_{fb,t}$, evolves as follows.

$$R_{fb,t} = \theta_{fb} R_{fb,t-1} + (1-\theta_{fb}) R_{fb,t}^{*}. \tag{12}$$

The higher the value of θ_{fb}, the more persistent average fixed interest rates. That is, θ_{fb} can be thought of interest rate stickiness similar to price or wage stickiness as in Calvo (1983) and Yun (1996).

$R_{fb,t}^{*}$ is determined at geometric average of variable interest rates in current period and next period multiplied by mark-up ζ_{fb} as below,

$$R_{fb,t}^{*} = \zeta_{fb} \left[R_{vb,t} E_t \{ R_{vb,t+1} \} \right]^{0.5}. \tag{13}$$

The mark-up can be considered as the compensation to financial intermediaries for giving up the power of setting new interest rates.

Deposits cannot exceed a certain fraction γ_b of total lending. This constraint can be interpreted as the net worth constraint.[5] Adjustment

5) See Iacoviello (2015) and Jain-Chandra et al. (2013) for detail.

costs occur when there are changes in amounts of real deposits and loans.

Financial intermediaries maximize utility from consumption, $c_{f,t}$. Then, the utility optimization of financial intermediaries is given as below,

$$Max_{c_{f,t},\, d_{s,t},\, l_{vb,t}} E_t \sum_{t=0}^{\infty} \beta_f^t \ln(c_{f,t} - b_f c_{f,t-1}),$$

$$\begin{aligned} s.t. \quad c_{f,t} &+ \frac{R_{s,t-1}}{\pi_t} d_{s,t-1} + l_{vb,t} + l_{fb,t} + \frac{\phi_d}{2}(d_{s,t} - d_{s,t-1})^2 \\ &+ \frac{\phi_{vb}}{2}(l_{vb,t} - l_{vb,t-1})^2 + \frac{\phi_{fb}}{2}(l_{fb,t} - l_{fb,t-1})^2 \\ &= d_{s,t} + \frac{R_{vb,t-1}}{\pi_t} l_{vb,t-1} + \frac{R_{fb,t-1}}{\pi_t} l_{fb,t-1}, \end{aligned} \tag{14}$$

$$d_{s,t} \leq \gamma_b (l_{vb,t} + l_{fb,t}), \tag{15}$$

where b_f is the degree of external habit formation in consumption and ϕ_d, ϕ_{vb} and ϕ_{fb} are parameters of adjustment cost.

The F.O.C. are given as follows

$$\begin{aligned} &\frac{1}{c_{f,t} - b_f c_{f,t-1}} [1 - \phi_d (d_{s,t} - d_{s,t-1})] = \\ &\lambda_{f,t}^l + \frac{\beta_f}{E_t\{c_{f,t+1} - b_f c_{f,t}\}} \left[\frac{R_{s,t}}{E_t\{\pi_{t+1}\}} - \phi_d E_t\{d_{s,t+1} - d_{s,t}\} \right], \end{aligned} \tag{16}$$

$$\begin{aligned} &\frac{1}{c_{f,t} - b_f c_{f,t-1}} [1 + \phi_{vb} (l_{vb,t} - l_{vb,t-1})] = \\ &\lambda_{f,t}^l \gamma_b + \frac{\beta_f}{E_t\{c_{f,t+1} - b_f c_{f,t}\}} \left[\frac{R_{vb,t}}{E_t\{\pi_{t+1}\}} + \phi_{vb} E_t\{l_{vb,t+1} - l_{vb,t}\} \right], \end{aligned} \tag{17}$$

where $\lambda_{f,t}^l$ represents Lagrange multiplier for Equation 15.

4. Intermediate Good Producers

Intermediate good producers make homogeneous intermediate goods y_t and sell those goods to wholesalers at the real wholesale price p_t^w. Producers hire labor of savers and borrowers via labor packers at real wage $w_{s,t}$ and $w_{b,t}$. The production function is given by Cobb-Douglas.

$$y_t = a_t (n_{s,t})^{(1-\varphi)} (n_{b,t})^{\varphi}, \tag{18}$$

where a_t is technology which follows the process as below,

$$a_t = a_{t-1}^{\rho_a} \epsilon_{a,t}, \qquad \epsilon_{a,t} \sim LN(0, \sigma_a^2), \tag{19}$$

where $\epsilon_{a,t}$ represents the technology shock.

Then, the profit maximization of intermediate good producers is given by,

$$Max_{n_{s,t}, n_{b,t}} p_t^w y_t - w_{s,t} n_{s,t} - w_{b,t} n_{b,t},$$

$$s.t. \ y_t = a_t (n_{s,t})^{(1-\varphi)} (n_{b,t})^{\varphi}.$$

Then, following F.O.C.s are obtained.

$$(1-\varphi) p_t^w y_t = w_{s,t} n_{s,t}, \tag{20}$$

$$\varphi p_t^w y_t = w_{b,t} n_{b,t}. \tag{21}$$

5. Nominal Stickiness

Two nominal stickiness, price and wage, are introduced in the model as in Calvo (1983), Yun (1996), Smet and Wouters (2007) and so on. Both stickiness are derived in the almost same way, so I only show the derivation of price stickiness.

5.1 Price Stickiness

Wholesalers buy homogeneous intermediate goods y_t at nominal wholesale price P_t^w and transform them into differentiated goods, $y_t(z)$, without cost. Since the product is differentiated, wholesalers have monopolistic competitive power over their goods. Wholesalers sell differentiated goods to retailers who combine differentiated goods into final homogeneous consumption goods.

Wholesalers choose optimal price $P_t^*(z)$ to maximize profits. All wholesalers, however, can not reset their price every period. Instead, only a certain portion $(1-\theta_y)$ of wholesalers can reoptimize their price. Wholesalers, who can not reoptimize their price, index the price with inflation rate in the previous period $\pi_{t-1} = \dfrac{P_{t-1}}{P_{t-2}}$. P_t is the price of final homogeneous consumption goods. Demand function for differentiated goods $y_t(z)$ is derived from the profit maximization of consumption good retailers[6] as below,

$$y_{t+i}(z) = \left(\frac{P_t^*(z)\dfrac{P_{t+i-1}}{P_{t-1}}}{P_{t+i}} \right)^{\frac{\zeta_y}{1-\zeta_y}} y_{t+i}.$$

where ζ_y shows the degree of differentiation between goods. As ζ_y becomes bigger, each goods becomes more differentiated. If ζ_y approaches one, on the contrary, each goods becomes more similar, which means individual goods becomes substitutes.

6) Retailers' profit maximization problem is given by

$$Max_{y_t(z)}\ y_t P_t - \int_0^1 y_t(z) P_t(z) dz,\ s.t.\ y_t = \left[\int_0^1 y_t(z)^{\frac{1}{\zeta_y}} dz \right]^{\zeta_y}.$$

Then, profit maximization of wholesalers is given by,

$$Max_{P_t^*(z)} \sum_{i=0}^{\infty} (\beta_s \theta_y)^i \frac{u'(c_{s,t+i})}{u'(c_{s,t})} \left(P_t^*(z) \frac{P_{t+i-1}}{P_{t-1}} - P_{t+i}^w \right) y_{t+i}(z),$$

$$s.t.\ \ y_{t+i}(z) = \left(\frac{P_t^*(z) \frac{P_{t+i-1}}{P_{t-1}}}{P_{t+i}} \right)^{\frac{\zeta_y}{1-\zeta_y}} y_{t+i}.$$

where $u'(c_{s,t+i})$ is savers' marginal utility of consumption. As all wholesalers choose the same optimal price, we can drop (z). Then, the optimal nominal price of consumption good P_t^* is given by,

$$P_t^* = \zeta_y P_{t-1} \frac{\sum_{i=0}^{\infty} (\beta_s \theta_y)^i u'(c_{s,t+i}) P_{t+i}^w \left(\frac{P_{t+i-1}}{P_{t+i}} \right)^{\frac{\zeta_y}{1-\zeta_y}} y_{t+i}}{\sum_{i=0}^{\infty} (\beta_s \theta_y)^i u'(c_{s,t+i}) P_{t+i-1} \left(\frac{P_{t+i-1}}{P_{t+i}} \right)^{\frac{\zeta_y}{1-\zeta_y}} y_{t+i}}. \tag{22}$$

We can derive the price of final homogeneous consumption goods P_t, from retailers' profit maximization, which is given by

$$P_t = \left[\int_0^1 P_t(z)^{\frac{1}{1-\zeta_y}} dz \right]^{1-\zeta_y}.$$

Since $(1-\theta_y)$ of wholesalers choose the optimal price P_t^* and the remaining wholesalers index the existing price with inflation rates in the previous period, we have the following price dynamics,

$$P_t = \left[\int_0^{\theta_y} (\pi_{t-1} P_{t-1})^{\frac{1}{1-\zeta_y}} dj + \int_{\theta_y}^1 (P_t^*)^{\frac{1}{1-\zeta_y}} dj \right]^{1-\zeta_y}$$

$$= \left[\theta_y (\pi_{t-1} P_{t-1})^{\frac{1}{1-\zeta_y}} + (1-\theta_y)(P_t^*)^{\frac{1}{1-\zeta_y}} \right]^{1-\zeta_y}. \tag{23}$$

5.2 Wage Stickiness

There are two kinds of wage stickiness because savers and borrowers supply labors, separately. However, the structure of each wage stickiness are exactly the same. Labor unions and labor packers play the same role as wholesalers and retailers in price stickiness.

The optimal nominal wage for savers $W_{s,t}^*$ is given by,

$$W_{s,t}^* = \zeta_s P_{t-1} \frac{\sum_{i=0}^{\infty} (\beta_s \theta_s)^i u'(c_{s,t+i}) W_{s,t+i}^u \left(\frac{P_{t+i-1}}{P_{t+i}} \right)^{\frac{\zeta_s}{1-\zeta_s}} n_{s,t+i}}{\sum_{i=0}^{\infty} (\beta_s \theta_s)^i u'(c_{s,t+i}) P_{t+i-1} \left(\frac{P_{t+i-1}}{P_{t+i}} \right)^{\frac{\zeta_s}{1-\zeta_s}} n_{s,t+i}}, \tag{24}$$

where ζ_s shows the degree of differentiation between labors supplied from savers. Wage dynamics for savers are given by,

$$W_{s,t} = \left[\theta_s (\pi_{t-1} W_{s,t-1})^{\frac{1}{1-\zeta_s}} + (1-\theta_s)(W_{s,t}^*)^{\frac{1}{1-\zeta_s}} \right]^{1-\zeta_s}. \tag{25}$$

Wage stickiness for borrowers are obtained by just replacing a subscript 's' with 'b' as below.

$$W_{b,t}^* = \zeta_b P_{t-1} \frac{\sum_{i=0}^{\infty} (\beta_b \theta_b)^i u'(c_{b,t+i}) W_{b,t+i}^u \left(\frac{P_{t+i-1}}{P_{t+i}} \right)^{\frac{\zeta_b}{1-\zeta_b}} n_{b,t+i}}{\sum_{i=0}^{\infty} (\beta_b \theta_b)^i u'(c_{b,t+i}) P_{t+i-1} \left(\frac{P_{t+i-1}}{P_{t+i}} \right)^{\frac{\zeta_b}{1-\zeta_b}} n_{b,t+i}}, \tag{26}$$

$$W_{b,t} = \left[\theta_b(\pi_{t-1}W_{b,t-1})^{\frac{1}{1-\zeta_b}} + (1-\theta_b)(W_{b,t}^{*})^{\frac{1}{1-\zeta_b}}\right]^{1-\zeta_b}. \quad (27)$$

6. Cental Bank

We assume the central bank control deposit interest rates $R_{s,t}$ via Taylor rule as follows,

$$R_{s,t} = (R_{s,t-1})^{\rho}(R_s)^{1-\rho}\left(\frac{P_t}{P}\right)^{(1-\rho)\Psi_P}\left(\frac{y_t}{y}\right)^{(1-\rho)\Psi_y}\epsilon_{R_{s,t}}, \qquad \epsilon_{R_{s,t}} \sim LN(0,\sigma_r^2). \quad (28)$$

ρ is the parameter which represents the persistence of deposit interest rates. Ψ_P and Ψ_y refer to responses of deposit interest rates to price and output gap. P and y are the steady-state of price and output, respectively. $\epsilon_{R_{s,t}}$ represents the monetary policy shock.

7. Market Clearing

The total labor n_t is given by the following identity,

$$n_t = n_{s,t} + n_{b,t}. \quad (29)$$

The total housing, which is fixed at 1, is the sum of housing of savers and borrowers.

$$1 = h_{s,t} + h_{b,t}. \quad (30)$$

The total lending to borrowers $l_{b,t}$ is given by the following identity,

$$l_{b,t} = l_{vb,t} + l_{fb,t}. \quad (31)$$

c_t is the final consumption of households, which is the sum of consumption of savers and borrowers.

$$c_t = c_{s,t} + c_{b,t}. \tag{32}$$

Total output y_t is the sum of consumption of households, consumption of financial intermediaries and adjustment costs of financial intermediaries.

$$\begin{aligned} y_t = c_t + c_{f,t} + \frac{\phi_d}{2}(d_{s,t} - d_{s,t-1})^2 + \frac{\phi_{vb}}{2}(l_{vb,t} - l_{vb,t-1})^2 \\ + \frac{\phi_{fb}}{2}(l_{fb,t} - l_{fb,t-1})^2. \end{aligned} \tag{33}$$

Ⅲ. Parameters

The time preference is very important in that it determines not only behavior of economic agents but also interest rates. Economic agents with high time preference have more utility from future consumption and housing than those with low time preference. Thus, the former become savers because they make deposits for future and the latter become borrowers because they take out loans for today.

The time preference of savers β_s is the highest at 0.995, at which the steady-state of annual deposit interest rates become 2.0%. The time preference of borrower β_b is set at 0.91. The time preference for financial intermediaries β_f stays between savers and borrowers because they receive deposits from savers and give loans to borrowers. In this paper, β_f is set at 0.95.

The steady-state of annual variable interest rates are determined jointly by β_s, β_f and γ_b, where γ_b is the net worth constraint for financial intermediaries. When γ_b is set at 0.90, The steady-state of annual variable interest rates is equal to 4.0%. As explained in Section Ⅱ.3, fixed interest rates are determined by geometric average of variable interest rates multiplied by mark-up ζ_{fb}. ζ_{fb} is set at 1.0025. Then, the steady-state of annual fixed-interest rates becomes 5.0%.

θ_{fb} is also a very important parameter. It decides maturity of fixed-rate loans and thereby persistence of fixed interest rates. Suppose $\theta_{fb} = 1$, this implies there are no fixed-rate loans whose interest rates are reset. This means the maturity of fixed-rate loans is infinity. Then, we have invariant fixed interest rates as follows.

$$R_{fb,t} = \theta_{fb} R_{fb,t-1} + (1-\theta_{fb}) R^*_{fb,t}\,,$$

$$R_{fb,t} = R_{fb,t-1}.$$

When $\theta_{fb} = 0$, on the contrary, interest rates for all fixed-rate loans are reset at $R^*_{fb,t}$ and the maturity becomes just one period.

The structure of borrowers' debt depends on m_b and m_{vb}. m_b determines the total amount of debt in comparison with the value of housing. m_b is set at 0.95. m_{vb} determines the ratio of nominal fixed-rate loans over nominal total loans in the economy as $\frac{L_{fb}}{L_b} = \frac{1}{1+m_{vb}}$. At $m_{vb} = 2.0$, the ratio is 33.3%. The ratio rises to 50.0% and 66.7% when the value of m_{vb} falls to 1.0, and 0.5.

The value of parameters in Taylor rule are typical. The persistence of deposit interest rates, ρ is set at 0.65. The sensitivity of deposit interest rates on price Ψ_P is 1.50 greater than 1.0 as in Bullard and Mitra (2002) and the sensitivity on output Ψ_y is set at 0.80.

The values of other parameters, not mentioned in this section, are generally employed from previous researches or textbook as in Milani and Park (2015a), Milani and Park (2015b), Galí (2008) and so on. These parameters are not vital in deciding the effects of fixed-rate loans on the steady-states of economy and monetary policy. For example, price and wage stickiness may affect dynamics of economy. The effectiveness of monetary policy in the ratio of fixed-rate loans, however, turns out to be the same at each point of price and wage rigidity. The value of parameters in the base model are summarized at Table 1.

Table 1. The Value of Parameters in the Base Mode

Time Preference	Savers	β_s	0.9950
	Borrowers	β_b	0.9100
	Financial Intermediaries	β_f	0.9500
Housing Preference	Savers	j_s	0.6150
	Borrowers	j_b	0.8000
Leisure Preference	Savers	τ_s	1.0000
	Borrowers	τ_b	1.0000
Collateral Constraint	Borrowers	m_b	0.9500
	Financial Intermediaries	γ_b	0.9000
Mark-Up	Consumption Good Prices	ζ_y	1.2000
	Saver Wages	ζ_s	1.2000
	Borrower Wages	ζ_b	1.2000
	Fixed Interest Rates	ζ_{fb}	1.0025
Stickiness	Consumption Good Prices	θ_y	0.6300
	Saver Wages	θ_s	0.6300
	Borrower Wages	θ_b	0.6300
Monetary Policy	Persistence	ρ	0.6500
	Price Coefficient	Ψ_P	1.5000
	Output Coefficient	Ψ_y	0.8000

Ⅳ. Steady-State Analysis

The most important parameters with regards to fixed-rate loans are m_{vb}, ζ_{fb} and θ_{fb}. The first two parameters change the steady-states of the model. The last parameter θ_{fb}, however, is related only to persistence of fixed interest rates without affecting the steady-states of model. This section explains how the steady-states of the model change in m_{vb} and ζ_{fb}. All financial economy variables in this section and next section are nominal.

1. Steady-States in the Ratio of Fixed-Rate Loans

Table 2 shows changes in steady-states of model for five values of m_{vb} = 1000, 2, 1, 0.5 and 0.001. The values of other parameters are the same in Section 3. At these values of m_{vb}, the ratio of fixed-rate loans is equal to 0.001, 0.333, 0.500, 0.667 and 0.999, respectively.

Since m_{vb} affects the ratio of fixed-rate loans, the steady-states of interest rates remains unchanged regardless of the value of m_{vb}. Fixed interest rates are the highest at 1.0123 and deposit interest rates are the lowest at 1.005. Since fixed-interest rates are higher than variable interest rates, borrowers bear higher interest costs and have incentives to reduce the use of total loans as the ratio of fixed-rate loans increases. Thus, the steady-states of nominal total loans L_b decrease in the ratio of fixed-rate loans. At the ratio of fixed-rate loans = 0.001, the steady-state of total loans is 4.4099. When the ratio rises to 0.500 and 0.999, the steady-state of total loans drops to 4.0400 and 3.7274, which are 91.6% and 84.5% level of 4.4099, respectively.

Loans are one of resources for borrowers to consume final goods and housing. Thus, decreases in the steady-state of total loans also cause the steady-states of housing, h_b, and consumption of final goods c_b to dwindle. To compensate for these losses, borrowers increase their labor supply n_b. Thus, declines of housing and consumption is smaller than those of total loans. When the ratio of fixed-rate loans rises to 0.999 from 0.001, the steady-state of housing and consumption decreases by 12.0% and 0.8%, respectively, while total loans declines by 15.5%.

Savers also experience decreases in the steady-state of consumption, c_s, as the ratio of fixed-rate loans increases. Decreases of total loans due to the higher ratio of fixed-rate loans lower the demand of financial intermediaries for deposits D_s. Thereby, interest incomes of savers decline, which leads into reduced consumption. Similarly to borrowers, savers increase their labor supply n_s to offset reduced interest incomes from deposits. Housing of savers in the steady-states, however, increases in the ratio of fixed-rate loans. As the ratio of fixed-rate loans rises, interest losses of borrowers become bigger than those of savers. Since total housing is fixed at 1, greater interest losses of borrowers lead into smaller share of housing. Thus, housing share of savers becomes greater in the ratio of fixed-rate loans.

The other side of interest losses of households is interest profits of financial intermediaries. Thus, consumption of financial intermediaries c_{fb} increases in the ratio of fixed-rate loans due to higher interest profits.

The steady-state of total output y is the sum of consumptions, c_s, c_b, and c_{fb}. Total output ranges from 0.6878 to 0.6896 as shown in Table 2. This variation of output is much smaller in comparison with variation of financial variables such as loans and deposits. This is mainly because saver and borrowers increase their labor supply to offset interest losses in the ratio of fixed-rate loans.

In sum, the ratio of fixed-rate loans have effects of reallocating financial gains among agents. Since fixed interest rates are higher than variable interest rates, financial gains are mainly transferred from borrowers to financial intermediaries in the ratio of fixed-rate loans. To compensate for these interest losses, however, households increase their labor supply, so the total output remains almost at the same level.

Table 2. Steady-States in the Ratio of Fixed-Rate Loans

	Ratio of Fixed-Rate Loans	0.001	0.333	0.500	0.667	0.999
	(Value of m_{vb})	(1000.0)	(2.0)	(1.0)	(0.5)	(0.001)
R_s	Deposit Interest Rates	1.0050	1.0050	1.0050	1.0050	1.0050
R_{vb}	Variable Interest Rates	1.0098	1.0098	1.0098	1.0098	1.0098
R_{fb}	Fixed Interest Rates	1.0123	1.0123	1.0123	1.0123	1.0123
D_s	Deposits	3.9689	3.7408	3.6360	3.5369	3.3546
L_{vb}	Variable-Rate Loans	4.4055	2.7710	2.0200	1.3100	0.0037
L_{fb}	Fixed-Rate Loans	0.0044	1.3855	2.0200	2.6199	3.7236
L_b	Total Loans	4.4099	4.1564	4.0400	3.9299	3.3274
h_s	Housing of Savers	0.7848	0.7942	0.7986	0.8028	0.8017
h_b	Housing of Borrowers	0.2152	0.2058	0.2014	0.1972	0.1893
n_s	Labor of Savers	0.6321	0.6328	0.6331	0.6333	0.6339
n_b	Labor of Borrowers	0.7483	0.7491	0.7494	0.7497	0.7503
c_s	Consumption of Savers	0.4211	0.4204	0.4201	0.4197	0.4191
c_b	Consumption of Borrowers	0.2434	0.2427	0.2424	0.2420	0.2415
c_f	Consumption of Financial Intermediaries	0.0232	0.0254	0.0264	0.0273	0.0290
y	Output	0.6878	0.6885	0.6888	0.6891	0.6896

Note: The steady-states in this table are quarterly figures. Annual figures can be obtained by raising numbers in the table to the 4th power.

2. Steady-States in the Mark-Up of Fixed Interest Rates

In previous section, changes in the steady-state in the ratio of fixed-rate loans are mainly due to higher burden of interests of borrowers. The gap between fixed and variable interest rates are also directly affected by mark-up ζ_{fb}. Thus, the mark-up has similar effects to the ratio of fixed-rate loans.

Table 3 shows changes in steady-states of model for five values of mark-up, $\zeta_{fb} = 1$, 1.00125, 1.0025, 1.00375 and 1.005 with $m_{vb} = 2$. When $\zeta_{fb} = 1$, variable interest rates are equal to fixed interest rates at

1.0098. When ζ_{fb} becomes greater, however, the difference of fixed and variable interest rates widens. Since higher fixed interest rates mean borrowers bear higher burden of interests, the changes of the steady-state in mark-up are very similar to those in the ratio of fixed-rate loans.

Table 3. Steady-States in the Mark-Up of Fixed Interest Rates

	Value of Mark–Up, ζ_{fb}	1.000	1.00125	1.0025	1.00375	1.005
R_s	Deposit Interest Rates	1.0050	1.0050	1.0050	1.0050	1.0050
R_{vb}	Variable Interest Rates	1.0098	1.0098	1.0098	1.0098	1.0098
R_{fb}	Fixed Interest Rates	1.0098	1.0110	1.0123	1.0136	1.0145
D_s	Deposits	3.9696	3.8518	3.7408	3.6360	3.5369
L_{vb}	Variable-Rate Loans	2.9405	2.8532	2.7710	2.6933	2.6199
L_{fb}	Fixed-Rate Loans	1.4702	1.4266	1.3855	1.3467	1.3100
L_b	Total Loans	4.4107	4.2798	4.1564	4.0400	3.9299
h_s	Housing of Savers	0.7848	0.7896	0.7942	0.7986	0.8028
h_b	Housing of Borrowers	0.2152	0.2104	0.2058	0.2014	0.1972
n_s	Labor of Savers	0.6321	0.6325	0.6328	0.6331	0.6333
n_b	Labor of Borrowers	0.7483	0.7487	0.7491	0.7494	0.7497
c_s	Consumption of Savers	0.4211	0.4208	0.4204	0.4201	0.4197
c_b	Consumption of Borrowers	0.2434	0.2430	0.2427	0.2424	0.2420
c_f	Consumption of Financial Intermediaries	0.0232	0.0243	0.0254	0.0264	0.0273
y	Output	0.6878	0.6881	0.6885	0.6888	0.6891

Note: The steady-states in this table are quarterly figures. Annual figures can be obtained by raising numbers in the table to the 4th power.

The steady-states of total loans decrease in the mark-up. When the mark-up is 1, the steady-state of total loans is 4.4107. When the mark-up rises to 1.0025 and 1.005, the steady-states drop to 4.1564 and 3.9299, which are 94.2% and 89.1% level of 4.4107. Fixed-rate loans and variable-rate loans also drop at the same rates as total loans because m_{vb} is fixed at 2.0. Housing and consumption of borrowers also diminishes as interest losses increases. To compensate these losses, borrowers increase their labor supply.

Decreases of total loans in mark-up lower the demand of financial intermediaries for deposits. Thereby, profits of interests for savers also dwindle, which leads into reduced consumption of savers. Similarly to borrowers, savers also increase their labor supply to make up for reduced interest profits. Housing of savers, however, increases because the total housing is fixed at 1 and borrowers have the lower steady-states of housing in the mark-up. Financial intermediaries, on the contrary, have the higher steady-states of consumption in mark-up because higher fixed interest rates brings greater interest profits to them.

Lastly, the steady-state of total output changes little. The output stays around 0.688. This is due to greater labor supply of households as explained earlier.

V. Impulse Response Analysis

This section examines how the effectiveness of monetary policy changes in m_{vb}, ζ_{fb} and θ_{fb} via impulse response functions. Results of impulse responses show that effects of monetary policy on financial variables, such as interest rates, deposits and loans, change in values of three parameters. However, these differences are not spilled over to real economy. That is, impulse responses of output, consumption and prices to monetary policy shocks remain virtually the same regardless of these parameters. This is because opposing effects among financial variables are cancelled out each other within their own financial economy.

1. Impulse Responses in the Ratio of Fixed-Rate Loans

Figure 3 and 4 show impulse responses to monetary policy shocks at three ratios of fixed-rate loans. The black-solid line, the blue-dashed line and the red-dotted line represent impulse responses to monetary policy shocks at the ratio of fixed-rate loans, 0.33, 0.50 and 0.67, respectively.

Impulse responses in both figures are fairly stylized. When monetary policy shocks occur, deposit interest rates rise instantaneously and gradually return to the steady-states as shown in the top-left panel in Figure 3. Variable interest rates and new fixed interest rates also show similar responses. The response of new fixed interest rates, however, is smaller than that of variable interest rates. This is because new fixed interest rates are the geometric mean of variable interest rates in current and next period. The impulse response of average fixed interest rates in the second-right panel in Figure 3 is less sensitive and more persistent because the response of new fixed interest rates are reflected only in $(1-\theta_{fb})$ of fixed-rate loans. As interest rates rise, borrowers reduce their loans, which lead into decreases in financial intermediaries' demand for deposits.

Since interest rates rise and loans diminish, both output and price decrease as shown the first-left and the bottom-left panel in Figure 4. Consumption and housing of borrowers decrease as lending interest rates rise. Consumption and housing of savers, however, increase because higher deposit interest rates bring greater interest profits to savers.

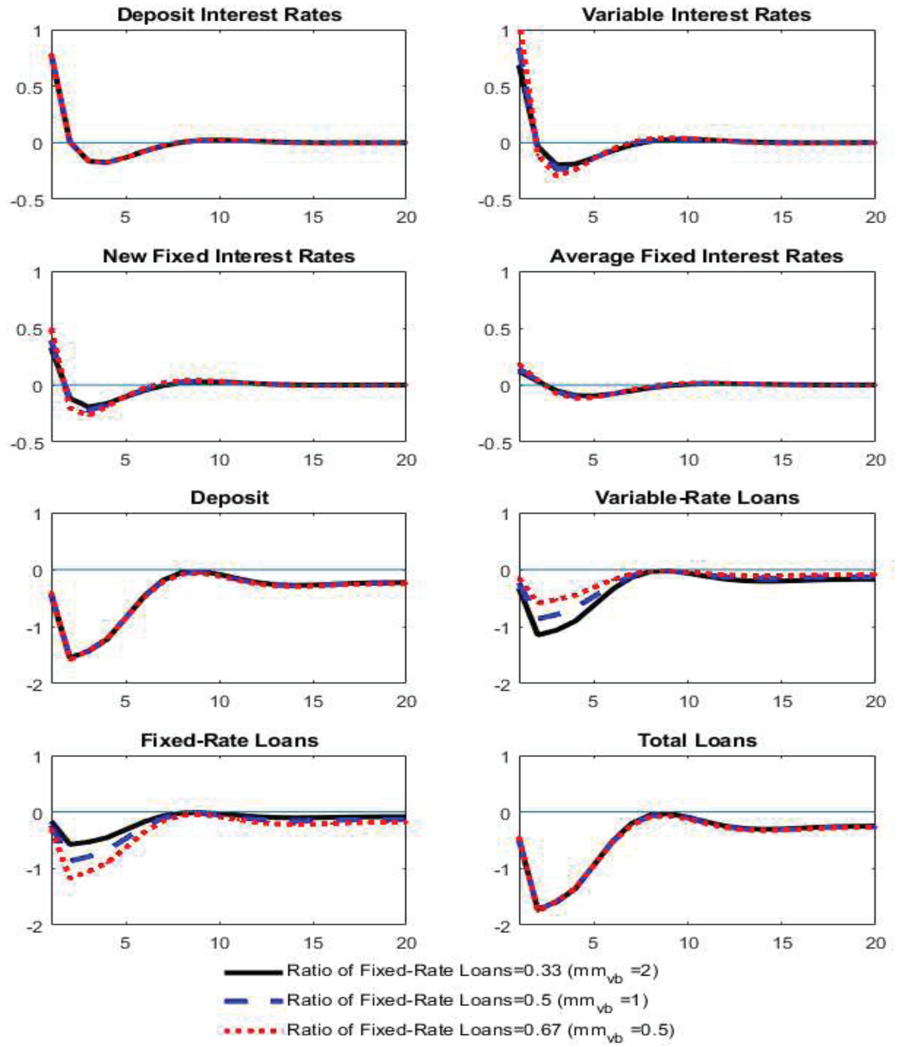
This subsection focuses on how impulse responses to monetary policy shocks vary in the ratio of fixed-rate loans. As shown in Figure 3, variables in financial economy show some variations in the ratio of fixed-rate loans. The most striking differences are shown in fixed-rate and variable-rate loans in the bottom-left and the third-right panels. As the ratio of fixed-rate loans rises from 0.33 to 0.67, responses of fixed-rate loans to monetary policy shocks become larger while responses of variable-rate loans become smaller. This is mainly because the weight of fixed-rate loans becomes greater in the ratio of fixed-rate loans but that of variable-rate loans becomes smaller. These opposing responses, however, are offset each other, so responses of total loans remain the same irrespective of the ratio of fixed-rate loans as shown in the bottom-right panel in Figure 3. Responses of deposits also remain unchanged in the ratio of fixed-ratio loans because deposits move in proportion to total loans.

Responses of variable and new fixed interest rates also vary in the ratio of fixed-rate loans as shown in the first-right and the second-left panel in Figure 3. As the ratio of fixed-rate loans increases, financial intermediaries have less chances to reoptimize interest rates, which implies reduced interest gains. To compensate for these interest losses, financial intermediaries set higher variable interest rates in the ratio of fixed-rates loans when positive monetary policy shocks occur. Since new fixed interest rates are geometric mean of variable interest rates in the present and the future, responses of new fixed interest rates also become bigger in the ratio of fixed-rate loans.

These differences in responses of financial economy variable in the ratio of fixed-rate loans, however, do not lead into differences in real economy variable. As seen in Figure 4, impulse responses of real economy variables are virtually the same regardless of the ratio of fixed-rate loans. This is because opposing responses of financial economy variables are cancelled out within their own. As mentioned earlier, larger responses of fixed-rate loans are offset by smaller response of variable-rate loans, so total loans and deposits have the same impulse responses regardless of the ratio of fixed-rate loans. Responses of interest rates are also cancelled out each other. That is, higher initial responses of variable interest rates and new fixed interest rates in the ratio of fixed-rate loans are offset by smaller reflection of new interest rates.

Since responses of total loans, deposits and their overall interest rates to monetary policy shocks remain unchanged in the ratio of fixed-rate loans, responses of real economy also remain the same, which means effectiveness of monetary policy on real economy are not affected by the ratio of fixed-rate loans.[7)]

Figure 3. Responses of Financial Economy Variables to Monetary Policy Shocks in the Ratio of Fixed-Rate Loans



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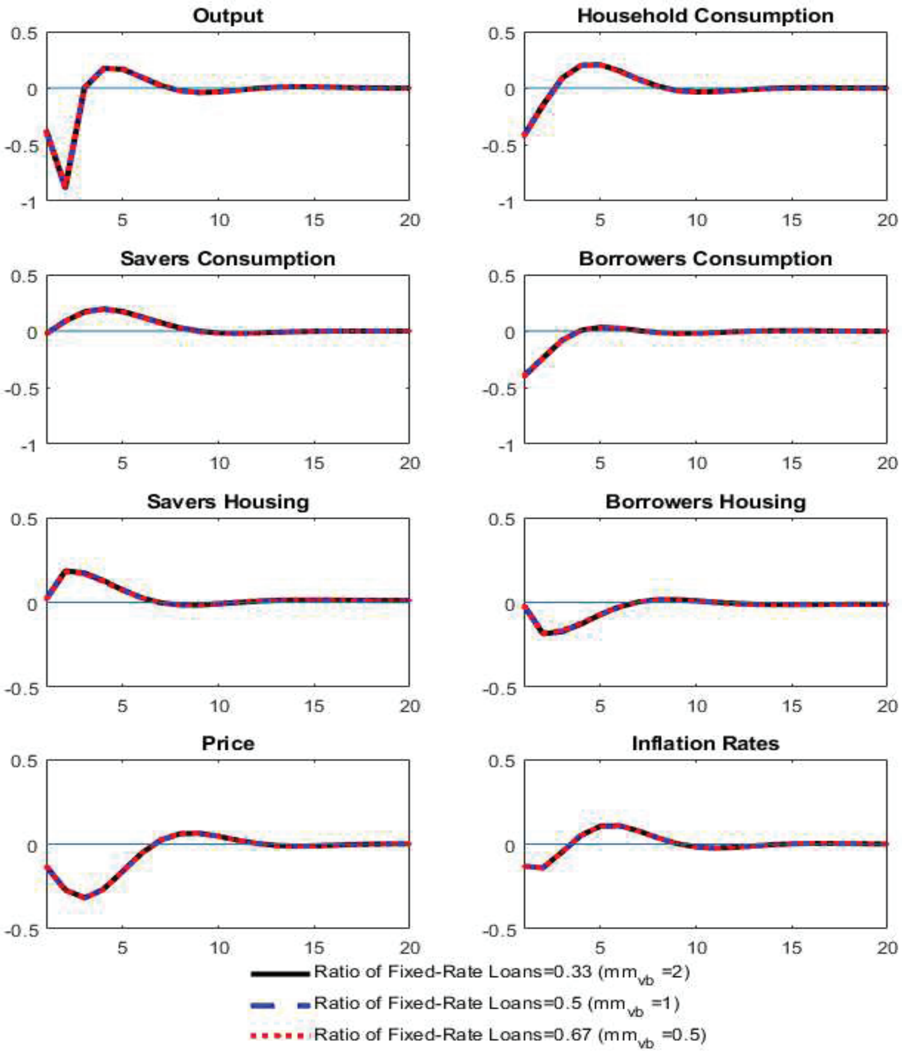
7) Closer look at impulse responses of real economy variables show there are small variations in the ratio of fixed-rate loans. Generally, quantitative variables, such as output and consumption, respond weaker in the ratio of fixed-rate loans while price variables, such as inflation and wage, respond stronger. In relation to the size of monetary policy shocks, however, differences in impulse responses of real economy variables are too small to be discernible in figures.

Figure 4. Responses of Real Economy Variables to Monetary Policy Shocks in the Ratio of Fixed-Rate Loans



2. Impulse Responses in the Mark-Up of Fixed Interest Rates

Figures 5 and 6 show impulse responses to monetary policy shocks at three values of mark-up of fixed interest rates. The black-solid line, the blue-dashed line and the red-dotted line represent impulse responses to monetary policy shocks at $\zeta_{fb} = 1$, 1.0025 and 1.005, respectively.

As the mark-up of fixed interest rates increases, responses of variable and fixed-rate loans to monetary policy shocks become smaller as shown in the third-right and the bottom-left panel of Figure 5. When the mark-up rises, fixed interest rates also hike, so borrowers bear more burden of interests. Thus, borrowers have incentives to reduce their loans, which lead into weaker responses of loans.

However, responses of variable and fixed interest rates to monetary policy shocks in the first-right and the second-left panel in Figure 5 are the same regardless of the mark-up. In previous subsection, financial intermediaries respond stronger to monetary policy shocks in the ratio of fixed-rate loans to compensate for decreased interest profits. The higher mark-up, on the contrary, raises interest profits of financial intermediaries. Increases in interest profits due to higher mark-up, however, are offset by decreases in interest profits due to smaller amount of variable and fixed-rate loans. Thus, financial intermediaries do not change responses of variable and fixed interest rates to monetary shock in the mark-up.

Figure 6 shows impulse responses of real economy variables to monetary policy shocks which are almost the same regardless of the mark-up of fixed interest rates. This implies different responses of variable and fixed-rate loans are cancelled out within financial economy and do not affect the real economy. Therefore, effectiveness of monetary policy on real economy remains unchanged in the mark-up as in the case of the ratio of fixed-rate loans in previous subsection.

Figure 5. Responses of Financial Economy Variables to Monetary Policy Shocks in the Mark-Up of Fixed Interest Rates

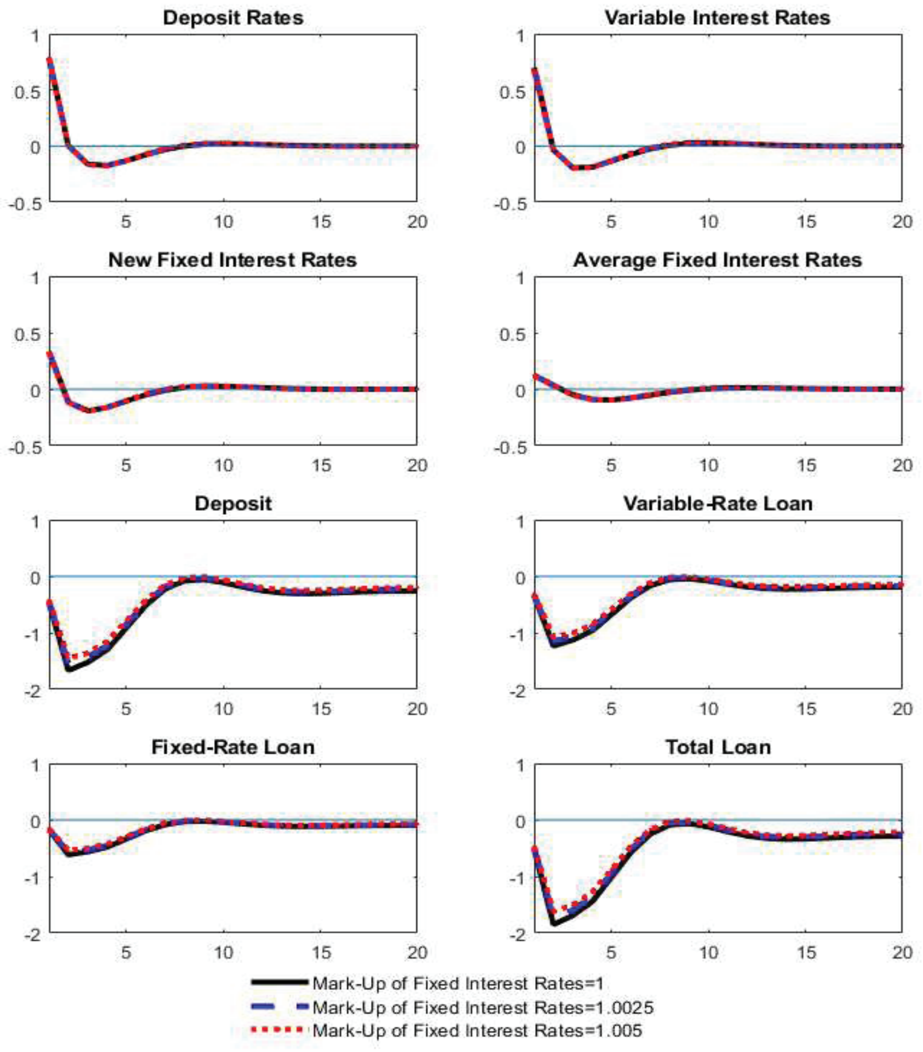
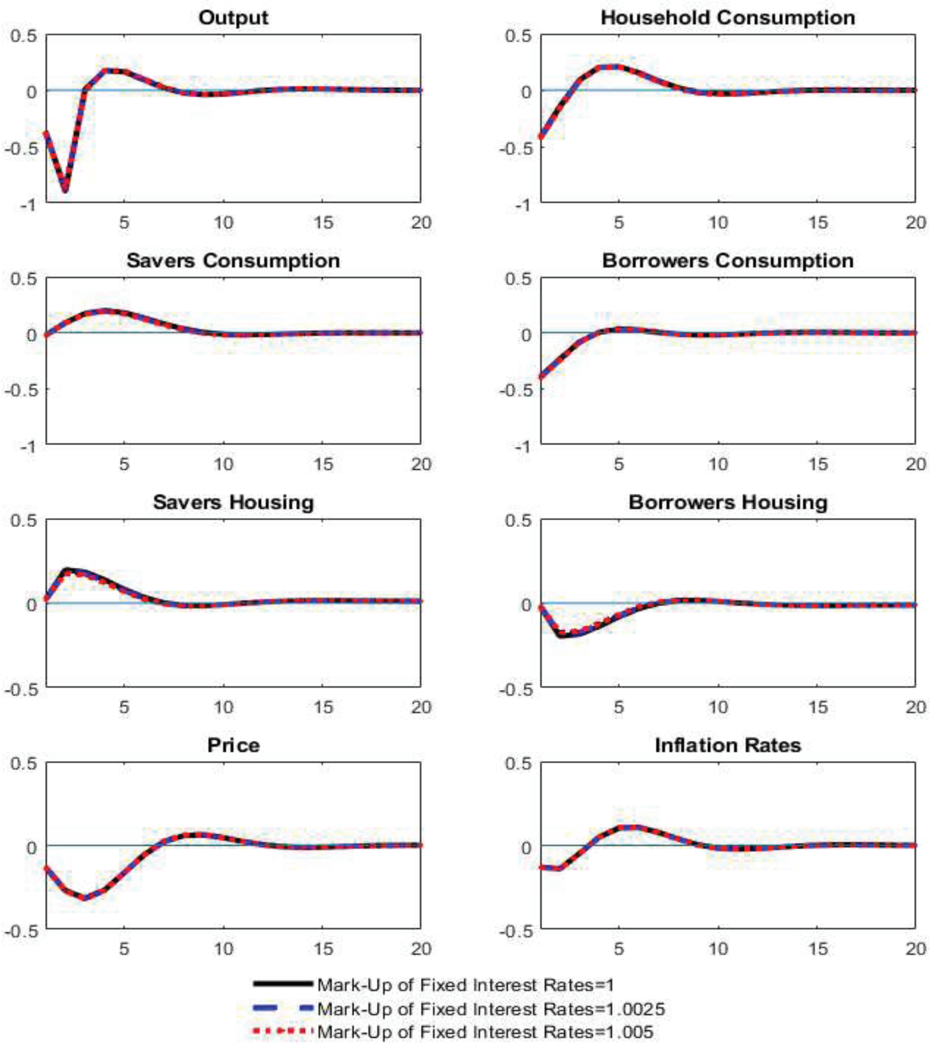


Figure 6. Responses of Real Economy Variables to Monetary Policy Shocks in the Mark-Up of Fixed Interest Rates



3. Impulse Responses in Fixed Interest Rate Stickiness

Figures 7 and 8 show impulse responses at three values of fixed interest rate stickiness. The black-solid line, the blue-dashed line and the red-dotted line represent impulse responses to monetary policy shocks at θ_{fb} = 0.1, 0.9 and 0.95, respectively. At these values, duration of fixed-rate loans becomes 1.11, 10.0 and 20.0, respectively.

As stickiness of fixed interest rates becomes stronger, responses of average fixed interest rates to monetary policy shocks become weaker and more persistent as shown in the second-right panel in Figure 7. When fixed interest rates become stickier, the less portion of fixed-rate loans are affected by new fixed interest rates. This implies financial intermediaries have less chance to adjust their fixed interest rates to maximize their consumption. Similar to the case of the ratio of fixed-rate loans, therefore, financial intermediaries experience decline of interest gain in stickiness of fixed interest rates. To compensate for these reduced interest gains, financial intermediaries choose higher variable interest rates and new fixed interest rates when positive monetary policy shocks occur as shown in the first-right and the second-left panel.

Responses of variable-rate loans and fixed-rate loans, however, remain unchanged regardless of fixed interest rate stickiness. This is because increases in interest losses of financial intermediaries caused by stickier fixed interest rates are offset by increases in interest profits caused by higher responses of variable interest rates and new fixed interest rates to monetary policy shocks. Thus, financial intermediaries do not have incentives to change their supply of loans.[8] Since responses of loans remains the same in the stickiness of fixed interest rates, those of deposits also remain unchanged.

Figure 8 shows impulse responses of real economy variables. As you can see, there are no differences in responses of real economy variables in the

8) From borrowers' point of view, decreases in interest costs caused by stickier fixed interest rates are offset by increases in interest costs caused by higher response of variable interest rates and new fixed interest rates. Thus, borrowers do not change their demand of loans.

stickiness of fixed interest rates. Thus, effectiveness of monetary policy on real economy are the same irrespective of fixed interest rate stickiness, just like case of the ratio of fixed-rate loans and the mark-up of fixed interest rates.

Figure 7. Responses of Financial Economy Variables to Monetary Policy Shocks in Fixed Interest Rate Stickiness

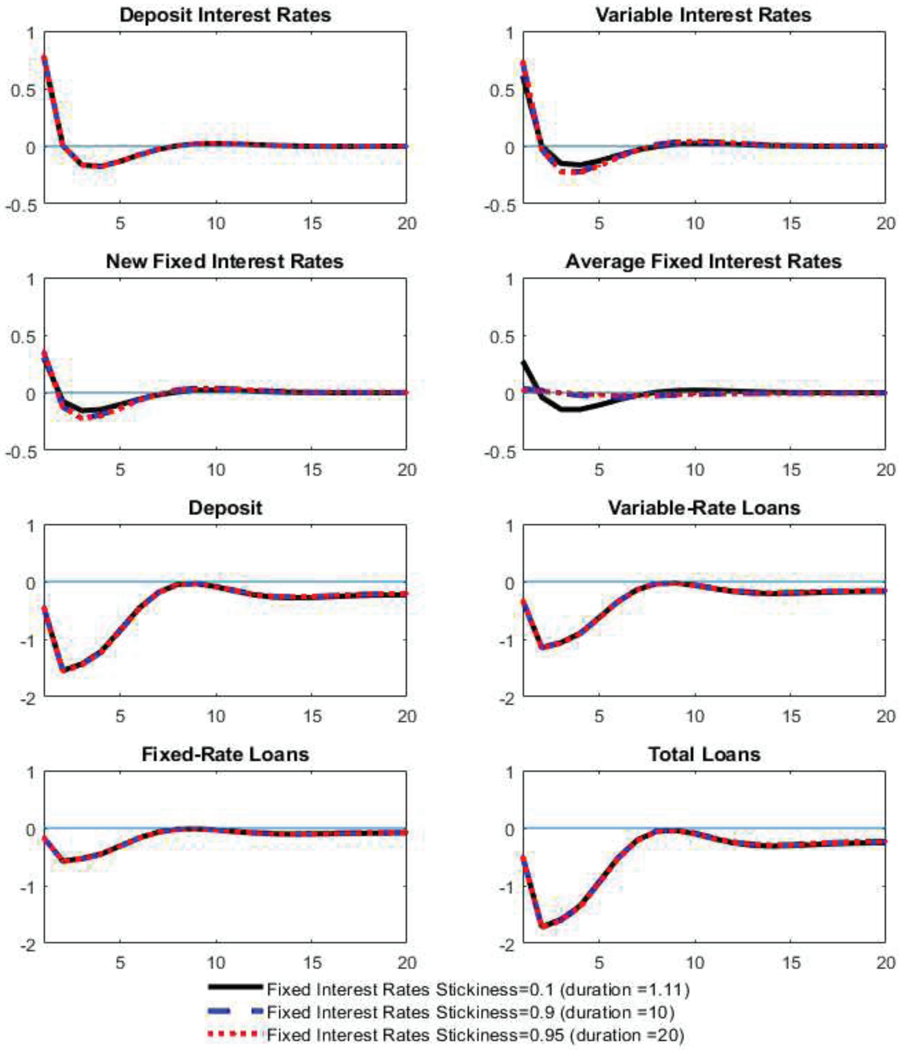
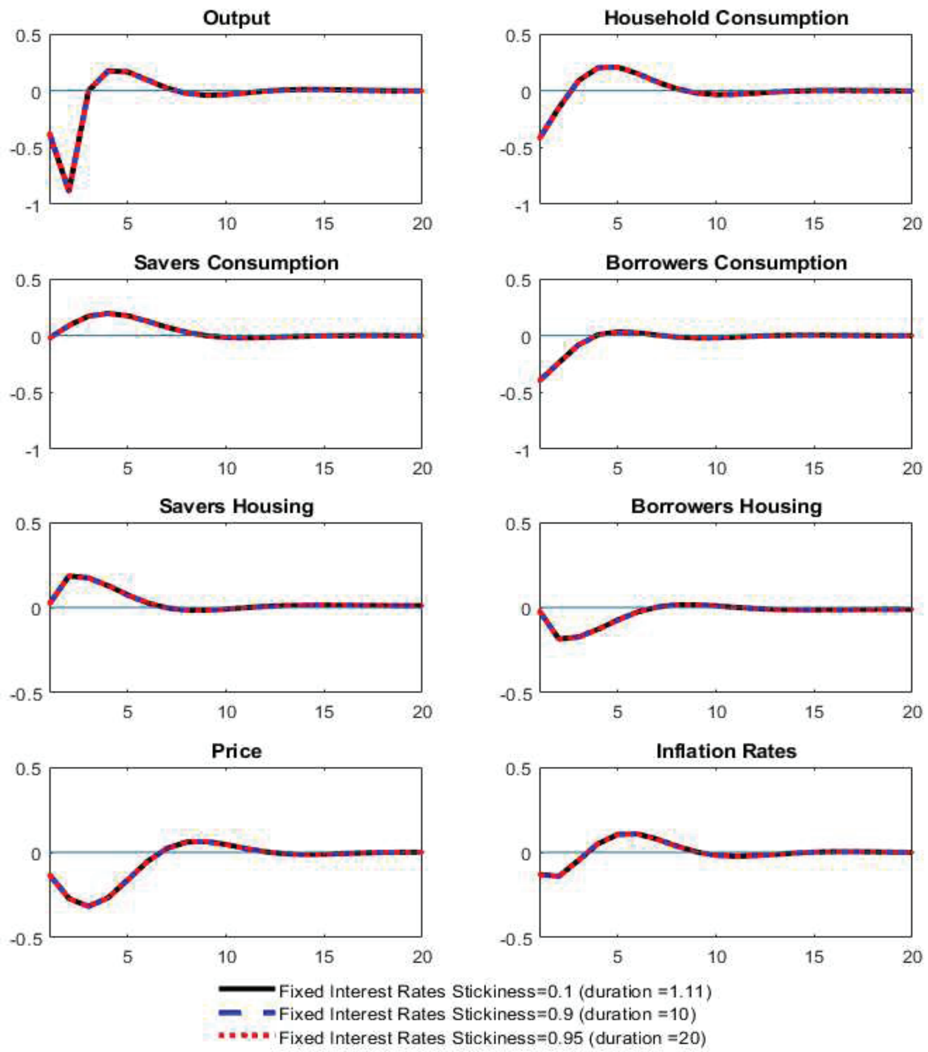


Figure 8. Responses of Real Economy Variables to Monetary Policy Shocks in Fixed Interest Rate Stickiness



Ⅵ. Conclusion

In this paper, I test whether fixed-rate loans affect the steady-states of economy and effectiveness of monetary policy in the ratio of fixed-rate loans, the mark-up of fixed interest rates and the stickiness of fixed interest rates.

Analysis of steady-states shows fixed-rate loans have effects of reallocating financial gains among economic agents because fixed interest rates are higher than variable interest rates. When the ratio of fixed-rate loans or the mark-up of fixed interest rates goes up, therefore, borrowers bear more burden of interest costs and thereby the level of loans decreases. Therefore, fixed-rate loans may contribute to financial stability through the lower level of debt in the economy. These interest losses of borrowers are mainly transferred to interest profits of financial intermediaries. The total output, however, remain almost the same regardless of importance of fixed-rate loans because households increase labor supply to compensate for interest losses.

Analysis of impulse responses show fixed-rate loans do not change effectiveness of monetary policy on real economy. Financial economy variables, such as interest rates and loans, responds differently to monetary shock in the ratio of fixed-rate loans, the mark-up of fixed interest rates and the stickiness of fixed interest rates. These differences, however, are offset by each other within financial economy and not transmitted to real economy. That is, responses of real economy variables, like output, consumption, and prices, to monetary shock are virtually the same regardless of importance of fixed-rate loans. This implies effectiveness of monetary policy on real economy remains the same irrespective of the importance of fixed-rate loans. This irrelevance may heighten the usefulness of fixed-rate loans as a policy tool for financial stability. That is, monetary policy can focus more on the stability of real economy without concerning about weakening effectiveness while fixed-rate loans are used to stabilize financial economy.

There is a case, however, where the above analysis of impulse responses may not hold. Suppose the economy in which fixed-rate loans comprise almost of all loans and the maturity of fixed-rate loans is extremely long. In this case, lending interest rates in the economy remain unchanged even if the central bank changes its policy rates. Then, financial stability can be negatively affected because financial intermediaries are exposed to higher interest rate risks. The effectiveness of monetary policy can be also partly affected due to the weakened transmission mechanism.

This paper has some rooms for improvement as follows. Firstly, fixed interest rates are determined in ad-hoc way, not from economic agent's optimization problem. For the model to be more consistent to theory, determination of fixed interest rates should be based on micro-foundation. Secondly, there can be cases when variable-rate loans are limited in their availability. If there are credit crunches in financial market, it is more likely that loans are not rolled over. Fixed-rate loans, which have long maturity, may can be comparatively freer from these rolling-over problem than variable-rate loans. If we consider these points in the model, fixed-rate loans may have an additional role in stabilizing real economy as well as financial economy. Thirdly, households may have some preferences for fixed-rate loans. Then, the ratio of fixed-rate loans is determined endogenously by utility maximization of borrowers, instead of exogenously given by financial authorities as in this paper. This could generate different dynamics of economy, which may lead into different implication for effects of fixed-rate loans on economy.

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‹Abstract in Korean›

고정금리대출과 통화정책 유효성

박성호*

고정금리대출은 이자율 변동성을 축소시켜 금융안정에 도움을 줄 수 있다. 그러나, 이러한 이자율 변동성 하락은 통화정책의 유효성을 저하시킬 가능성이 있다. 또한, 고정금리대출은 변동금리대출 보다 일반적으로 이자율이 높기 때문에 대출에 대한 차입자의 유인구조에 영향을 미쳐 경제의 균형상태를 변화시킬 가능성도 있다. 본고는 동태확률일반균형(Dynamic Stochastic General Equilibrium, DSGE) 모형을 통해 고정금리대출이 경제의 균형상태 및 통화정책 유효성에 미치는 영향을 분석하였다.

경제의 균형상태는 고정금리대출에 영향을 받는 것으로 나타났다. 고정금리대출은 이자율이 높기 때문에, 차입자는 고정금리대출 비중이 커지면 이자부담이 늘어나 대출을 줄이게 되고 따라서 경제 전체에서 금융이 차지하는 비중이 감소하게 된다. 그러나, 총산출은 고정금리대출에 따른 변화가 거의 나타나지 않았는데 이는 고정금리대출 증가 시 발생하는 금융손실을 보전하기 위해 가계가 노동공급을 증가시키기 때문인 것으로 생각된다. 이러한 결과는 고정금리대출의 가산금리를 증가시키는 경우에도 유사하게 나타났다.

고정금리대출의 통화정책에 대한 영향은 금융경제와 실물경제에서 서로 상이하게 나타났다. 이자율, 대출 등의 금융경제 변수들의 통화정책 충격에 대한 반응은 고정금리대출 비중에 따라 큰 차이를 보였다. 그러나 이러한 차이는 금융경제 내에서 서로 상쇄되어 실물경제로 파급되지는 않았다. 즉, 총산출, 소비, 물가 등 실물경제 변수들은 통화정책 충격발생 시 고정금리대출 비중에 따라 반응의 차이를 보이지 않았다. 고정금리대출의 가산금리나 이자율의 경직성을 변화시킬 경우에도 비슷한 결과가 나타났다.

핵심 주제어: 고정금리대출, 통화정책, 동태확률일반균형모형, 금융안정성, 이자율경직성

JEL Classification: E43, E44, E52, E58

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BOK 경제연구 발간목록

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