Unconventional Monetary Policy and a Financial Intermediary: Were they relevant to fluctuations in the Japanese economy?

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Abstract

In this paper we examine the effect of unconventional monetary policy(UMP) in Japan by investigating the relation within the fluctuations in the Japanese macroeconomic data and the increased banks lending. We conducted a Bayesian estimation of a DSGE model with an endogenous financial intermediary, and the central bank in the model is allowing to conduct a credit policy. Our finding can be summarized in the following: First, by shock decomposition, we find that the credit supply shock of bank sector played a crucial role in the GDP and investment fluctuations in the sample period. Second, empirical data preferred a model set with a credit easing policy by reported a higher marginal likelihood. Third, by our estimation results, UMP in Japan is effective in the sense of supplying banks enough funds to prevent any increases in funds intermediate cost when adverse shocks hit. Finally, we argue that financial frictions are essential to the Japanese economy and should be considered in the policy-making process.

Keywords: Financial friction, Unconventional monetary policy, DSGE, Bayesian estimation.

1 Introduction

Japan has experienced a low inflation environment since its economic bubble collapsed at the beginning of the 1990s. After the burst of the bubble, the nominal interest rate had been getting lower and reached zero in 1999, meaning that there was no room for effective conventional monetary policy. Consequently, the central bank has been conducting unconventional monetary policy (UMP). UMP has taken many forms in Japan: Quantitative Easing (QE) was conducted during the period 2001-2006, Comprehensive Monetary Easing (CME) was conducted during from 2010 to 2013, and the Abe administration's "Abenomics" called for "bold monetary policy" in 2013, which is referred to as Quantitative and Qualitative Easing (QQE). Recently, the Bank of Japan (BOJ) pursues a "negative interest rate" policy and yield curve control policy that it was introduced in 2016.

Substantial shifts in monetary policy like those pursued by Japan are rare. A notable aspect of these changes to monetary policy is a significant monetary base increase through BOJ's assets purchase operation from the market. The direct effect of this BOJ's operation is shown in Figure 1, a significantly increased scale of its bonds holding. This number started from 111 trillion JPY by the implementation of QQE in 2013, by 2019 the number increased to 475 trillion JPY.

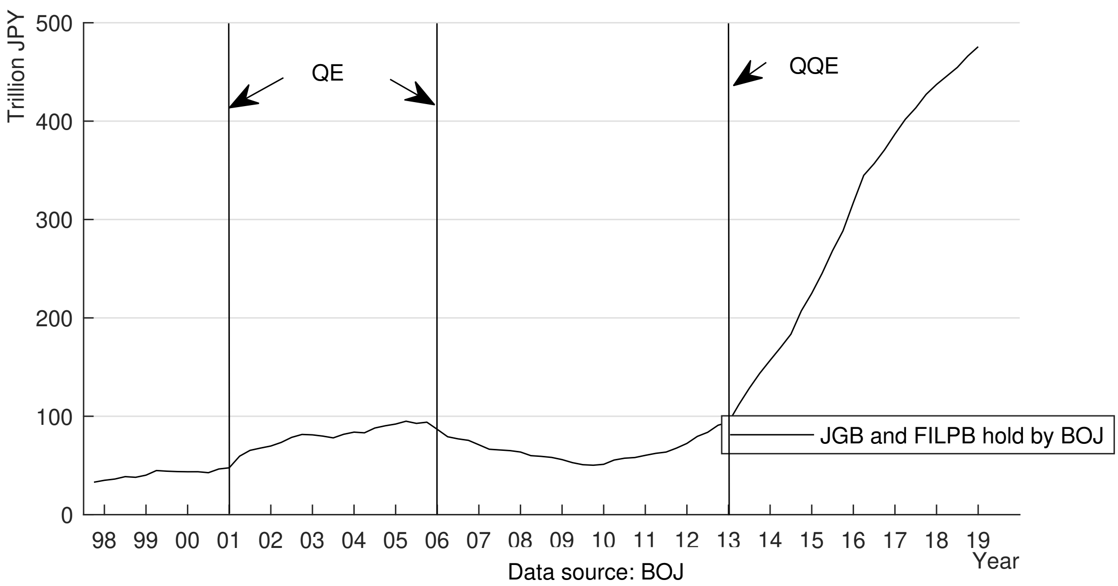

Figure 1: JGB and FILPB hold by BOJ(Trillion JPY)

Such substantial injections of money into the economy is an interesting topic and remains an area of widespread debate among policymakers and macroeconomists. Ideally, the injection of money at such a huge scale would expand the credit line of banks and in turn positively affect the economy. Figure 2 showed the Outstanding loans and Holding cash plus Deposits at BOJ by Japanese banks. As shown in the figure, there seems to be a positive correlation within these data. Some studies attempt to identify if the large value of excess reserves held by commercial banks will generate an increase in banks lending. Shioji (2019) used the panel data of Japanese banks and reported that bank lending is positively related to the excess reserves held by banks, but the magnitude of effects are different because the banks are heterogeneous. Honda et al. (2013) and Otsubo (2018) used aggregate time series data associated with a VAR approach to identify the transmission channel of UMP. They found that the connection between UMP and bank lending is not significant during the QE period, but it appears some positive effect during the QQE period. Regarding the different effect of the bank lending channel of UMP in the QE and the QQE period, as indicated in Hoshi and Kashyap (2004), the significant loan losses from the 1990s in Japan may still affect the economy in the QE period. Therefore, deal with the problem caused by bad debt and the non-performing loans was the priority objective at the time.

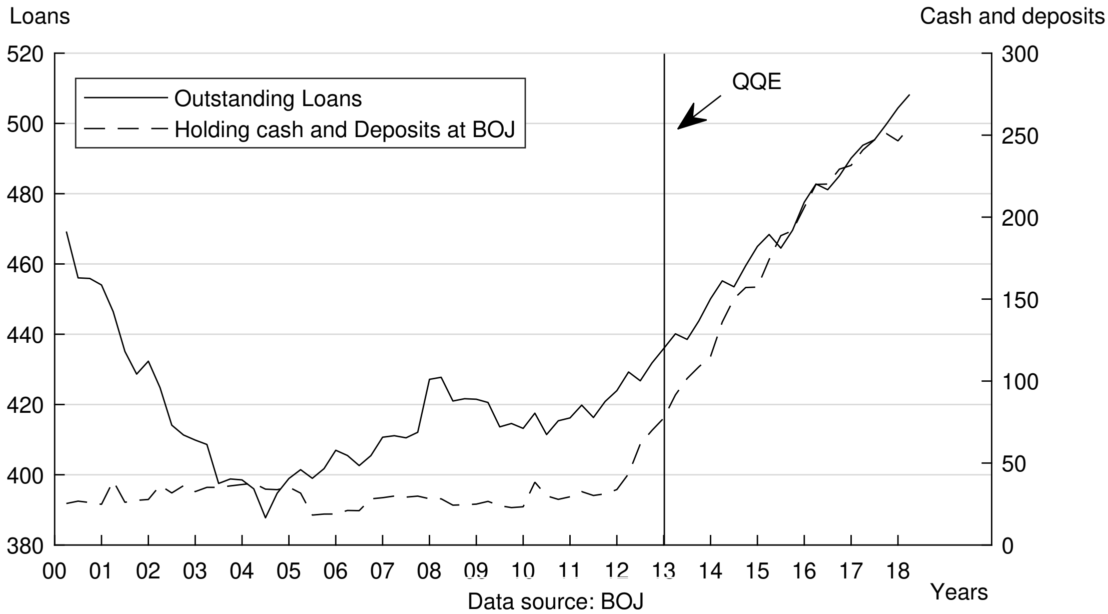

Figure 2: Outstanding loans and Cash plus deposits at BOJ of Japanese banks(Trillion JPY)

From the macroeconomics perspective, UMP is not associated with a clear theoretical basis since it is “unconventional”, which leads to the argument among whether these financial factors have crucial roles in the fluctuations of the economy. One of the perspectives suggests that a lowered level of TFP caused tightened financial constraints. Because a lowered level of TFP will lead to the situation that firms are not able to meet their expected profits, which is the major problem above financing funds. Hayashi and Prescott (2002) used a Neoclassic model and Kaihatsu and Kurozumi (2014) used a New Keynesian model who confirmed this perspective, that TFP shock is the main driven force in the fluctuations in the Japanese economy in the 1990s.

However, after the implementation of QQE, there is some evolution in macroeconomic data deserves a discussion. From 2013 to 2019, real GDP increased from 504 trillion to 538 trillion. In the same period, the number of private consumption barely moved, it increased from 297 trillion to 300 trillion. The driven force of the GDP growth is from private investment, it increased from 71 trillion to 88 trillion, account for nearly 50% of the growth in GDP. This scenario is shown in Figure 3, and it is computed in their share of GDP formation.

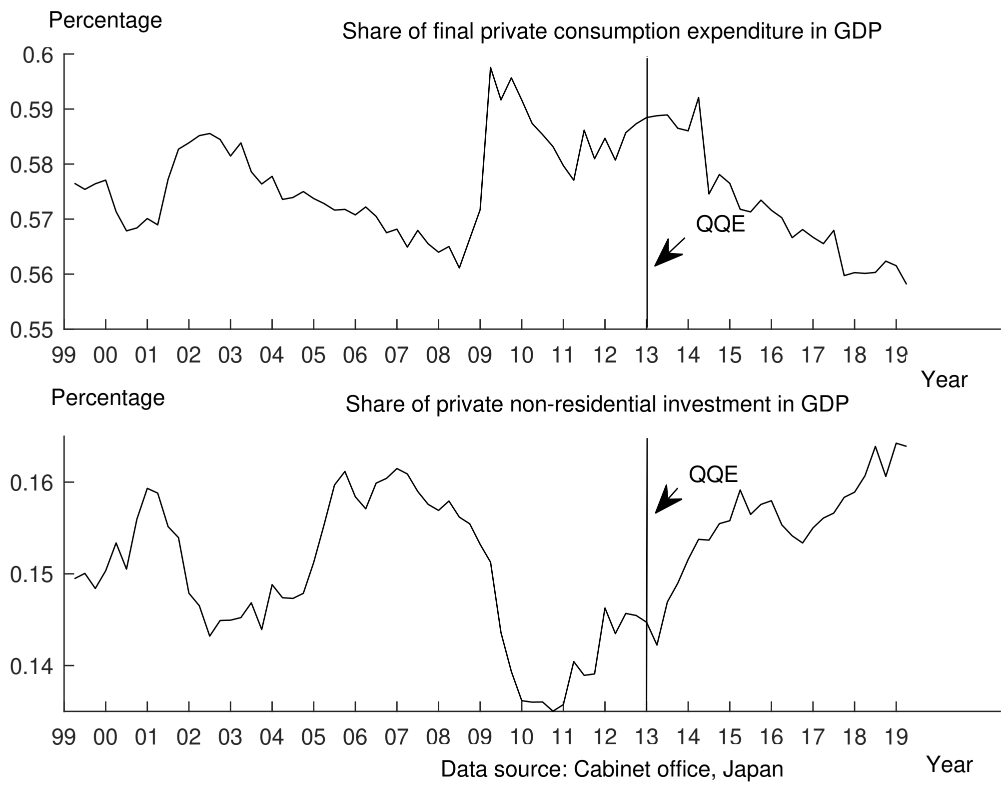

Figure 3: Share of Consumption and Investment in GDP (Seasonally adjusted)

Regarding this evolution of macroeconomic data, there is a perspective that suggests the financial factors do matter for the economy. As shown in Kiyotaki and Moore (1997), a model with the credit market imperfection, exogenous shocks can generate large fluctuations economy-wide. Moreover, the financial accelerator mechanism, studied in Bernanke et al. (1999), suggests there are propagation and amplification effect due to the financial conditions of firms. Specifically, in the financial accelerator mechanism, the more net worth the firms have, the less finance cost that firms face. After the Global financial crisis, Gertler and Karadi (2011)(GK) proposed a model with frameworks of endogenous financial intermediaries sector and a credit easing policy from the central bank. GK model shows that a credit easing policy can reduce the economic losses when the adverse shock hit.

Were the financial factors relevant to the fluctuations in the Japanese economy? Did the increased banks lending generated by UMP account for the fluctuations in the Japanese economy? To answer these questions, we conducted a Bayesian estimation of a DSGE model. The model we used for estimation is based mainly on the model proposed by Gertler and Karadi (2011)(GK). We found that by shocks decomposition, the banks' credit supply shock accounts for a large part of fluctuations in the data of GDP and investment. Moreover, we compared models with and without a credit policy, and the later model reported a higher marginal likelihood. This is meaning that the empirical data preferred a credit easing framework in the model. Finally, based on our estimation results, we argue Japan's UMP is effective in preventing increases in the intermediate cost of funds when adverse shocks hit.

The remainder of this paper is organized as follows: Section 2 describes model details, Section 3 presents details on the data and the estimation strategy, Section 4 summarizes the estimation results with a discussion, and Section 5 concludes the paper.

2 The GK model

The GK model has the following main features. First, there were non-financial firms who are financing funds from financial intermediaries, and financial intermediaries are facing an endogenous balance sheet constraint. Second, the central bank was allowed to conduct a credit policy through a market intervention, to intermediate funds. Third, nominal rigidities has been incorporated into the model, as in Christiano et al. (2005) and Smets and Wouters (2007).

We now briefly go through the GK model. There were six agents in the GK model, they are households, financial intermediaries, intermediates goods firms, capital producers, final goods retailers, and a central bank.

Households consume, supply labors and save. In addition, in each period the fraction f members of households are workers, and the $1 - f$ fraction members are bankers. Bankers are holding savings of households and then lend these funds to intermediates goods firms. In every period $1 - \theta$ of bankers exist and become workers, the remaining fraction θ stays bankers to next period. The profits of remaining bankers are from a riskless rate on their equity and a risky return on their total assets. The newly entered bankers are provided the fraction ω as their initial funds from households. Households objective function is given by

$$\max E_t \sum_{i=0}^{\infty} \beta_i [\ln(C_{t+i} - hC_{t+i-1}) - \frac{\chi}{1+\varphi} L_{t+i}^{1+\varphi}] \tag{1}$$

where β is discounted factor, h is the measure for consumption habit formation, χ, φ is the weight of leisure and the elasticity of labour supply. The fraction $1 - f$ of bankers maximize their total revenue by lending to non-financial firms and holding bonds.

$$V_{jt} = \nu_t Q_t S_{jt} + \eta_t N_{jt} \tag{2}$$

where Q_t is the relative price of assets, therefore $Q_t S_{jt}$ denoted bankers total assets and N_{jt} is the banker's net worth. ν_t and eta_t express the evolution of earnings on lending and the revenue of holding bonds. Revenue on lending earns a lending rate R_{kt+1} and holding bonds earns a rate R_t. In each period, the fraction λ of bankers assets will be transferred back to the household, and the cost of doing so is that bankers go into bankruptcy. This gives the following incentive constraints

$$V_{jt} \geq \lambda Q_t S_{jt} \tag{3}$$

The left side of equation (3) represents the loss for bankers from diverting funds, the right side is the result of diverting, that funds will hold by households as savings. Combines equation (2) and (3), the leverage ratio ϕ_t can be iterated

$$Q_t S_{jt} = \frac{\eta_t}{\lambda - \nu_t} N_{jt} = \phi_t N_{jt} \tag{4}$$

The dynamic of variable N_t is the combination of survival bankers N_{et} and new bankers N_{nt}, they are

$$N_{et} = \theta[(R_{kt} - R_t)\phi_{t-1} + R_t]N_{t-1} exp(-e_t^n) \tag{5}$$

$$N_{nt} = \omega Q_t S_{t-1} \tag{6}$$

where ω is the initial funds received by new bankers from households, $-e_t^n$ is a negative net worth shock.

In the GK model, a central bank is allowed to conduct a credit policy through market intervention. Thus, the assistance funds $\psi Q_t S_t$ will be injected into the financial market. This can be expressed by

$$Q_t S_t = \phi_t N_t + \psi_t Q_t S_t = \phi_{ct} N_t \tag{7}$$

The banker's assets will be lent to the intermediate goods firms through a frictionless capital market. At the end of period t, these funds will be transferred to the intermediate goods firms and be used as capital for production at the beginning of period $t+1$ by firms

$$Q_t K_{t+1} = Q_t S_t \tag{8}$$

Firm's production function is a general Cobb-Douglas type

$$Y_t = A_t (U_t \xi_t K_t)^\alpha L_t^{1-\alpha} \tag{9}$$

where U_t is the capital utilisation rate, and ξ_t denote the capital efficiency shock. There is a capital producing firms who repaired capital and build new capital, the objective function is give by

$$\max E_t \sum_{\tau=t}^{\infty} \beta^{T-t} \Lambda_{t,\tau} [(Q_\tau - 1) I_{n\tau} - f(\frac{I_{n\tau} + I_{ss}}{I_{n_{\tau-1}} + I_{ss}})(I_{n\tau} + I_{ss})] \tag{10}$$

where $f(')$ denote the investment adjustment cost. The capital accumulation process is given by

$$I_{nt} \equiv I_t - \delta(U_t)\xi_t K_t \tag{11}$$

Sticky prices are associated in the GK model, retailers set the optimal price P_t^* with the following objective function

$$\max E_t \sum_{i=0}^{\infty} \gamma^i \beta^i \Lambda_{t,t+i} [\frac{P_t^*}{P_{t+i}} \prod_{k=1}^{i} (1 + \pi_{t+k-1})^{\gamma_P} - P_{mt+i}] Y_{ft+i} \tag{12}$$

the evolution of the price level is given by

$$P_t = [(1-\gamma)(P_t^*)^{1-\varepsilon} + \gamma(\Pi_{t-1}^{\gamma_P} P_{t-1})^{1-\varepsilon}]^{1/(1-\varepsilon)} \tag{13}$$

where the parameter γ is denote the Calvo type sticky price, γ_p is the price indexation to past inflation. Monetary policy rule is a Taylor rule with interest-rate smoothing

$$i_t = (1-\rho)[i + \kappa_\pi \pi_t + \kappa_y (\log Y_t - \log Y_t^*)] + \rho i_{t-1} + \varepsilon_t \tag{14}$$

where the parameter κ_π,κ_y are the Taylor rule on inflation and the output gap, ε_t is a monetary policy shock. A credit policy is also allowed according to the following feedback rule

$$\psi_t = \psi + \nu E_t[(\log R_{kt+1} - \log R_{t+1}) - (\log R_k - \log R)] \tag{15}$$

when the risk spread increased, central bank will intervene financial market and conduct funds lending to the non-financial firms through the credit policy, by using funds from issued debt at the rate R_t and lend at the lending rate R_{kt}.

3 The estimation strategy and the data

3.1 Model calibration and prior distributions

Calibration of the model parameters was mostly followed Sugo and Ueda (2008) and Kaihatsu and Kurozumi (2014) who estimated a DSGE model for Japanese economy. For those the model specific parameters calibration, we followed Gertler and Karadi (2011). The habit formation parameter $h = 0.7$, the investment adjustment cost $f = 4$, survival rate of the bankers $\theta = 0.95$, Calvo price parameter $\gamma = 0.5$, Capital share in production $\alpha = 0.33$. For Taylor rule's monetary policy's smoothing parameter ρ_i, we calibrated it to $\rho_i = 0$ by considering that over our sample period zero interest rate has become a common state, where the central bank's attention was focused on output and inflation more than the past interest rate. Table 1 summarized the prior setting of the model parameters.

Table 1: Prior information (parameters)

Parameters	Description	Distribution	Mean	Std.dev.
e^a	S.D. of Technology shock	Inv. Gamma	0.1000	Inf
e^k	S.D. of Capital efficiency shock	Inv. Gamma	0.1000	Inf
e^g	S.D. of Government spending shock	Inv. Gamma	0.1000	Inf
e^n	S.D. of Bank net worth shock	Inv. Gamma	0.1000	Inf

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Table 1: (continued)

Parameters	Description	Distribution	Mean	Std.dev.
e^i	S.D. of Monetary policy shock	Inv. Gamma	0.1000	Inf
ρ_a	Persistence of Technology shock	Beta	0.5000	0.2000
ρ_k	Persistence of Capital efficiency shock	Beta	0.5000	0.2000
ρ_g	Persistence of Government spending	Beta	0.5000	0.2000
ρ_i	Monetary policy smoothing	Beta	0.5000	0.2000
κ_Y	Taylor rule on output gap	Gaussian	0.1250	0.0500
κ_π	Taylor rule on inflation	Gaussian	1.5000	0.5000
σ	Intertemporal elasticity of substitution	Gaussian	1.0000	0.3750
θ	Survival rate of the bankers	Beta	0.9500	0.0500
γ	Calvo sticky price	Beta	0.5	0.25
f	Investment adjustment cost	Gaussian	4.0000	1.5000
h	Habit formation	Beta	0.7000	0.1500

To conduct Bayesian estimation, we first log-linearized the model and then constructed a state space between the model and the observables. As in many previous studies, we used Dynare to conduct a Bayesian estimation. We set two MCMC chains to estimate and pick the one with higher acceptance rate to conduct our analysis. Each chain was applied to the Metropolis-Hastings algorithm to generate 250,000 draws from the posterior distribution of model parameters, first 50,000 of has been discarded. Based on the remaining 200,000 of the draws, we conduct empirical analysis.

3.2 The data

We pick macroeconomic data for the best fit of the model. Data are aggregate quarterly GDP as a measure for output, households final expending for consumption, non-residential investment for investment, Consumer Price Index excluding food for the price level, overnight call rate for the nominal interest rate. The time horizon for data is 1999:Q1-2017: Q4, where the data we picked is from the beginning of the zero interest rate policy. The first three data are from Cabinet Office, and the CPI is from Statistics Bureau, overnight call rate is from Bank of Japan. To give data access to the model, observation equations need to be constructed. We first take logs of the data and then pass the data through one-side Hodrick-Prescott filter. The corresponding observation equations are

$$\begin{bmatrix} \log Y^{obs} \\ \log I^{obs} \\ \log C^{obs} \\ \pi^{obs} \\ i^{obs} \end{bmatrix} = \begin{bmatrix} Y_t - Y_{t-1} \\ I_t - I_{t-1} \\ C_t - C_{t-1} \\ \Pi_t \\ i_t - i_{t-1} \end{bmatrix}$$

4 Estimation results

4.1 Posterior distribution of the model parameters

Table 2 reports the estimated posterior of the model parameters value. In posterior distribution, the parameter of investment adjustment cost f increased significantly, from prior value of 4 to posterior mean of 5.997. This is consist with Iiboshi et al. (2006) and Sugo and Ueda (2008), that indicating the motion of the investment data in Japan need to be treated in a specific way. Taylor rule on inflation κ_π increased from prior value of 1.5 to posterior mean to 1.727, which is meaning that the nominal interest rate is reacting more aggressively to inflation compared to the prior information we have. Habit formation parameter h decreased from prior value of 0.7 to posterior mean of 0.631, such a decrease might indicate that households optimal consumption decision is less relying on the value of consumption made on last period. Calvo price parameter γ increased from prior value of 0.5 to posterior mean of 0.746, such an increase might suggest that the motion of firms prices re-optimization is less frequent.

Table 2: Results from Metropolis-Hastings (parameters)

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
ρ_a	beta	0.500	0.2000	0.584	0.0267	0.5363	0.6238

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Table 2: (continued)

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
ρ_k	beta	0.500	0.2000	0.656	0.0285	0.6081	0.7019
ρ_g	beta	0.500	0.2000	0.952	0.0202	0.9220	0.9876
ρ_i	beta	0.500	0.2000	0.024	0.0140	0.0035	0.0453
κ_Y	norm	0.125	0.0500	0.211	0.0153	0.1889	0.2374
κ_π	norm	1.500	0.5000	1.727	0.0773	1.6176	1.8618
σ	norm	1.000	0.3750	1.976	0.1624	1.7191	2.2308
θ	beta	0.950	0.0500	0.980	0.0002	0.9797	0.9803
γ	beta	0.500	0.2500	0.746	0.0193	0.7166	0.7700
f	norm	4.000	1.5000	5.997	0.2130	5.7029	6.4102
h	beta	0.700	0.1500	0.631	0.0042	0.6238	0.6364

Table 3: Results from posterior maximization (standard deviation of structural shocks)

	Prior			Posterior	
	Dist.	Mean	Stdev	Mode	Stdev
e^a	invg	0.100	Inf	0.0539	0.0205
e^k	invg	0.100	Inf	0.0174	0.1898
e^g	invg	0.100	Inf	0.0341	0.0031
e^n	invg	0.100	Inf	0.6081	0.8663
e^i	invg	0.100	Inf	0.0254	0.1077

Table 3 reports the exogenous shock variables, the shock to bank net worth e^n occurs most frequently at the value of 0.6081 with a standard deviation of 0.8663. Such values suggest that the variations of bank net worth frequently shifted during the estimation. The second most crucial shock is the TFP shock e^a, with a persistence coefficient of 0.584.

The posterior of the model parameters is quite satisfactory that the estimation results are mainly matched the phenomenon in the Japanese economy. Interest rate smoothing parameter acted in a lower position of the value 0.024, that is, from the period of zero interest rate policy, Japan's interest rate was hardly fluctuated, therefore the effect of the conventional monetary policy was limited.

4.2 Is the credit policy functional?

In this section, we report the impulse response when the exogenous shocks hit the model. There are five shocks in the model: the technology shock, government spending shock, bank net worth shock, capital efficiency shock, and monetary policy shock. Each of these shocks has been generated in a negative direction to observe when adverse shocks hit the model. We set the credit policy parameter $\nu = 100$, which is meaning that there was a market intervention operation that has been conducted exogenously during our sample period. In other words, we assume the UMP has enhanced the flow of funds lending. As we show in later of this section, the marginal likelihood of the model is supporting this model setting.

Figure 4 reports the observables response to a negative technology shock. The direct influence of a negative technology shock is a reduction in output and investment. This will lead to an increase in price level because firms will reset the optimal price level to maximize their profits. Therefore, households will consume less. A fall in investment also has an adverse effect on asset prices, which will cause a tightening in banks balance sheet and reduce its efficiency in intermediate funds.

Figure 5 reports the response to a negative bank net worth shock. A decrease of bank net worth worsens banks financial condition and encourage banks to increase the lending rate, which will lead to a reduction in total lending since banks have an endogenous constraint. Investment falls under such a situation, so do the output. Therefore, households are not able to consume more, which will also cause an adverse effect on inflation.

Figure 6 is generated from models with and without a credit policy. Specifically, the parameter of credit feedback rule ν has been set to equal 0 to capture the model behavior without a credit policy, and set $\nu = 100$ to allowing a market intervention by a central bank. As showed in Figure 6, when a negative net worth shock hits the economy, credit policy can reduce falls in output and investment. The mechanism works as follow: when a negative net worth shock hit, bank's ability of intermediating becomes less efficient due to a worsened financial condition, which will lead banks to increase lending rate. Increased lending rate further triggers a reduction in investment and this reduction will transmit to the output. The conduction of credit policy can recover the leverage ratio of banks when the shock hit, therefore, recovered the bank's financial condition will no longer trigger a further adverse effect. This mechanism has shown in the impulse response, that a credit policy is reducing the losses in output and investment and the length of their recovery path. We also conducted the model comparison by associating marginal likelihood. A model without a credit policy has a marginal likelihood of 825.29, where a model with a credit policy has a marginal likelihood of 985.89. This implies that the data set preferred the later model.

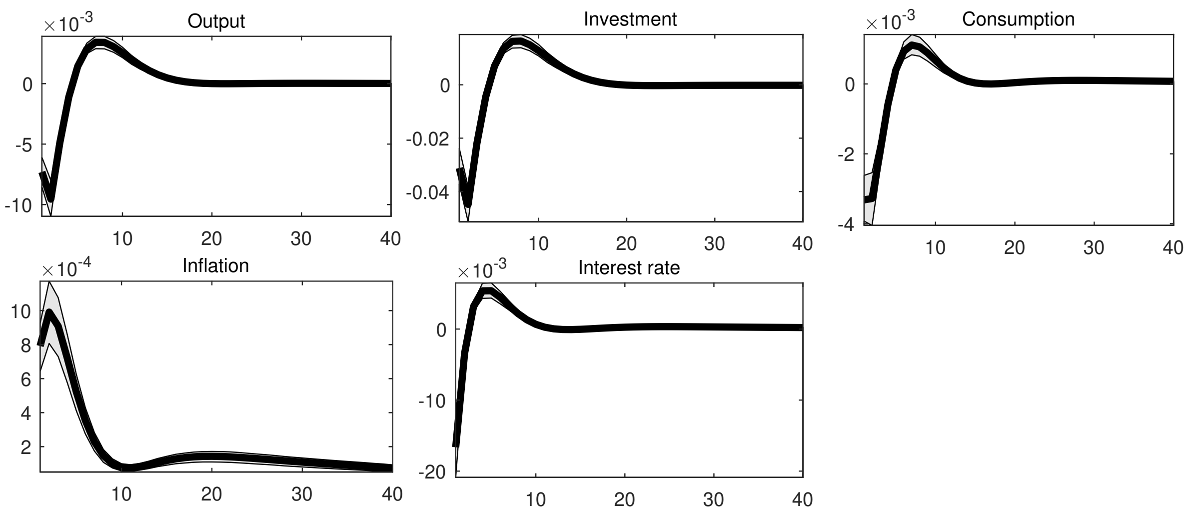

Figure 4: Estimated impulse response function: Technology shock

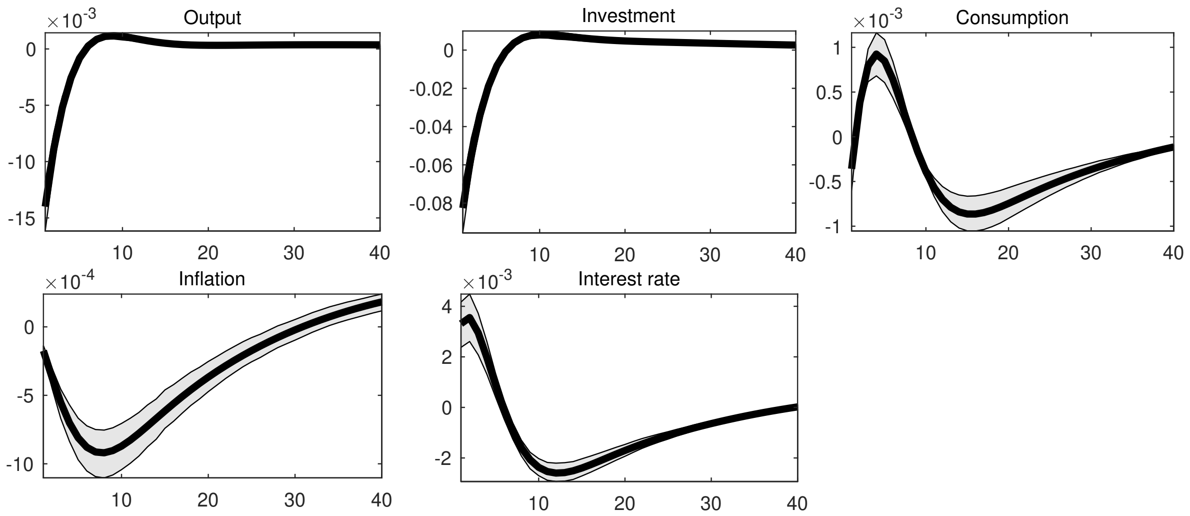

Figure 5: Estimated impulse response function: Net worth shock

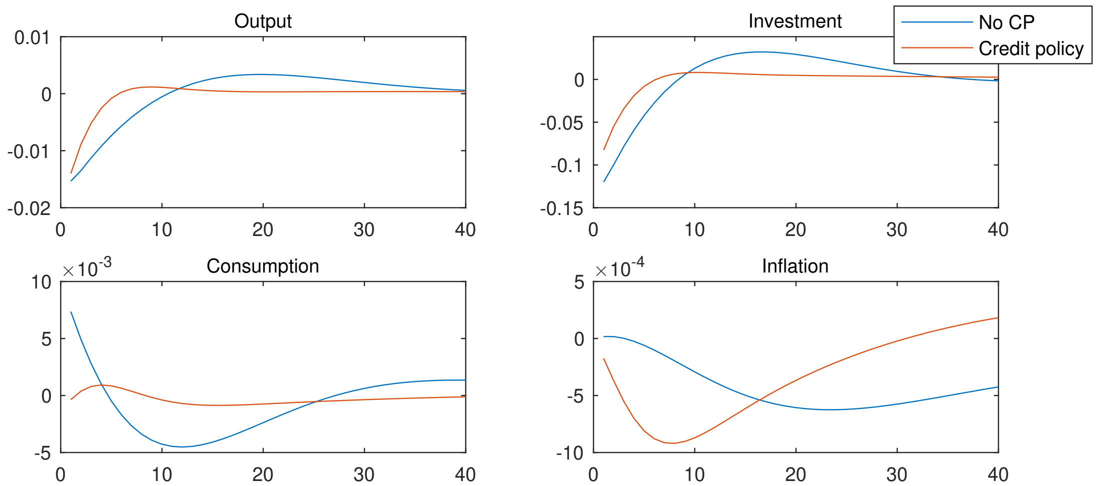

Figure 6: Estimated impulse response function comparison: Net worth shock

4.3 Which shock contributed to the fluctuations of the economy?

In this section, we discuss which shock contributes to the fluctuations by studying the shock decomposition. The data we used for estimation has been detrended by pass the data through one-side HP filter.

Therefore, the cycle components in the data have been excluded. The black line in Figure 7 represents the output fluctuation. The plotted color bars is representing the contribution of five shocks in the model. The vertical axis represents the deviation from the cycle components in log level, where 0.1 is corresponding to 10% deviation. The horizontal axis is corresponding to the frequency of the data, which is, one quarter.

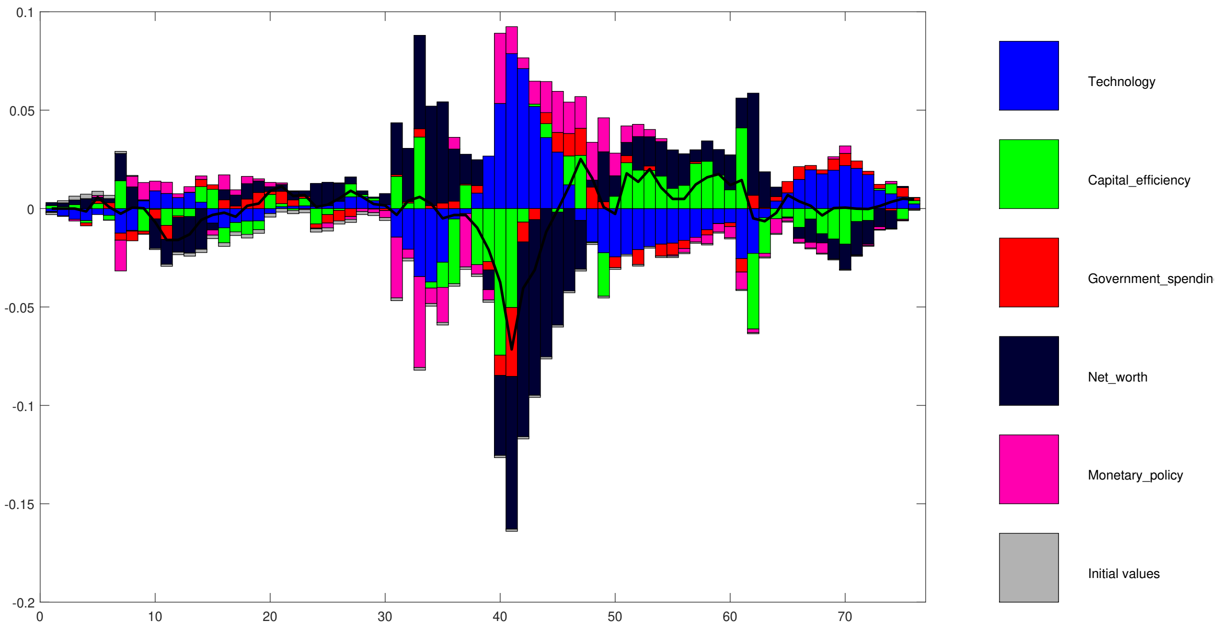

Figure 7: Historical shock decomposition : Output

Vertical axis: deviation from steady state, 0.1 = 10%. Horizontal axis: 1 = one quarter data, 4 = one year, starting from 1999

As the figure shown, technology shock and net worth shock are primary sources in the fluctuation of output. Moreover, during the sub-prime loans crisis in 2008, there was a nearly 10% sharp fall in output. In this sharp fall, bank net worth shock, capital efficiency shock, and government spending shock contributed downturn effects. This is implying that in the crisis, not only the quality of capital produced a downturn, but also there is a downturn produced by the worsened bank's balance sheet condition, which is consisted with the accelerator mechanism. Since the model for estimation is a closed economy model, government spending shock captures the remaining effect that might come from the external factor, that is, external demand is included in this shock. Technology shock contributed in a positive direction. The potential explanation is that this crisis did not hurt the production ability of domestic firms.

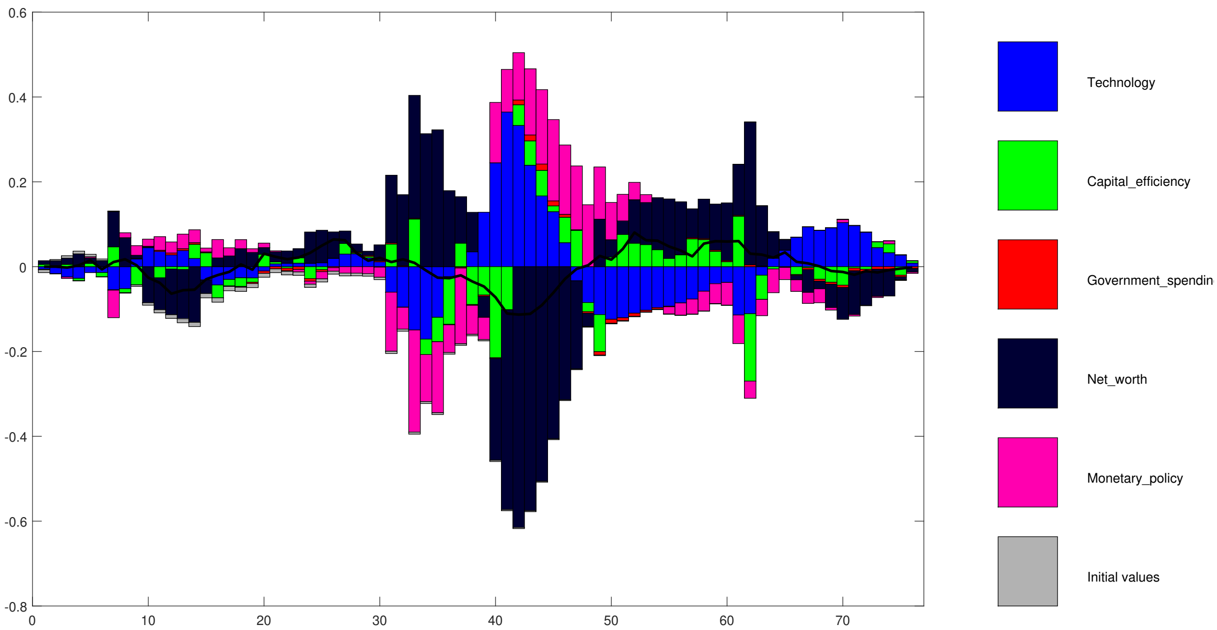

Figure 8: Historical shock decomposition : Investment

Vertical axis: deviation from steady state 0.1 = 10%, Horizontal axis: 1 = one quarter data, 4 = one year, starting from 1999

Figure 8 showed the shock decomposition to the investment fluctuation. Besides the contribution from technology shock, there is also significant influence from the financial sector. The black bar in Figure 8 represents the net worth shock, and we can observe there is a positive correlation between net worth shock and the investment fluctuation. This is implying when there is a expand in investment, a functional financial market is always able to produce a positive effect, to accelerate the expansion. Conversely, when a sharp fall occurred, the degree of the fall will also be accelerated. Note that in 2008, the fall in investment is almost explained by a negative net worth shock. This is meaning that firms are not able to obtain funds from financial intermediaries because there is a substantial negative shock that caused financial intermediaries to pursue profits by increase the lending cost for firms. Therefore, because of increased funds financing cost from banks, firms will demand fewer resources for production.

After the crisis, investment recovered, so the net worth shock turned into a direction of positive effect.

4.4 Decreased bad debt in QE and increased investment in QQE

While there was a negative growth of outstanding loans in the QE period, there also evidence that indicates the handling of bad debt and non-performing loans is responsible for this negative growth. Since we are not able to find the actual data about the total value of bad debt in QE period, we then examine the time series data of banks reserve for possible loan losses, shown in Figure 9.

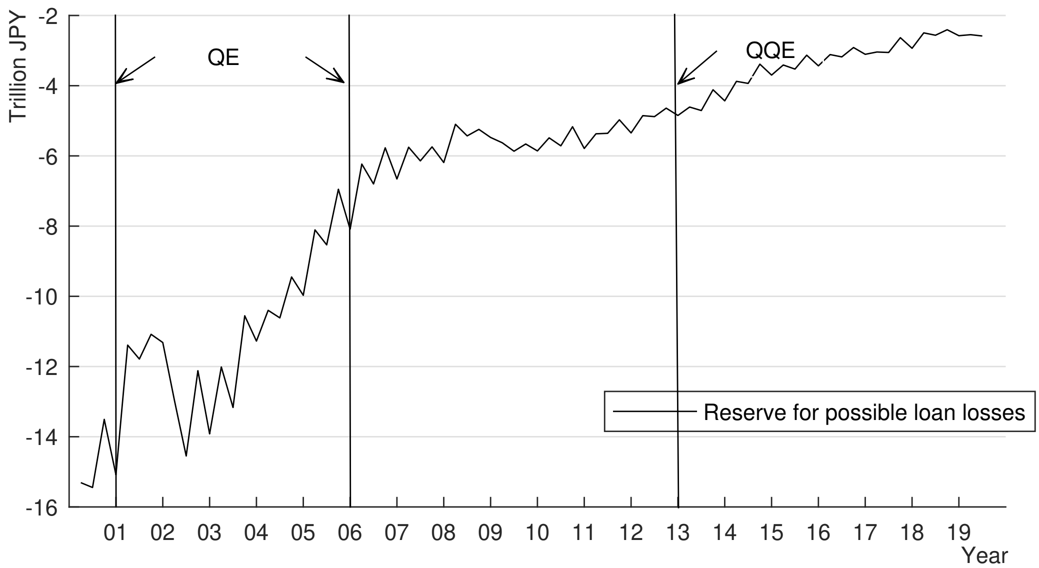

Figure 9: Reserve for possible loan losses

As shown in the figure, there is a visible improvement during QE period. Behind the handling of bad debt and non-performing loans, there were other problems faced by Japanese banks at the time. Fukuda et al. (2006) indicates that the deteriorated bad debt ratio of Japanese banks drives the banks to lend more to the “zombie firms”, the firms who are already economically bankrupted. Because by doing so, it can help the banks to stay away from realizing losses on their balance sheet. From the firms perspective, Ogawa (2007) reported that the outstanding bad debt leads to the reduction in the firm’s R&D investment. These studies supported the views that during QE period, the priority objective is to the handling of bad debt and then induce the financial system back to functional.

This is consistent with the financial accelerator mechanism in the model. When the adverse shock hits, the incentive for financial intermediaries to gain more profits, which is also the incentive for them to stay away from realizing losses caused the inefficiency in lending. At the same time, adverse shocks also increase firms' cost in financing funds, therefore, investment decrease.

In comparison, there is not a severely bad debt issue or the inefficiency in lending in the QQE period. By our estimation results, an increased credit supply accounts for the fluctuations in the sample period of GDP and investment, which is meaning that the increased bank lending generated by UMP induced increases in investment, and in turn positively affected the total output.

5 Conclusion

We estimated the GK model by using Bayesian techniques for the Japanese economy. By our estimation results, a model with an endogenous financial intermediary mainly explained the fluctuations in the Japanese economy. The behavior of the financial sector seems to account for a large part of the fluctuations, and the UMP is effective in the sense of supplying banks enough funds. Therefore, we argue that financial factors are important in the economy and it should be considered in the policy-making process.

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