行政院國家科學委員會專題研究計畫 成果報告

信用傳遞機制，金融風暴與政府政策之總體經濟意涵
研究成果報告(精簡版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 98-2410-H-004-058-
執 行 期 間 ：98 年 08 月 01 日至 99 年 10 月 31 日
執 行 單 位 ：國立政治大學經濟學系

計 畫 主 持 人：黃俞寧

計畫參與人員：碩士班研究生-兼任助理人員：賴建男
碩士班研究生-兼任助理人員：何佩螢
碩士班研究生-兼任助理人員：林銘峰
博士班研究生-兼任助理人員：陳冠彰
博士班研究生-兼任助理人員：簡義哲

報 告 附 件 ：出席國際會議研究心得報告及發表論文

處 理 方 式 ：本計畫可公開查詢

中 華 民 國 100 年 01 月 21 日

行政院國家科學委員會補助專題研究計畫 √ 成 果 報 告 □期中進度報告

（計畫名稱）

信用傳遞機制，金融風暴與政府政策之總體經濟意涵

計畫類別：√ 個別型計畫　□整合型計畫
計畫編號：NSC　98 － 2410 － H － 004 － 058 －
執行期間： 98 年 08 月 01 日至 99 年 10 月 31 日

執行機構及系所：政治大學經濟系

計畫主持人：黃俞寧
共同主持人：無
計畫參與人員：陳冠彰，簡義哲，賴建男，何佩瑩，林銘峰

成果報告類型(依經費核定清單規定繳交)：√精簡報告　□完整報告

本計畫除繳交成果報告外，另須繳交以下出國心得報告：
□赴國外出差或研習心得報告
□赴大陸地區出差或研習心得報告
√ 出席國際學術會議心得報告
□國際合作研究計畫國外研究報告

處理方式：除列管計畫及下列情形者外，得立即公開查詢
□涉及專利或其他智慧財產權，√一年□二年後可公開查詢

中　華　民　國 100 年 01 月 21 日

Macroeconomic Implications of Policies under Financial Crisis

Yu-Ning Hwang[1]

Department of Economics

National Chengchi University

December 2010

ABSTRACT

The objective of this study is to examine quantitatively the macroeconomic implications of monetary and fiscal policies on the economy under a financial crisis. By using the model in Goodfriend and McCallum (2007) which introduces a banking sector in a dynamic stochastic general equilibrium (DSGE) model, we can investigate the effects of rescue policies in response to shocks to the credit market, the primary cause of the financial crisis. The model with money and banking permits the endogenous determination of various interest rates and the external finance premium, instead of one single interest rate in conventional settings. The calibration results are in line with the consensus recently reached by most economists. A fiscal policy which is large and is implemented rapidly can precipitate economic recovery better than the other way round. In addition, since the external finance premium declines with the implementation of the fiscal policy, it may dampen the crowding-out effects of expansionary government expenditure. On the other hand, the expansion in the high-powered money is more effective as a policy than the interest rate cuts. This is because the expansion in the base money increases bank reserves, facilitates deposits and encourages consumption, a mechanism that is absent from a model that neglects money and banking.

Keywords: Credit channel, Financial crisis, External finance premium

JEL Classifications: F13; F41; E42

[1] *Yu-Ning Hwang is an Assistant Professor in the Department of Economics at National Chengchi University, Taipei, 116 Taiwan. Comments are most welcome. Contact details: e-mail to yuning@nccu.edu.tw; Tel.: 886-2-29393091 ext. 51641. I am grateful to Professor Tien-Wang Tsaur, Fu-Sheng Hung and all the participants in the Conference for the Financial Crisis and the seminar at the Central Bank of the Republic of China (Taiwan) for helpful comments and suggestions.

1. Introduction

The objective of this research is to examine quantitatively the effects of monetary and fiscal policies under a financial crisis which was triggered by dysfunctional credit markets. A dynamic stochastic general equilibrium (DSGE) model that includes the banking sector is established for policy analyses, following Goodfriend and McCallum (2007). In this model, shocks to the credit markets can characterize the current financial crisis that initiated from the credit markets. Equipped with the adequate specification of financial shocks, this study conducts calibrations based on the US data to evaluate the effects of different monetary and fiscal policies, in line with the current debates on alternative specifications of rescue policies in reaction to the worst financial crisis since the Great Depression decades ago. Moreover, while most economists' arguments are based on earlier theories, this study examines policies with a structural framework which offers a different angel to analyze policies' effects through numerical assessments.

The crisis broke out by the end of 2006 when the subprime mortgage default rates rose sharply after the housing bubble burst in 2005. Starting from the beginning of this century, consecutive interest rate cuts allowed banks to make loans to low-income families without the need to exercise prudent control over the credit risks. These loans were funded by loan-backed securities which were available worldwide. Aided by an extraordinarily easy monetary policy, investors could easily obtain funds with high leverage for investments, and even on low-quality asset-backed securities. Therefore, the housing crunch led to a chain of events: the value of the collateral for the mortgages fell, and this was immediately followed by mounting default rates, which caused sharp declines in the values of the underlying securities and in turn the asset markets as a whole. The slump in the values of the asset-backed securities led to a deterioration in the balance sheets of banks and firms, and this gave rise to difficulties in raising funds. The deterioration in the balance sheets exacerbated the problem of information asymmetry in the credit markets, and led to credit contractions in both the financial and real sectors, which resulted in recessions worldwide. The failure to monitor the loans and the decline in the collateral values were two of the main causes of the financial crisis.

During a financial crisis when markets fail to function normally, governments play an essential role as Keynesian theory suggests. Initially, central banks all over the world implement expansionary monetary policies by cutting interest rates, which can be performed both quickly and flexibly. However, in contrast to normal times, the effects of interest rate rules seem to be limited in the event of a financial crisis and fail to offset the recession that the crisis brings about. Hence, a massive fiscal stimulus is needed. However, the specification of the policy is critical. The timing, size and priority areas of the spending remain an open question.[2]

In the past decade, the DSGE model has served as the primary platform for the monetary policy analyses of central banks all over the world. Nevertheless, while various asset market structures, complete or incomplete, have been examined extensively under this framework, they are not the primary cause of the current financial crisis. Therefore, it is crucial to include the credit market. It thus seems to be natural to start from a model with a credit channel, which stresses the credit market's imperfections, as initially proposed by Bernanke and Blinder (1988), followed by Bernanke and Gertler (1989, 1995), Bernanke, Gertler and Gilchrist (1998) and others. Bernanke and Gertler (1988) state that rising interest rates, which are caused by a tightening of monetary policy, may worsen balance sheets, raise agency costs and lead to higher loan rates for borrowers. The rise in the loan rate gives rise to a higher external finance premium (EFP), which is the difference between the loan rate and the cost of internal funds. As a result, the movement in the EFP can signal the asymmetric information problem in the credit markets and exacerbate the downturn in economic activities. Therefore, the credit channel serves as the financial accelerator of monetary policy, as has been illustrated by many studies. Edwards and Vegh (1997), Kiyotaki and Moore (1997), Carlstrom and Fuerst (1997), Kocherlakota (2000) and Cooley and Marimon (2004) have made substantial contributions to credit channel studies.

In line with the literature on the DSGE model and credit channels, the model presented in Goodfriend and McCallum (2007) (henceforth, GM (2007)) offers a good platform to understand the causes and transmission mechanism of financial crises which initiates from the credit market. The model is essentially a combination of the DSGE model and the credit channel. While other models on

[2] In a presentation at the January 2009 meeting of the American Economic Association, Feldstein (2009) stated that big and quick spending on increasing aggregate activity and employment is required.

the credit channel include real sectors only, GM (2007) highlight the role of money in an economy with a banking sector. They argue that the omission of money would lead to the role of the demand for money in facilitating transactions, which may attenuate the effects of the financial accelerator, being neglected. On the other hand, it is also the first study to introduce the banking sector in a DSGE model.[3] In the model, the loan services that the banking sector offers require monitoring efforts and collateral consisting of bonds and capital. As a result, the interest rates on the financial services and assets, namely, the loan rate, bond rate, deposit rate and interbank rate, are endogenously determined. The external finance premium (EFP) can be generated accordingly.

In this model, two shocks exist in relation to the credit markets, in addition to the productivity shock to the production sector. One is the efficiency of the monitoring effort and the other is the effectiveness of the collaterals for loans, which resemble the causes of the current financial crisis. GM (2007) calibrates the model based on US data and finds that the EFP is generally countercyclical and that the financial shocks do raise the EFP, thus signaling the rising agency costs in the market, which is consistent with the credit channel literature. However, the calibration results also show that the EFP may be procyclical in some cases due to the "financial attenuator" caused by the demand for money.

This model is good for the analyses on policies in response to the current financial crisis for several reasons. First, the financial shocks they adopt in the model can well characterize the financial turmoil that occurred since 2007. Second, the calibrations show that the rise in the EFP with the financial shocks is in line with the data for the EFP since the beginning of this century, as shown below. Third, this framework allows us to examine alternative fiscal and monetary policies. Differing from GM (2007) which performs the analyses in order to understand the implications of the monetary policy for the shocks, this study will focus on the effects of alternative monetary and fiscal policies in the event of a financial crisis. In line with recent debates on the rescue policies in relation to the financial crises all over the world, both the expansionary monetary and fiscal policies are examined.[4]

[3] For example, Glarida, Galí and Gertler (1999, 2000, 2002) and Kollmann (2002), Schmitt-Grohé (2002), and Sutherland (2006) who use the prevalent DSGE models for monetary policy studies do not consider the role of banking in their models.

[4] In this study, I do not intend to discuss the bailouts which have brought up substantial controversy for three reasons. First, the bank in this model does not hold any financial assets and thus does not face a deteriorating balance sheet due to the decline in asset prices as is the case with many of the banks suffering nowadays. Therefore, it would be difficult to formulate such bailouts in an attempt to prevent the bank from encountering bankruptcy. Secondly, this study will focus on the macroeconomic implications of the financial crisis and related policies, instead of the rising agency cost which is the

Two fiscal policies are proposed: one that involves a small but persistent amount of public spending, and another that consists of a large amount of government spending that is less persistent. While both of them are able to help the economy recover from the recession, the first policy causes the economy to recover sooner than the second at the cost of drastic initial drops in consumption and investment. Due to the initial decline in consumption, a massive amount of financial spending that takes place quickly may be more desirable, as Feldstein (2009) points out.

Furthermore, it is worth pointing out that, while the importance of the credit channel to the monetary policy transmission mechanism has been well recognized in the literature, no studies have performed an examination of the transmission of fiscal policy based on the credit market paradigm. However, the banking sector may play a significant role in the transmission of fiscal policy, similar to what it does in the case of monetary policy. The calibration results in this model show that the EFP declines with the government expenditure, and thus may offset the crowding-out effect of expansionary fiscal policy. The decline in the EFP in this model does not imply the existence of a lower asymmetric information problem (the moral hazard problem which is one of the main concerns in regard to large bailouts) under fiscal policy, but demonstrates that the fiscal policy alters the demand for and supply of loans and deposits, causing loan and deposit rates to move divergently.

Two monetary policies are examined as well, namely, the conventional monetary policy on the control over the high-powered money and the interest rate rule. The calibrations show that the expansion in the monetary base can boost the economy. The effect essentially comes from its direct influence on the demand for money to facilitate consumption. The effect of the interest rate rule, however, strongly depends on the persistence of the financial shock. If the credit market can be restored quickly and thus more loans can be made out of the same amount of collateral, a small interest rate cut is good enough for the economic recovery. On the contrary, persistent financial shocks nullify the interest rate rule. This result may explain the fading effect of the interest rate since the crisis started.

Even if this model can serve as a good platform for policy analyses under a financial crisis, there are certain restrictions due to the massive model structure. First, there are no defaults. The model

primary concern of bailouts. Thirdly, no study has so far incorporated fiscal policies into this framework.

characterizes the credit market imperfection by the decline in the effectiveness of capital as collateral for loans, but there are no defaults for loans even if the value of the collateral has been low. While the crisis may have been triggered by the surging default rates, this assumption seems to be unrealistic and could be relaxed in future studies. Moreover, there are no investments. The capital in this model is thus assumed to remain at the steady state level and the movements in investment are completely reflected by the changes in the value of capital.

The remainder of this paper is organized as follows. In Section 2, we present the data on the EFP from the beginning of this century, and the analysis illustrates that the EFP surged when the financial crisis broke out. Section 3 outlines the specifications of the model. The dynamic analyses are listed in Section 4 to discuss the dynamic responses of the macroeconomic variables in response to shocks to policies and the financial sector, respectively. Several rescue policies for the financial crisis are examined in Section 5. This analysis centers on the effects of fiscal policies of different sizes and speeds as well as on alternative monetary policies. Section 6 concludes.

2. The significant movements in the EFP under financial crises

Fig. 1 lists the differences between the prime loan rate and the Federal funds rate[5], which constitute the external finance premium (EFP), in the early part of this century. While the EFP was fluctuating at around the 3% level, it jumped up significantly in December 2000 and September 2001 after the Internet bubble burst and the Enron scandal came to the fore. Similarly, the EFP also rose in August 2007 when the subprime crisis started to spread, followed by the sharp rise in mid-September 2008 after Lehman Brothers went bankrupt. While the Fed decided not to bail out Lehman Brothers, the EFP remained at a high level throughout the last quarter of 2008. It was because the worsening balance sheets of firms led to higher financing costs for borrowers that the EFP was forced to rise. With the higher costs of external funds, firms cut back on their production, employment and investment

[5] We use the interbank rate, instead of the short-term CD rate for two reasons. While the EFP associated with the CD rate exhibits the similar pattern as the EFP that is obtained from the Fed funds rate before 2008, the CD rate was increased abnormally to a higher level, causing the EFP down to zero, even negative in Oct. 2008. Moreover, GM (2007) uses the interbank rate instead of the deposit rate to calculate the EFP because the values of these two rates are very close.

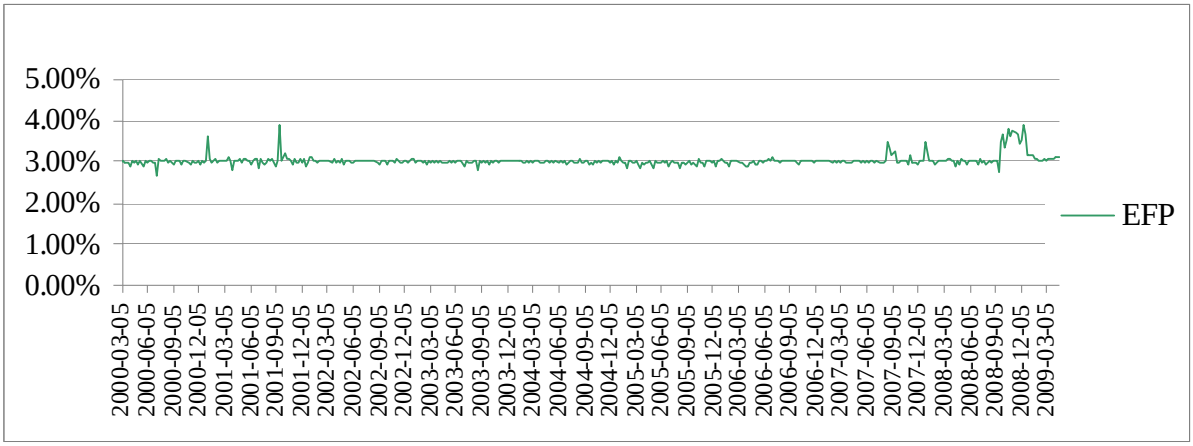

Figure 1: The External Finance Premium

projects.

It is evident that the EFP rose sharply in times of financial distress, signaling the worsening of the asymmetric information problem in the credit market. These times were

usually followed by economic recessions and thus were countercyclical as argued by Bernanke and McCallum (1995). Therefore, it is important to use a model under which the loan and interbank interest rates can be distinguished and the EFP is determined endogenously to capture the rising EFP after the financial crisis and the asymmetric information problem that may exacerbate the downturn of the economy after the financial crisis.

3. Model

The primary difference between this model and a typical DSGE specification is the inclusion of the banking sector. In this model, consumers need to hold deposits in the bank for their own consumption, and the bank can make loans. The loan services require real capital and marketable bonds as collateral, along with labor input for credit monitoring. Therefore, households supply labor in both the goods and banking sectors, and hold real capital for goods production as well as the collateral for loan services.

3.1 Goods Market

Since the goods market is assumed to be monopolistically competitive, a typical consumption bundle consists of a variety of differentiated goods, formed according to the Dixit-Stiglitz composite consumption index with υ as the elasticity of substitution. The aggregate consumption index and the associated aggregate price level are shown below:

$$C_t = \left[\int_0^1 C_t^{i\frac{\upsilon-1}{\upsilon}} di\right]^{\frac{\upsilon}{\upsilon-1}}, \quad P_t = \left[\int_0^1 P_t^{i1-\upsilon} di\right]^{\frac{1}{1-\upsilon}}$$

Accordingly, the demand function for each individual good is:

$$C_t^i = \left[\frac{P_t^i}{P_t}\right]^{-\upsilon} C_t$$

where C_t^i and P_t^i are the consumption and price of good i, and C_t and P_t are the aggregate consumption and price indices. Goods can be used for consumption, capital investment and government expenditure. The aggregate capital good, K_t, and government spending, G_t, which are also composed of a variety of goods, are assumed to follow the same composition as the consumption goods.

The firm employs labor and capital for the production of goods and its productivity is subject to exogenous shocks. Thus, under monopolistically competitive markets, the goods market clearing condition for a typical good j can be written as:

$$K_t^{j\alpha}\left(A_t^P l_t^{dj}\right)^{1-\alpha} = AD_t\left(P_t^j / P_t\right)^{-\upsilon} \qquad (1)$$

where A_t^p denotes the productivity shock and α denotes the share of capital in production. AD_t represents the aggregate demand in the economy which can be written as $C_t + q_t I_t + G_t$, where δ is the depreciation rate, $I_t = K_{t+1} - (1-\delta)K_t$ and q_t is the market price of capital. Therefore, the profit of a typical firm, Π_t^{Fj}, can be stated as:

$$\Pi_t^{Fj} = AD_t\left(\frac{P_t^j}{P_t}\right)^{1-\upsilon} - w_t l_t^{dj} - q_t K_t^j$$

where w_t states the wage rate and r_t is the rental rate on capital. l_t^d represents the labor demand of the firm.

To simplify the model, the capital stock is assumed to remain at the steady-state level, which is endogenously determined. Therefore, in each period, goods are invested simply for making up depreciation. While capital remains constant at the steady state level, q_t is the essential factor that determines the investment movements.

3.2 Households

The representative individual household obtains utility from the consumption bundle and labor supply:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\gamma \tilde{C}_t^{i(1-\rho)} / (1-\rho) + (1-\gamma) \log\left(1 - l_t^{si} - n_t^{si}\right) \right]$$

where

$$C_t = \left(\varphi C_t^{-\rho} + (1-\varphi) G_{t-1}^{-\rho}\right)^{-1/\rho}$$

l_t^s and n_t^s are labor supplies in the production and banking sectors, respectively. β is the subjective time preference. The budget constraint for the household can be written as:

$$q_t I_t^i + \frac{B_t^i}{P_t} + \Pi_t^{F_i} + \frac{\left(1+R_t^D\right) D_{t-1}^{di}}{P_t} - \frac{\left(1+R_t^L\right) L_{t-1}^{di}}{P_t} + w_t \left(l_t^{si} + n_t^{si}\right) + r_t K_t^i = \frac{B_{t+1}^i}{P_t \left(1+R_t^B\right)} + C_t^i + T_t + \frac{D_t^{di} - L_t^{di}}{P_t} \qquad (2)$$

Households hold two types of assets, bonds B_t and demand deposits D_t. The interest rates associated with the bond and deposit are R_t^B and R_t^D respectively.[6] In addition, they borrow from the bank L_t at the loan rate R_t^L. The superscript d is used to denote the demand of the assets from the households. T_t is the lump-sum tax.

Here, household faces the deposit-in-advance constraint, which is binding every period:

$$C_t^i = \frac{\nu D_t^i}{P_t} \qquad (3)$$

where ν is a constant, reflecting the assumed rigidity, and D_t denotes the nominal deposit.

[6] As shown below, the balance sheet of the bank shows that $H_t = D_t - L_t$ in equilibrium, where the central bank acts as the reserve supplier. Together with the profit functions of the firm and bank, we can obtain the individual budget constraint in GM (2007).

3.3 Bank

The balance sheet for a typical banking sector is:

$$H_t + L_t = D_t \tag{4}$$

where H_t is the reserve that the bank holds toward the deposit and L_t represents the bank loans to households. Assume θ is the reserve ratio, thus $H_t = \theta D_t$ and $L_t = (1-\theta) D_t$. The loan service is provided by using labor for monitoring and collateral, which consists of the bonds and capital that the household holds. The loan production function can be written as:

$$L_t / P_t = F\left(b_{t+1} + A_t^k m q_t k_{t+1}\right)^{\eta} \left(A_t^n n_t\right)^{1-\eta}, 0 < \eta < 1 \tag{5}$$

where $b_{t+1} = B_{t+1} / P_t \left(1 + R_t^B\right)$ and η is the fraction of the collateral takes in the loan production. F characterizes the overall efficiency of the loan production and a higher value of F stands for more efficient loan making which incurs lower marginal cost. $0 < m < 1$ indicates that real capital embeds higher risk and is less efficient than bonds as collateral.[7] A_t^k and A_t^n are shocks to the collateral and monitoring efforts, respectively. The negative A_t^k indicates the financial distress resembling the current crisis which was triggered by the decline in the housing price, the collateral for mortgage. A negative shock to A_t^n, on the other hand, describes the lack of monitoring for loans.

3.4 Government

The government budget constraint can be written as:

$$G_t - T_t = \left(H_t - H_{t-1}\right) / P_t + B_{t+1} / P_t \left(1 + R_t^B\right) - B_t / P_t \tag{6}$$

where G_t is the government expenditure which is assumed to be exogenous[8].

[7] It is because real capital usually requires greater monitoring effort to verify its physical condition and market value.

[8] G_t is assumed to be zero in GM (2007).

3.5 Optimality Conditions

Under the model specifications, household i, as a worker and firm, chooses the variables l_t^{si}, l_t^i, n_t^{si}, n_t^i, K_{t+1}^i, P_t^i and B_{t+1}^i to maximize her utility, subject to the constraints, Eq. (1) and (2), with the multiplier ς_t and λ_t respectively. The associated first-order conditions are similar to those in GM (2007), except for the nonzero G_t. With the banking sector, the first-order conditions differ from those in conventional settings in the role of bonds and capital, which function as the collaterals for loans and thus provide additional liquidity services for households. Let

$$\Lambda_t = \eta C_t \Big/ \left(b_{t+1} + A_t^k m q_t K_{t+1} \right) \tag{7}$$

Then the Euler equation associated with the bond can be derived as the equation below:

$$\left(\frac{\gamma C_t^{-\rho}}{\lambda_t} - 1 \right) \Lambda_t - 1 + \beta E_t \left(\frac{\lambda_{t+1} P_t}{\lambda_t P_{t+1}} \left(1 + R_t^B \right) \right) = 0 \tag{8}$$

The first term of the Eq. (8) stands for the loans that one unit of the bond can support. Similarly, the capital also yield similar liquidity service, and thus the condition with respect to capital possesses the additional term in the front:

$$\left(\frac{\gamma C_t^{-\rho}}{\lambda_t} - 1 \right) m \Lambda_t q_t - q_t + \beta \left(1 - \delta \right) E_t \left(\frac{\lambda_{t+1}}{\lambda_t} q_{t+1} \right) + \beta \alpha \left(\frac{\varsigma_{t+1}}{\lambda_t} \left(\frac{A 1_{t+1} l_{t+1}}{K_{t+1}} \right)^{1-\alpha} \right) = 0 \tag{9}$$

Since all the individuals are assumed to be identical, $P_t^i = P_t$ and the superscript i is dropped for all variables.

3.6 Interest rates

There are four interest rates in the overall credit markets. Because these interest rates are associated with the consumption, labor supplied, and the costs that the liquidity services incur, these corresponding interest rates are endogenously determined by the optimizing behaviors of consumers and competitive banks. In addition to the market interest rates, an uncollateralized interest rate, which

is the interest rate in the conventional general equilibrium model without banking, is treated as the benchmark rate:

$$1+R_t^T = E_t \frac{\lambda_t P_{t+1}}{\beta \lambda_{t+1} P_t} \tag{10}$$

Therefore, the difference between the bond rate and the uncollateralized rate can be obtained by combining Eq. (8) with Eq. (10)

$$1+R_t^B = \left[1-\left(\frac{\gamma C_t^{-\rho}}{\lambda_t}-1\right)\Lambda_t\right]\left(1+R_t^T\right) \tag{11}$$

Other interest rates that are associated with the operation of the banking sector will involve the real marginal costs that the operation incurs. Since the Federal funds market is the primary source of funds for the bank, the interbank rate R_t^{IB} is the cost of the fund for the bank to make loans. Therefore, when the bank loans the funds out, uncollateralized or collateralized, the interest rates have to cover the real marginal cost that the loan process requires. Without certain conditions such as collateral or credit checks, the uncollateralized rate R_t^T has to cover the interbank rate and the real marginal cost that is associated with the loan process which is $\nu w_t n_t / \left((1-\eta)(1-\theta)C_t\right)$ and thus the relationship between the interbank rate and the uncollateralized rate can be expressed as:

$$\left(1+R_t^{IB}\right)\left(1+\frac{\nu w_t n_t}{(1-\eta)(1-\theta)C_t}\right)=\left(1+R_t^T\right) \tag{12}$$

On the other hand, the real marginal cost of the collateralized loans is $\nu w_t n_t / \left((1-\theta)C_t\right)$ which is the partial derivative of the loan services with respect to n_t. The primary difference between the marginal cost of collateralized and uncollateralized loans lie in $(1-\eta)$, the share of monitoring in the loan process which can effectively reduce the marginal cost. Thus, the collateralized rate R_t^L can be written in a similar fashion:

$$\left(1+R_t^L\right)=\left(1+R_t^{IB}\right)\left(1+\frac{\nu w_t n_t}{(1-\theta)C_t}\right) \tag{13}$$

Moreover, since the bank keeps θ fraction of the deposits as the reserve without loaning out, the

relationship between the interbank rate and the deposit rate can be written as:

$$R_t^D = R_t^{IB}\left(1-\theta\right) \tag{14}$$

Thus, from Eq. (13), we can obtain the EFP, which expresses the spread between the bank's external and internal interest rates as a function of endogenous variables[9]:

$$EFP_t = R_t^L - R_t^{IB} \approx \frac{\nu w_t n_t}{\left(1-\theta\right)C_t} \tag{15}$$

The real marginal cost of loan supply, as indicated by GM (2007), is determined by the endogenous variables C_t , m_t , w_t , and the parameters associated with the loan production. Therefore, while the government's monetary and fiscal policies affect consumption, labor and the wage, they also alter the EFP that the household undertakes.

3.7 Nominal rigidity

While the prices are flexible in the long run, we assume that prices are rigid in the short run and that firms adopt Calvo staggered pricing as the pricing strategy. Without specifically specifying the firms' optimal pricing, the price adjustment process is characterized as follows:

$$\Delta p_t = \beta E_t \Delta p_{t+1} + \psi\sigma_t + u_t \tag{16}$$

where $\psi > 0$ and

$$\Delta p_t = \log(P_t) - \log(P_{t-1}) \tag{17}$$

which stands for the inflation rate of the aggregate price level. σ_t denotes the real marginal cost of goods production and can be identified as:

$$\sigma_t = \varsigma_t / \lambda_t \tag{18}$$

3.8 Exogenous shocks

The exogenous shocks, A_t^P and A_t^n, are assumed to follow a constant growth rate ϕ in the long run

[9] Since the interbank rate is only slightly lower than the deposit rate due to small θ , here the interbank rate is used for the derivation of EFP.

but to fluctuate in the short run. The shock to the efficiency of capital as the collateral, however, is assumed to be stationary. Since the cause of the financial crisis is the dysfunctional credit market caused by lower efficiency in loan production, the following analyses will focus on the impacts of the unit shocks A_t^k and A_t^n. The detrended (trendless) shocks are assumed to follow an AR(1) process:

$$e_t^k = \rho_k e_{t-1}^k + \varepsilon_t^k$$

$$e_t^n = \rho_n e_{t-1}^n + \varepsilon_t^n$$

where ε_t^k, ε_t^n are *iid* random variables and ρ_k, ρ_n indicate the persistence of these shocks, both of which are specified as 0.95 for the dynamic analyses to capture the slow recovery speed of the credit markets that is subject to financial innovations and restoration.[10] Since the effects of the shocks A_t^k and A_t^n on the economy are quite similar, we will discuss only the cases under the shock to the effectiveness of collateral e_t^k.

3.9 Policies

The crucial part of the calibration is the specification of policies. The government will respond to the financial shocks through interest rate cuts, expansion in monetary base, or expansionary government expenditure. As for the monetary policy, we propose two types of monetary rules. The central bank takes control over the interbank rate R_t^{IB}:

$$R_t^{IB} = (1-\mu_3)\left[\mu_0 + (1+\mu_1)\Delta p_t + \mu_2\sigma_t\right] + \mu_3 R_{t-1}^{IB} - D_R e_t^k + e_{R,t} \qquad (23)$$

where $\mu_1, \mu_2 > 0$ and $0 < \mu_3 < 1$, and $e_{R,t}$ is the policy shock to the interbank rate. This is essentially the Taylor rule under which the central bank raises the interest rate persistently and positively in response to inflation rate and the marginal cost σ_t to serve as the output gap.[11] Moreover, under the financial crisis, the central bank may want to reduce the interbank rate to lessen the impacts of the

[10] However, we will see that the persistence of the shocks has important implications for the interest rate rule in Section 5.3.
[11] The setup implies that the target inflation rate is equal to zero.

financial distress on the economy with the magnitude of D_R in response to a unit shock to e_t^k. The interest rate cut implies that the value of D_R should be negative.

In addition to the Taylor rule, an alternative monetary policy that involves controlling the growth rate of high-powered money is also discussed. Although most central banks all over the world regularly implement the interest rate rule, the financial crisis has forced governments to adopt the "quantitative easing" strategy by providing the markets with abundant liquidity. The rule is stated below:

$$m_t = \rho_m m_{t-1} + e_{m,t} - D_m e_t^k \tag{24}$$

where $m_t = \log(H_t) - \log(H_{t-1})$ which is the growth rate of the monetary base. Under this policy, the interbank interest rate is endogenously determined. $e_{m,t}$ is the shock to the stock of money, and D_m stands for the central bank's response to the shock which should be positive.

As for the fiscal policy, we assume that the government will respond to the shock by increasing the government expenditure, which is assumed to be an exogenous process:

$$G_t = (1-\rho_g)\bar{G} + \rho_g G_{t-1} + e_{g,t} - D_g e_t^k \tag{25}$$

where $\bar{G}$ is the steady state value of the government expenditure, ρ_g states the persistence of the temporary spending, and $e_{g,t}$ is the government spending shock. In a similar fashion, D_g characterizes the magnitude of the government spending in response to the shock and thus should be positive. The government can finance the spending by issuing bonds, money or increasing taxes. To obtain the equilibrium, we will need to exogenously specify one of the fiscal policies, the process of issuing bonds or levying taxes, leaving the other to be endogenously determined. In the calibrations below, we assume that the government maintains the ratio of bonds to consumption, φ_t, stationary:

$$\varphi_t = (1-\rho_b)\bar{\varphi} + \rho_b \varphi_{t-1} + e_{b,t} \tag{26}$$

where $e_{b,t}$ is the current shock to the bond-consumption ratio.[12]

[12] In future studies, we may relax this assumption by merely levying the income tax, thereby leaving the quantity of outstanding bonds to be endogenously determined.

3.10 Equilibrium

The sticky-price equilibrium which is constituted by C_t, l_t, n_t, P_t, w_t, q_t, B_t, T_t, D_t, L_t, R_t^B, ς_t, λ_t, σ_t, Δp_t and Λ_t can be obtained by solving Eq. (1)-(13), (20)-(22) under exogenous specifications of monetary policy (24) and the fiscal policy (25) and (26). In turn, R_t^{IB} along with all other interest rates can be determined by Eq. (15)-(18). Nevertheless, the equilibrium of an economy where the central bank exercises the interest rate rule can be characterized by replacing the monetary policy rule Eq. (24) with the interest rate rule Eq. (23).

In the calibrations, the steady state is assumed to be deterministic where shocks are absent and can be obtained by solving the system under flexible prices.[13] The dynamic analysis is performed through loglinearization with respect to the endogenous variables around the steady state, with some parameters being chosen to match certain features of the steady state values.

4 Dynamics

Before proceeding further with the examination of the policies under the financial crisis, Section 4 lists the impulse response functions for each shock: $e_{g,t}, e_{m,t}, e_t^k$, respectively. The calibration results in this section illustrate the implications of money and banking for the policies and the financial shocks. The discussion in this section will help us better understand the implications of the policies for the financial crisis, how they should be implemented and their effects.

4.1 Parameters

Since the outbreak of the financial crisis in the US, the calibrations are conducted based on US data. Therefore, most of the parameter values are chosen according to GM (2007), which is based on

[13] In a flexible-price steady state, the marginal cost is constant: $\varsigma_t/\lambda_t = (\upsilon - 1)/\upsilon$, which replaces Eq. (20).

quarterly data in the US.[14] Differing from GM (2007) in which case there was an absence of government expenditure, public spending is assumed to be 0.22 in the steady state in order to capture the share of government spending in GDP as 20%, following Schmitt-Grohe and Uribe (2002). The ratio of bonds to consumption in the steady state is assumed to be equal to 0.56. $\gamma = 0.38$ is calibrated to obtain the steady state labor supply, which is approximately equal to 1/3 after the government expenditure is added.[15] The steady-state money stock is chosen by letting the aggregate price level be equal to one. In addition, while the value of capital is allowed to fluctuate in the short run, it is assumed to be one in steady state, $q = 1$. The growth rate of exogenous shock is specified as $\phi = 0.005$.

The elasticity of substitution υ is assumed to be equal to 11 to capture the markup of 1.1 for the monopolists. Following the conventional setup, we assume $\beta = 0.99$, $\alpha = 0.36$ for the capital share in production and $\delta = 0.025$ to capture the quarterly depreciation rate. The parameters in the banking sector are specified as those calibrated in GM (2007). In the banking sector, GM (2007) calibrate US data and find that $\nu = 0.31$, $\eta = 0.65$, $m = 0.2$ and $\theta = 0.005$. $F = 9$ is calibrated to characterize the inefficient production in the banking sector which results in nonzero marginal costs. ψ is assumed to be equal to 0.02 as the recent literature indicates.

4.2 Unit shock to the government expenditure

[14] The large scale of the model is another reason and thus the choice of parameters is relatively restricted. An alternative specification of the parameters may generate negative steady-state values or multiple equilibria.

[15] With the parameter values specified here, the overall employment, $(l + n)$, is approximately 0.36 in the steady-state.

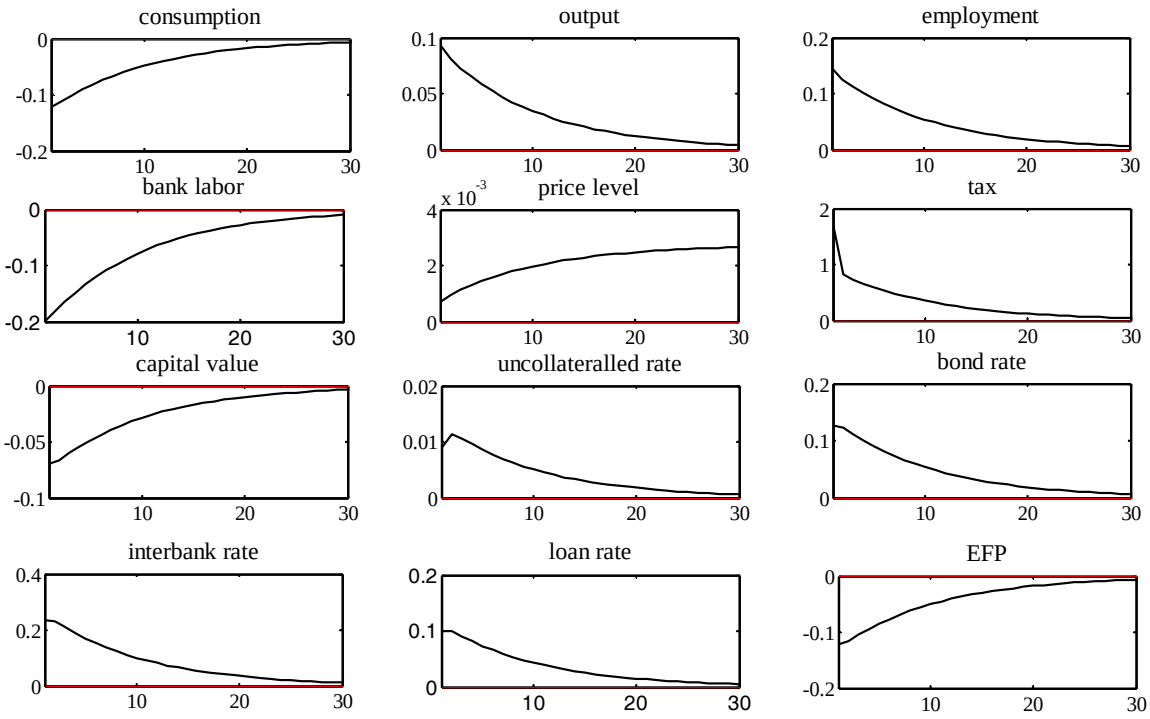

Fig. 2: 1% increase in government expenditure, $\varepsilon_{g,t} = 0.01$.

To examine the effects of fiscal policy on an economy with money and banking and highlight the role of money and banking in the dynamic responses of macroeconomic variables to expansionary government spending, here we calibrate the model with a unit shock to the government expenditure. It is conducted based on the interest rate rule with the policy parameters being specified as: $\mu_1 = 0.15$, $\mu_2 = 0.5$ and $\mu_3 = 0.95$.

Fig. 2 shows that employment in the production sector rises by 0.14% in response to a 1% point increase in the government expenditure, resulting in a 0.09% increase in output, which is slightly lower than 1%. The rising aggregate demand causes the price level and all the interest rates to increase with the expansionary government expenditure as the Keynesian theory suggests. The increased interest rates result in crowding-out effects on output by lowering consumption and the price of capital, indicating the decline in investment. However, the EFP is lowered by 0.12%. As shown in Eq. (19),

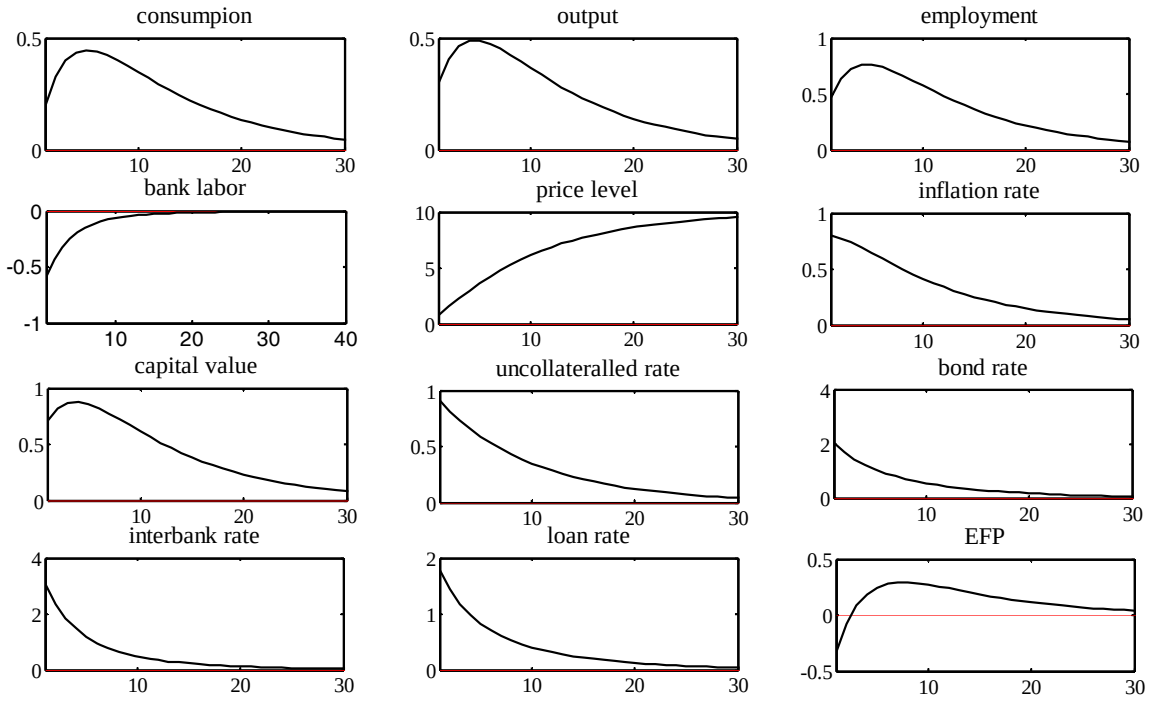

Fig. 3: 1% increase in the high-powered money, $\varepsilon_{m,t} = 0.01$.

$E\hat{F}\hat{P} = \hat{w} + \hat{m} - \hat{c}$. While m, w and c are all reduced, the decrease in consumption dominates. If the investment and consumption in the economy can be financed externally, the lower EFP will raise the level of investment as well as consumption, thereby offsetting the crowding-out effect of government expenditure. As a result, the drops in consumption and investment are relatively moderate, being 0.12% and 0.07%, respectively.

Therefore, a model which neglects banking and money may overstate the crowding-out effect of the fiscal policy. While the public spending crowds out consumption, the demand for deposits is lowered, which should be accommodated by the proportionate drop in the loan. However, the lower demand for the loan is offset partially by the decreases in investment and employment in the banking sector which are crowded out by the expansionary government spending. The smaller magnitude of the loan rate rise reduces the EFP.

4.3 Unit shock to the growth rate of high-powered money

Bernanke & Gertler (1995) argue that the EFP is countercyclical and that it plays the role of financial

accelerator in the transmission mechanism of monetary policy, which is mainly caused by the balance sheet effect. The exclusion of money in the conventional credit channel literature, however, may neglect the impact of the demand for money on the EFP that may in turn attenuate the influences of the financial accelerator, as argued by GM (2007).

The mixed effects of the expansionary monetary policy on the EFP are evident in Fig. 3. With the calibration on the high persistent growth of money $\rho_m = 0.9$, the 1% increase in the growth rate of money causes the EFP to drop initially, to rise afterward to a level above the steady state value, and then to decline gradually to the normal level. The initial drop, which is countercyclical, may be viewed as the "financial accelerator" as in Bernanke & Gertler (1995), but the positive levels in the following periods represent the "financial attenuator" as referred to by GM (2007).

Except for the movements in the EFP, all other variables are consistent with the results that GM (2007) report. Consumption increases by 0.44% and output rises by 0.48%. The economic boom drives up the inflation as well as q_t, whose effects die away gradually after 2 quarters.

4.4 Unit shock to the effectiveness of collaterals

Before implementing policies under the financial shock, we need to understand how the financial shock impacts the economy. The calibration results are listed in Fig. 4. Most of the results here coincide with the results that GM (2007) report. Consumption, output and employment decrease upon the impact of the shock. The shock causes these three variables

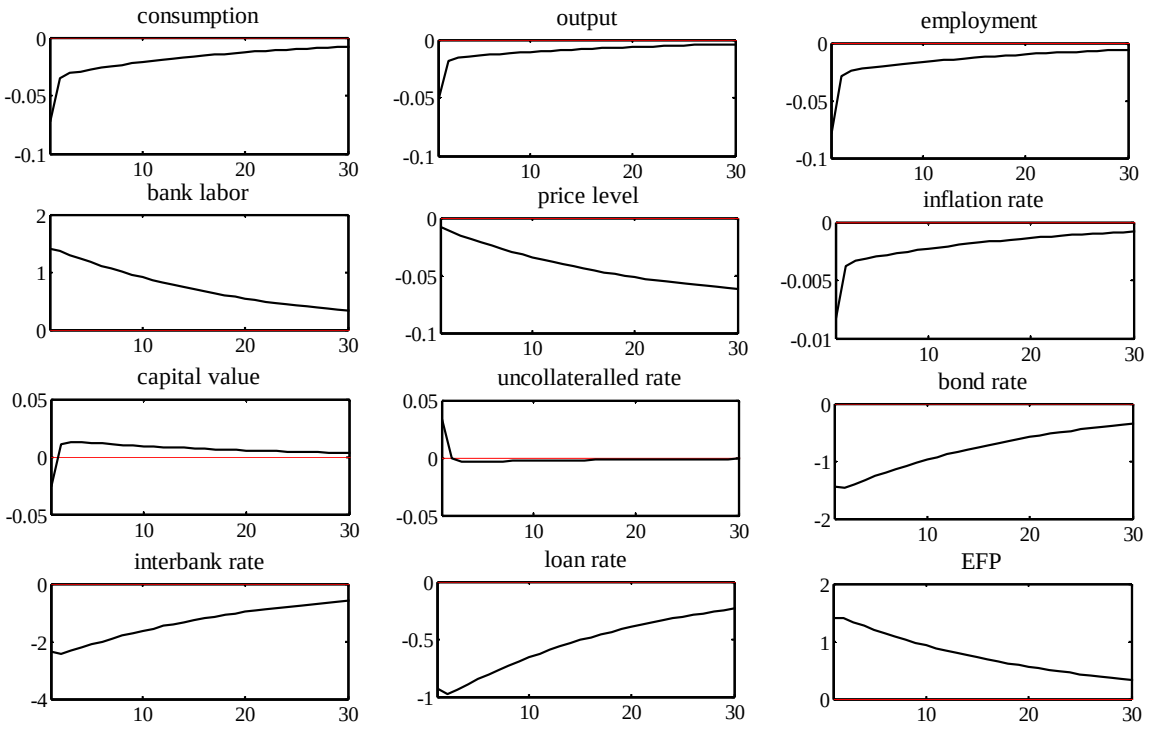

Fig. 4: 1% shock to the effectiveness of collaterals, $\varepsilon_t^k = -0.01$.

to drop sharply on impact, and then adjust gradually back to the steady state without any policy assistance. The recession is accompanied by deflation. This is consistent with what is usually observed after the financial crisis strikes. Most of the interest rates decrease as well, except for the uncollateralized rate.[16] The increase in R_t^T may, however, mislead the reactions of governments. In a model that does not distinguish between interest rates, R_t^T is the only interest rate that guides the consumption and investment decisions of households and firms. In a model where external financing for private spending is likely, however, R_t^L and R_t^B are the crucial determinants of consumption and saving behavior. While their movements diverge, the interest rate rule of the central bank that views R_t^T as the benchmark interest rate may be misleading. This finding illustrates the importance of money and banking for policy making.

The EFP rises upon the shock, consistent with the statement of Bernanke & Gertler (1995) the EFP is countercyclical and characterizes the worsening asymmetric information problem under the crisis. The

[16] The rise in EFP coincides with the data shown in Fig. 1: EFP increases significantly while the crisis strikes.

countercyclical EFP will cause the credit to contract, thereby delaying the recovery of the economy. The value of capital, q_t, decreases at the outbreak of the shock, but rebounds rapidly to a level that is greater than the steady state in one quarter, because the decline in interest rates raises the discounted sum of the future marginal product of capital. Notwithstanding the initial decline in capital value is close to that in the real world, the speed of recovery seems to be too fast. A possible reason that accounts for the rapid adjustment of q_t is the frictionless capital market where there is no price stickiness or costs that the capital adjustment may incur.

5 Policies under the financial crisis

Based on the above discussions, the policies under the financial crisis will be examined. In this section, we let $\varepsilon_t^k = -1\%$ in all cases and policies are allowed to react to the financial shock. Instead of determining the optimal monetary and fiscal policies, this section will investigate the effects of various policies on the dynamic responses of the economy and whether they can precipitate the economic recovery. In particular, the assessment in this section will center on the sizes and speeds of various policies. The results reveal that large and rapid government expenditure performs better than small and persistent government expenditure. On the other hand, while an expansionary monetary policy will help the economy recover from the crisis, the effects of the interest rate rule crucially depend on the persistence of the financial crisis. The results correspond to Feldstein's suggestions on the format of fiscal rescue policies, but casts some doubt on the effectiveness of interest rate

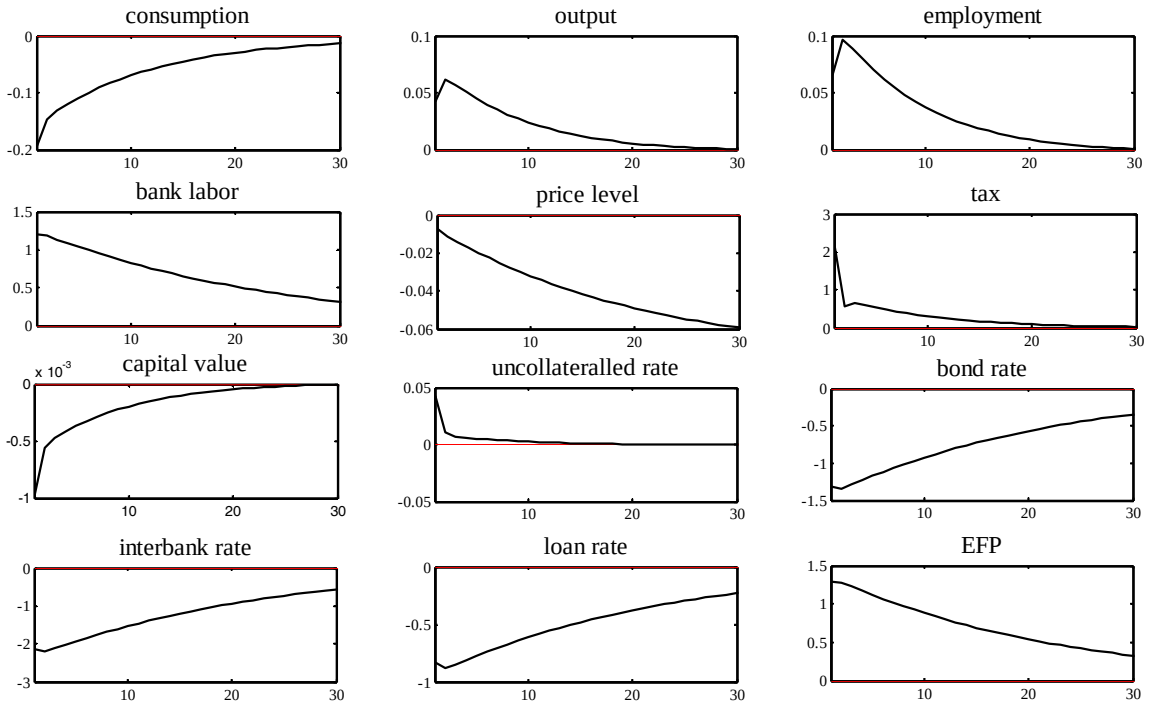

Fig. 5: small but persistent government expenditure: $D_g = 1$ and $\rho_g = 0.9$.

rules. As a result, this study can also serve as a justification for the large public spending policies that most governments all over the world are currently implementing while the effects of interest rate rules die away quickly or are even not strong enough to offset the impacts of the crisis.

5.1 Fiscal policy

Two fiscal policies are examined in this section: a stable government expenditure plan, which is small but persistent, and a drastic cure policy, which is large and less persistent. While the first one stands for normal government expenditure, the second one is conducted to find support or objections to the recent policy plans that most economists have proposed for the economy to recover from the recession following the financial distress.

5.1.1 Small and persistent government expenditure

Here we propose a highly persistent government expenditure and allow the public spending to react 100% to the financial shock. Therefore, $D_g = 1$ and $\rho_g = 0.9$. Similar to Section 4.2, the examination of the fiscal policy is conducted under the persistent interest rate rule. The effects of the expansionary fiscal policy are evident by comparing Fig. 4 and Fig. 5. As shown, the implementation of the government spending can successfully help the economy avoid recessions. Output increase by 0.06% instead of -0.05% when there is no public spending.

However, there is no free lunch. The expansionary public spending makes consumption drop, instead of increasing, by 0.19% and the investment decline by 0.1%, compared with the earlier levels before the policy was implemented of -0.07% and 0.013%, respectively. The increase in the aggregate demand leads to a rise in interest rates and the crowding-out effects.

Nevertheless as output and interest rates rise, the EFP is lowered but remains above the normal level and thereby becomes procyclical. This may dampen the crowding-out effect of expansionary fiscal poliy as discussed. Differing from the “financial attenuator” in GM (2007), the procyclical EFP is caused by the expansionary fiscal policy which drives up the output, but is not strong enough to push down the EFP to the level below the steady-state value.

5.1.2 Large and rapid government expenditure

While the more persistent policy can successfully help the economy recover, most economists urge the government to engage in “quick and large” government expenditures in

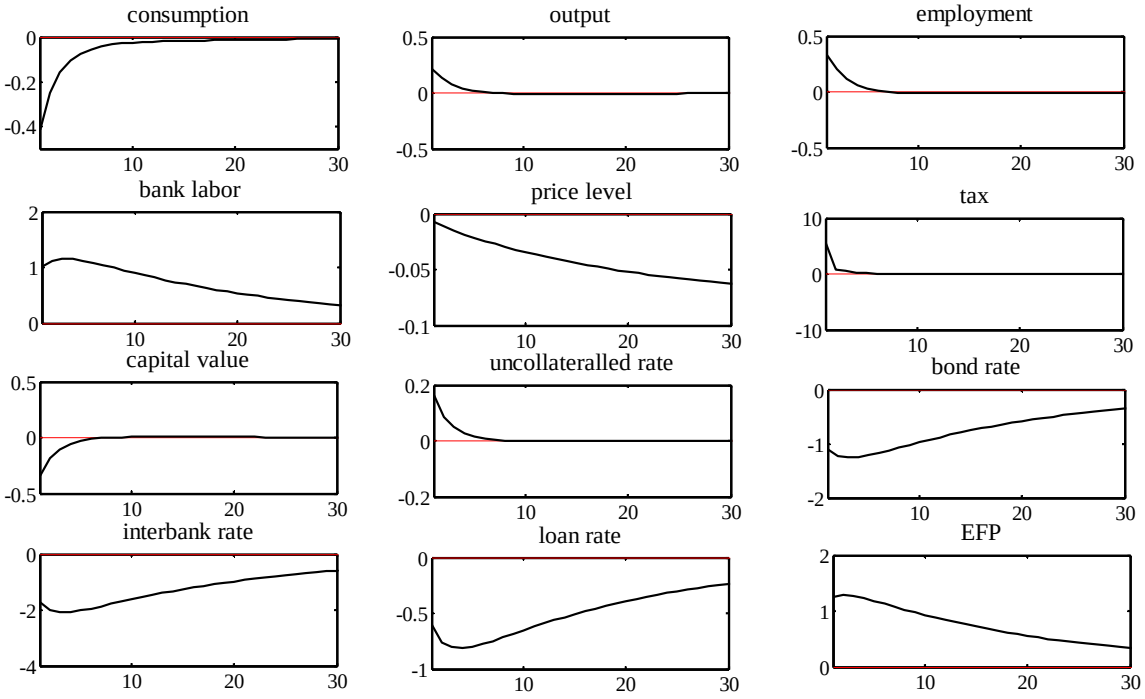

Fig. 6: large and rapid government expenditure: $D_g = 3$ and $\rho_g = 0.6$.

response to the financial crisis when there is no room for further interest rate decreases, the economy has run into recessions for more than 4 quarters, consumption and investment have fallen significantly, and there seem to be no signs for the private sector to recover on its own accord. Therefore, we propose another large and rapid government expenditure by assuming that $D_g = 3$ and $\rho_g = 0.6$, which can generate a similar price level path to that under the previous policy. With the low persistence, the 3% increase in government expenditure in response to a 1% financial shock will die out in 10 quarters approximately. Fig. 6 shows that this policy can stimulate the production immediately to 0.2%, but declines quickly with the less persistent spending. The fast adjustment speed also applies to other variables. While the large government expenditure causes drastic drops in consumption and investment initially, they rise back to the normal level in 5 quarters. Similarly, the tax increases greatly at the beginning, but falls down and remains at the steady-state level after 4 quarters. Interest rates, on the other hand, do not vary much with policies.

The quick recovery of the economy, 5 quarters before the government expenditure expires, provides strong support for the large-scale and rapid implementation of policy. As long as the economy is able or

handle the drastic drop in consumption in the early period, without being adversely affected by the current and future inflationary pressure, this enormous aggregate demand stimulus can help the private sector to accumulate enough income and capital to restore the credit market as well as the economy to its normal level before the crisis hit. Compared with the persistent but relatively small fiscal policy, this policy would be more desirable as people wish to avoid the recession sustaining.

5.2 Monetary policy

Since the monetary policy can be easily implemented, it is usually the first step that the government will take in response to the financial crisis. While the interest rate rule does not seem to be effective, control over the base money is also exercised. This finding follows along the same lines as the development of US policies after the outbreak of the financial crisis. While the Fed has consecutively cut the Fed fund rate target from 5.25% to 0.25% within 5 quarters, there do not seem to be any signs of a recovery. In March 2009, the chairman of the Fed, Ben Bernanke, announced that the Fed was planning to purchase 300 billion in bonds from the markets. While this “quantitative easing” of the environment seems to be needed for the economy, it is also accompanied by mounting worries over high inflation after the recession ends. The analysis below may help explain the limited effects of the interest rate rule, and the possible success of the quantitative easing strategy of the Fed.

5.2.1 Interest rate rule

We assume that the interbank rate will be lowered by 1% in response to a 1% shock to the

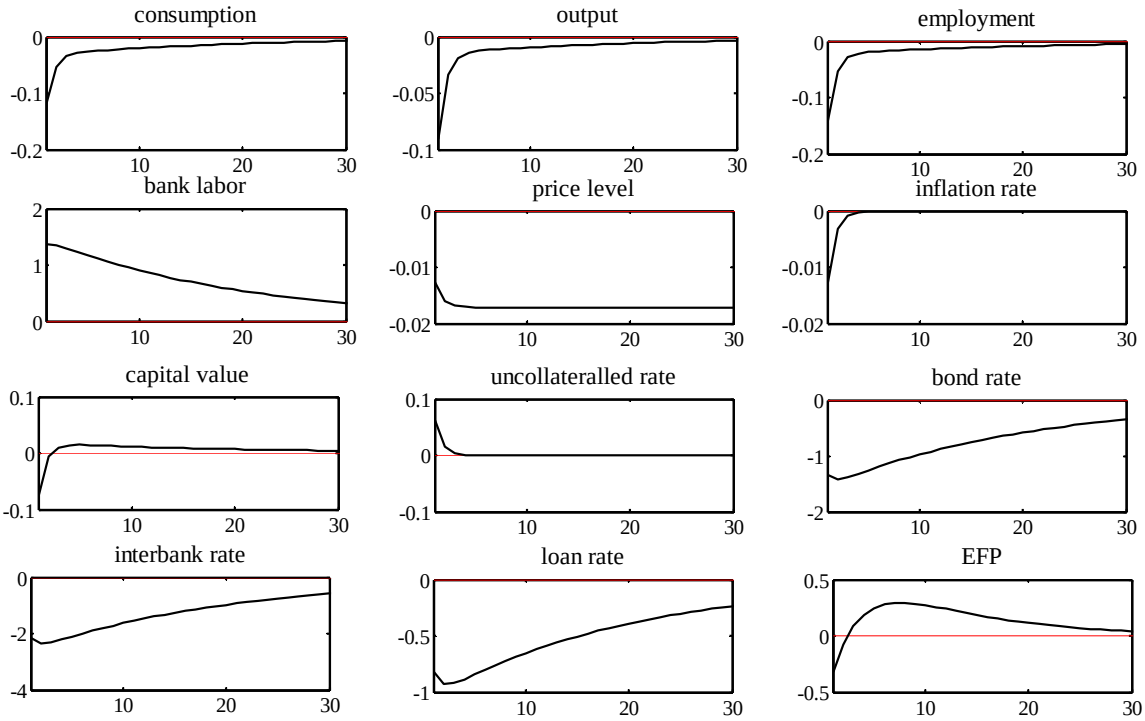

Fig. 7: interest rate rule under a persistent financial shock: $D_R = -1$, $\rho_k = 0.95$.

collateral effectiveness, and so $D_R = -1$. To characterize the persistent interest rate cut in reaction to the prolonged crisis, the persistence of the interbank rate, $\mu_3 = 0.95$, is specified. However, compared with Fig. 4, the interest rate cut does not result in much difference under the interest rate smoothing rule, but causes larger declines in consumption and output as well as slight rises in interest rates. The interest rate increases lower the discounted value of the marginal product of capital and thus reduce the value of capital, compared with Fig. 4. The decline in investment worsens the downturn in output and consumption.

This peculiar result may be caused by the relative magnitude of the interest rate rule's responses to the past interest rate and current inflation and output gap. While the 1% cut in the interest rate is not large enough, the interest rate responds more to the current output gap and inflation rate. Because the output rebounds to the normal level in only two quarters, the zero output gap prevents further interest rate cuts. This result is quite robust even under an unrealistic 5% quarterly cut in the interest rate to the shocks or inflation targeting rule with the assumption that $\mu_1 = 10$ and $\mu_2 = 0$. The calibrations of the same policies under the

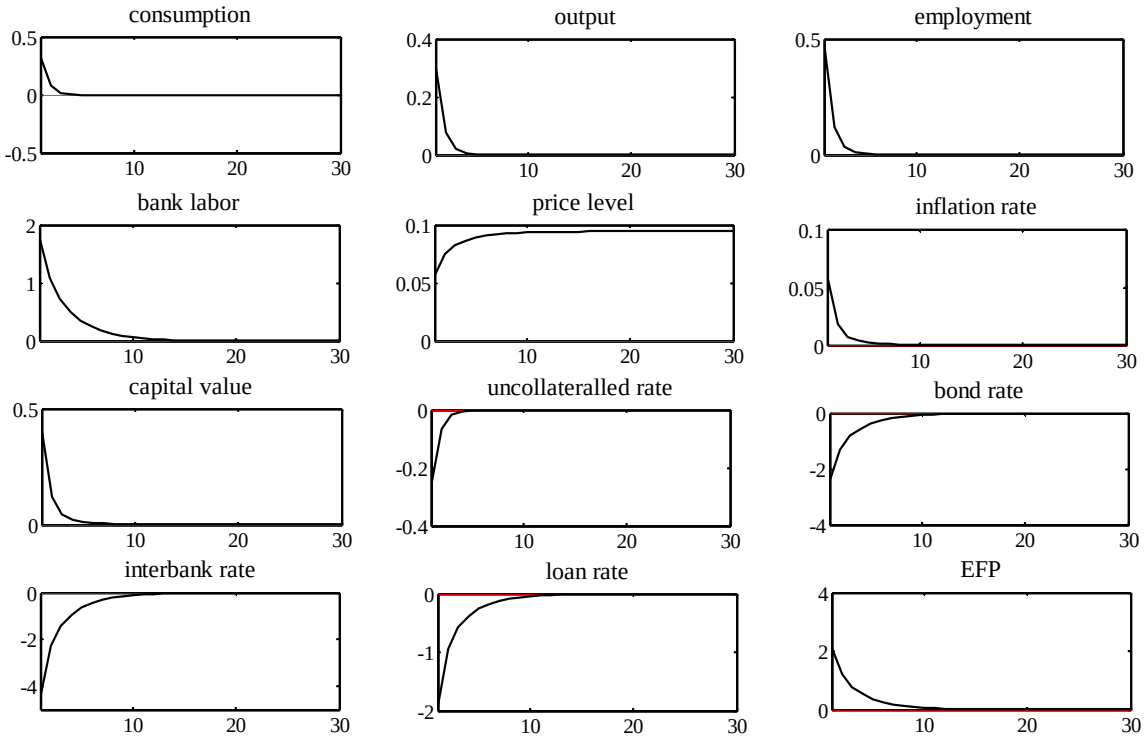

Fig. 8: interest rate rule under less persistent financial shocks: $D_R = -1$, $\rho_k = 0.7$.

shock to the monitoring in the banking sector also generate the same results.

The crucial determinant seems to be the persistence of the shocks. If the persistence of the shock is lowered to 0.7, instead of 0.95 as in previous cases, a 1% interest rate cut is enough to help the economy recover regardless of whether it is interest rate smoothing, as shown in Fig. 8. Both consumption and output rise slightly above the normal level, accompanied by an increase in investment. This implies that the interest rate rule is not effective unless the credit market efficiency is quickly restored, which in turn depends on the confidence of the banking sector in the production of loans. In Fig. 7, we can see that although the banking sector hires more people to monitor the loan making and the value of the capital goods increases, lower consumption implies that the outstanding loans remain at a low level. The lower interest rate is not able to stimulate the banking employment or restore the amount of collateral required to make the loans at the level before the shock hits. However, Fig. 8 shows that the swift rebound in the financial shock enables the economy to

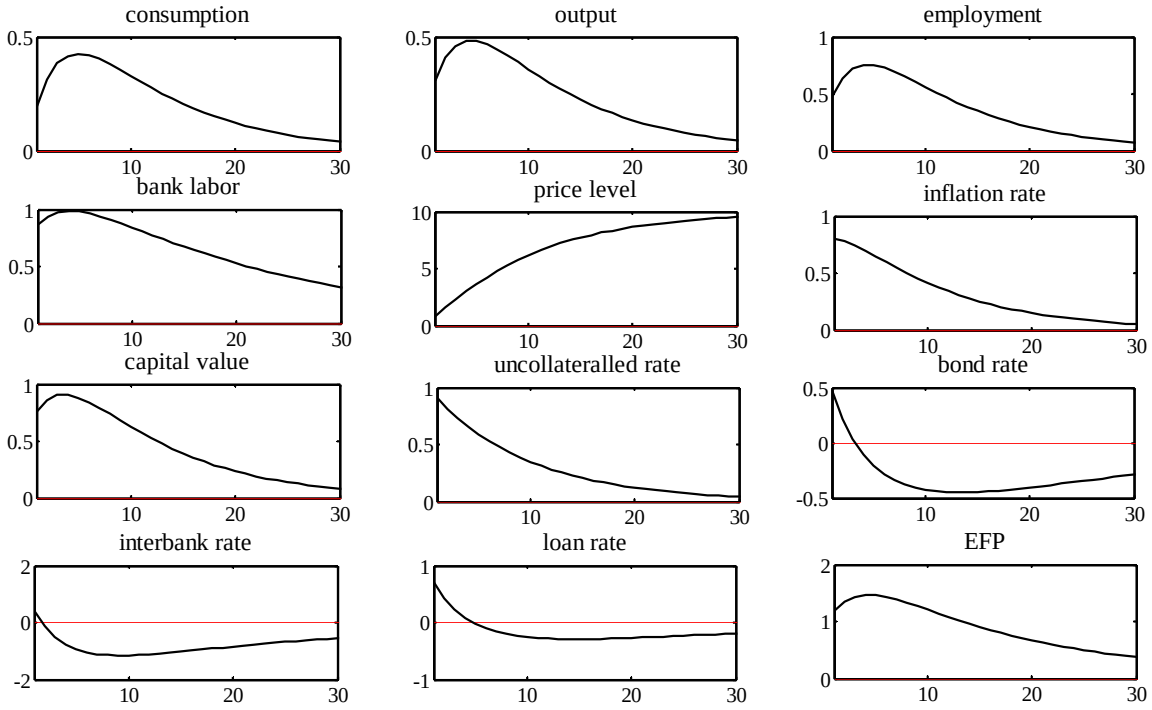

Fig. 9: expansionary high-powered money: $D_m = 1$.

rapidly recover. Therefore, the effectiveness of the interest rate rule strongly relies on the reestablishment of the credit market is crucial for the economy to recover but not the other way round.

5.2.2 Expansionary monetary base

While the interest rate rule does not seem to be effective in the face of the crisis, the expansionary base money seems to work much better. With the persistence of the high-powered money growth equaling 0.9 and responding to a 1% financial shock by a 1% increase in the growth rate of the monetary base, Fig. 9 shows that the consumption and output can grow without experiencing the initial recession. The 1% increase in the base money will cause the interbank interest rate to fall by 1.14% in each quarter, which is equivalent to 4.8% per annum. This decline does not seem to be unrealistic because the Fed has lowered the Federal funds rate by 5% within just one year.[17] The essential reason for the effectiveness of the monetary expansion is the quantitative easing environment. While a larger high-powered money growth induces a greater demand for consumption followed by higher deposit and

[17] Before the crisis, GM (2007) pointed out that the 1.2% quarterly drop in the interbank interest rate was unrealistic.

loan demand, the interest rates are lowered. A lower interest rate stimulates investments and the capital stock, and is helpful in restoring the quantity of loans to a higher level.

In particular, from the balance sheet of the bank, $H + L = D$, we can see that the bank reserves rise with the expansion in high-powered money. Deposits are increased accordingly which can facilitate consumption. This mechanism is absent from the conventional literature on monetary policy, which neglects the banking sector, as well as from the studies on credit channels without considering money. This channel is also absent in an economy with an interest rate rule which crucially depends on the interest rate elasticity of consumption and investments.

6 Conclusion

This paper investigates quantitatively the macroeconomic implications of monetary and fiscal policies under the current financial crisis based on the model in GM (2007). By using the DSGE model with the banking sector, we can successfully characterize the financial crisis that was initiated in the credit markets in terms of the shock to the loan production of banks and see how the shock impacts other sectors within the economy. With money and banking, this model allows for the endogenous determination of various interest rates and the EFP.

The effects of policies are examined quantitatively by means of calibrations based on US data where the crisis started. The calibration results show that expansionary government expenditure can successfully help the economy recover, but the timing and size of the policy's implementation may matter. When characterized by a 3% increase in government spending in response to a 1% shock to the effectiveness of collateral with an AR(1) coefficient of 0.6, this policy will enable the economy to accumulate enough wealth and recover within four quarters, though by sacrificing initial consumption. Compared with the long-lasting recessions under a 1% increase in public spending with a persistence of 0.9, a large-scale and rapid policy implementation seems to be more desirable.

Moreover, the calibration results also illustrate that the EFP declines with the implementation of fiscal policy. Since the decrease in the EFP will be an additional force that stimulates investment, the

crowding-out effect of fiscal policy due to rising interest rates will be attenuated. Therefore, a model without distinct interest rates may overstate the crowding-out effects and the effects of the fiscal policy may be stronger than was thought. While the credit channel literature focuses on the examination of monetary policies, the implications of credit channels for fiscal policy have not been noted before.

The effects of monetary policy also strongly rely on the way the policy is applied. A 1% expansion in the growth rate of base money in response to a unit shock to the effective collateral can successfully stimulate the economic recovery. The increase in the monetary base can raise the demand for consumption as well as deposits, thereby boosting the economic growth. However, with the high persistence of the financial shock of 0.9, as in all other cases, a 4% p.a. interbank rate reduction by the Fed will fail to pull the economy out of the recession, no matter how persistent the interest rate rule is or how large the initial cut is (interest rate smoothing or inflation targeting). It will only be effective if the financial shock is less persistent. That is, the effectiveness of the collateral needs to be restored soon and thus the banking sector will be able or will be willing to provide enough loans for consumption. This finding coincides with the fading effects of the interest rate rule since the financial crisis broke out which has led to an emphasis on “quantitative easing” policy or massive government spending. It shows that it is the effectiveness of the interest rate relies on the credit market restoration, but not the other way round.

However, the policies in this model are relatively simple: the government expenditure focuses on goods without contributing to productivity or consumption directly in the economy. There will be differences if the emphasis is on productive spending or consumables. The way to finance the government expenditure also matters. Whether the funds for the spending are raised by issuing bonds, money or by taxes will result in different interest rate movements and the EFP, and these will have different effects on the economy.

References

Bernanke, B. S. and A. S. Blinder (1988) "Credit, Money and Aggregate Demand" *American Economic Review, 78(2), 435-439.*

Bernanke, B. S. and M. Gertler (1989) "Agency Costs, Net Worth, and Business Fluctuations" *American Economic Review*, 79, 14-31.

Bernanke, B. S. and M. Gertler (1995) "Inside the Black Box: The Credit Channel of Monetary Policy Transmission" *Journal of Economic Perspectives, 9, 27-48.*

Bernanke, B., Gertler, M. and Gilchrist, S. (1998) "The Financial Accelerator in a Quantitative Business Cycle Framework" *NBER Working Papers, No.6455*

Carlstrom, C. T. and T. S. Fuerst (1997) "Agency Costs, Net Worth, and Business Fluctuations: a Computable General Equilibrium Analysis" *American Economic Review*, 87(5), 893-910.

Clarida, R., J. Galí and M. Gertler (1999) "The Science of Monetary Policy: A New Keynesian Perspective" *Journal of Economic Literature*, 37, 1661-1707.

Clarida, R., J. Galí and M. Gertler (2000) "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory" *Quarterly Journal of Economics*, 105(1), 147-180.

Clarida, R., J. Galí and M. Gertler (2002) "A Simple Framework for International Monetary Policy Analysis" *Journal of Monetary Economics*, 49(5), 879-904.

Cooley T. and R. Marimon (2004) "Aggregate Consequences of Limited Contract Enforceability" *Journal of Political Economy*, 112, 817-847.

Edwards, S. and C. A. Végh. (1997) "Banks and Macroeconomic Disturbances under Predetermined Exchange Rates" *Journal of Monetary Economics*, 40, 239-278.

Goodfriend, M. and McCallum B. T. (2007) "Banking and Interest Rate in Monetary Policy Analysis: A Quantitative Exploration" *Journal of Monetary Economics*, 54, 1480-1507.

Feldstein M. (2009) "Rethinking the Role of Fiscal Policy" *presented at the AEA meetings , January, 2009.* Retrieved April 24, 2009 from the World Wide Website: http://www.nber.org/feldstein/RethinkingtheRoleofFiscalPolicy.html

Kiyotaki, N. and J. Moore (1997) "Credit Cycles" *Journal of Political Economy*, 105, 211-248.

Kocherlakota, N. (2000) “Creating Business Cycles through Credit Constraints” *Federal Reserve Bank of Minneapolis Quarterly Review*, 24(3), 2-10.

Kollmann, R. (2002) “Monetary Policy Rules in the Open Economy: Effects on Welfare and Business Cycles” *Journal of Monetary Economics*, 49, 989-1015.

Schmitt-Grohé, S. and Martín Uribe (2002) “Optimal Fiscal and Monetary Policy Under Sticky Prices” *NBER Working Paper No. 9220*

Sutherland, A. 2006. “The expenditure switching effect, welfare and monetary policy in a small open economy,” *Journal of Economic Dynamics and Control*, vol. 30, no. 7, pp. 1159~1182.

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

   √ 達成目標

   □ 未達成目標（請說明，以 100 字為限）

   □ 實驗失敗

   □ 因故實驗中斷

   □ 其他原因

   說明：

2. 研究成果在學術期刊發表或申請專利等情形：

   論文：□已發表 √未發表之文稿 □撰寫中 □無

   專利：□已獲得 □申請中 □無

   技轉：□已技轉 □洽談中 □無

   其他：（以 100 字為限）本研究主題”macroeconomic implications of policies under financial crisis” 一文已刊登於「世紀初金融風暴學術研討會」會議論文集中，並已準備投稿學術期刊。相關研究 “Implications of Economic Openness for Financial Crisis” 已發表於社會科學論叢中(第四卷第一期, 51-74 頁)。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）

本研究是在一包括金融中介機構的動態隨機一般均衡模型（DSGE）下探討金融部門所造成的金融危機對於總體經濟的影響，以及貨幣政策與財政政策在這樣的金融衝擊下對於促進總體經濟復甦的有效性。研究的結果發現，財政政策與量化寬鬆的貨幣政策是有效的，但降息是無效的。此一研究，可以幫助我們瞭解金融危機對於總體經濟的衝擊，以及金融風暴下，較為適當的政策措施。於學術面，此一模型可以更進一步幫助我們瞭解貨幣政策的傳遞效果；於政策面，我們可以更清楚，政府應採取什麼樣的措施來因應金融風暴，協助總體經濟的復甦。

本人並已將此研究延伸到小型開放經濟體系的架構下來探討金融風暴對於匯率，乃至總體經濟的影響，亦藉此模型來探討台灣最適的貨幣政策。本次次級房貸風暴發生之後，國際間對於金融中介機構與貨幣政策的研究於質與量上皆有大幅度的成長，因此，包含了金融中介機構的 DSGE 模型在未來具有相當大的發展潛力。

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：99 年 7 月 20 日

計畫編號	NSC 98－ 2410 － H － 004 － 058 －		
計畫名稱	信用傳遞機制，金融風暴與政府政策之總體經濟意涵		
出國人員 姓名	黃俞寧	服務機構 及職稱	政治大學經濟系助理教授
會議時間	99 年 7 月 15 日至 99 年 7 月 17 日	會議地點	英國倫敦
會議名稱	（中文） （英文）16th CEF Annual Conference, July15-July17, 2010, City University of London		
發表論文 題目	（中文）美元本位制下的福利與貨幣政策分析 （英文）Welfare and Monetary Policy under a Dollar Standard		

一、參加會議經過

本人於 7 月 14 日晚抵達英國倫敦。15 日與 Stephen Turnovsky 教授與夫人，以及 Paul McNelis 教授相聚，並遇見多位去年在雪梨 CEF 年會相識的學者，相談甚歡。接下來兩天，與 Stephen Turnovsky 交換了許多想法，並與 Paul McNelis 教授就我們的合作計畫做更進一步的探討。16 日晚間，會議晚宴在英國皇家科學院 (the Royal Society) 舉行，與 The Federal Reserve Bank of Minneapolis 的知名經濟學家 Ellen McGrattan、德國央行、國際清算銀行等研究機構的經濟學者同席，交換本次金融風暴與歐債風暴的看法。本系陳樹衡老師並於席間當面邀請國際知名學者 Michel Juillard 教授來台訪問，Michel Juillard 教授也當面承諾將於今年四月間來台，目前本系正在積極安排中。本人則於 7 月 17 日上午發表”Welfare and Monetary Policy under a Dollar Standard”一文，當天晚間即啟程返回台灣。

二、與會心得

參與此次會議使我獲益良多，除了可與 Stephen Turnovsky 教授伉儷敘舊之外，與 Paul McNelis 教授的合作計畫上並有所進展。除此之外，並與德國央行的 Felix Hammermann 與國際清算銀行的經濟學家就實務上交換了許多意見，更進一步了解歐洲央行與國際清算銀行的運作。整體來說，因為此一會議與我的研究有高度相關, 參與此一會議，不論是對於目前的學術研究或是未來的研究規劃，皆有相當的助益。而對於此次在研討會上所認識的國際學者，我們仍保持密切聯繫，未來當能有更進一步的交流與討論，在學術研究上得有更深更廣的發展。

三、考察參觀活動(無是項活動者略)

四、建議

因為本次報告排在最後一天，參加的人數較少，而獲得較少回應。若能排在會議前兩天，當可獲得更多寶貴的建議，而對本篇論文未來的研究進展有所幫助。

五、攜回資料名稱及內容

因為所有論文都有電子檔，因此並未攜回書面資料，需要時上網下載即可。

六、其他

行政院國家科學委員會補助專題研究計畫 √ 成 果 報 告 □期中進度報告

（計畫名稱）

信用傳遞機制，金融風暴與政府政策之總體經濟意涵

計畫類別：√ 個別型計畫　□整合型計畫
計畫編號：NSC　98 － 2410 － H － 004 － 058 －
執行期間： 98 年 08 月 01 日至 99 年 10 月 31 日

執行機構及系所：政治大學經濟系

計畫主持人：黃俞寧
共同主持人：無
計畫參與人員：陳冠彰，簡義哲，賴建男，何佩瑩，林銘峰

成果報告類型(依經費核定清單規定繳交)：√精簡報告　□完整報告

本計畫除繳交成果報告外，另須繳交以下出國心得報告：
□赴國外出差或研習心得報告
□赴大陸地區出差或研習心得報告
√ 出席國際學術會議心得報告
□國際合作研究計畫國外研究報告

處理方式：除列管計畫及下列情形者外，得立即公開查詢
□涉及專利或其他智慧財產權，√一年□二年後可公開查詢

中　華　民　國 100 年 01 月 21 日

Macroeconomic Implications of Policies under Financial Crisis

Yu-Ning Hwang[1]

Department of Economics

National Chengchi University

December 2010

ABSTRACT

The objective of this study is to examine quantitatively the macroeconomic implications of monetary and fiscal policies on the economy under a financial crisis. By using the model in Goodfriend and McCallum (2007) which introduces a banking sector in a dynamic stochastic general equilibrium (DSGE) model, we can investigate the effects of rescue policies in response to shocks to the credit market, the primary cause of the financial crisis. The model with money and banking permits the endogenous determination of various interest rates and the external finance premium, instead of one single interest rate in conventional settings. The calibration results are in line with the consensus recently reached by most economists. A fiscal policy which is large and is implemented rapidly can precipitate economic recovery better than the other way round. In addition, since the external finance premium declines with the implementation of the fiscal policy, it may dampen the crowding-out effects of expansionary government expenditure. On the other hand, the expansion in the high-powered money is more effective as a policy than the interest rate cuts. This is because the expansion in the base money increases bank reserves, facilitates deposits and encourages consumption, a mechanism that is absent from a model that neglects money and banking.

Keywords: Credit channel, Financial crisis, External finance premium

JEL Classifications: F13; F41; E42

[1] *Yu-Ning Hwang is an Assistant Professor in the Department of Economics at National Chengchi University, Taipei, 116 Taiwan. Comments are most welcome. Contact details: e-mail to yuning@nccu.edu.tw; Tel.: 886-2-29393091 ext. 51641. I am grateful to Professor Tien-Wang Tsaur, Fu-Sheng Hung and all the participants in the Conference for the Financial Crisis and the seminar at the Central Bank of the Republic of China (Taiwan) for helpful comments and suggestions.

1. Introduction

The objective of this research is to examine quantitatively the effects of monetary and fiscal policies under a financial crisis which was triggered by dysfunctional credit markets. A dynamic stochastic general equilibrium (DSGE) model that includes the banking sector is established for policy analyses, following Goodfriend and McCallum (2007). In this model, shocks to the credit markets can characterize the current financial crisis that initiated from the credit markets. Equipped with the adequate specification of financial shocks, this study conducts calibrations based on the US data to evaluate the effects of different monetary and fiscal policies, in line with the current debates on alternative specifications of rescue policies in reaction to the worst financial crisis since the Great Depression decades ago. Moreover, while most economists' arguments are based on earlier theories, this study examines policies with a structural framework which offers a different angel to analyze policies' effects through numerical assessments.

The crisis broke out by the end of 2006 when the subprime mortgage default rates rose sharply after the housing bubble burst in 2005. Starting from the beginning of this century, consecutive interest rate cuts allowed banks to make loans to low-income families without the need to exercise prudent control over the credit risks. These loans were funded by loan-backed securities which were available worldwide. Aided by an extraordinarily easy monetary policy, investors could easily obtain funds with high leverage for investments, and even on low-quality asset-backed securities. Therefore, the housing crunch led to a chain of events: the value of the collateral for the mortgages fell, and this was immediately followed by mounting default rates, which caused sharp declines in the values of the underlying securities and in turn the asset markets as a whole. The slump in the values of the asset-backed securities led to a deterioration in the balance sheets of banks and firms, and this gave rise to difficulties in raising funds. The deterioration in the balance sheets exacerbated the problem of information asymmetry in the credit markets, and led to credit contractions in both the financial and real sectors, which resulted in recessions worldwide. The failure to monitor the loans and the decline in the collateral values were two of the main causes of the financial crisis.

During a financial crisis when markets fail to function normally, governments play an essential role as Keynesian theory suggests. Initially, central banks all over the world implement expansionary monetary policies by cutting interest rates, which can be performed both quickly and flexibly. However, in contrast to normal times, the effects of interest rate rules seem to be limited in the event of a financial crisis and fail to offset the recession that the crisis brings about. Hence, a massive fiscal stimulus is needed. However, the specification of the policy is critical. The timing, size and priority areas of the spending remain an open question.[2]

In the past decade, the DSGE model has served as the primary platform for the monetary policy analyses of central banks all over the world. Nevertheless, while various asset market structures, complete or incomplete, have been examined extensively under this framework, they are not the primary cause of the current financial crisis. Therefore, it is crucial to include the credit market. It thus seems to be natural to start from a model with a credit channel, which stresses the credit market's imperfections, as initially proposed by Bernanke and Blinder (1988), followed by Bernanke and Gertler (1989, 1995), Bernanke, Gertler and Gilchrist (1998) and others. Bernanke and Gertler (1988) state that rising interest rates, which are caused by a tightening of monetary policy, may worsen balance sheets, raise agency costs and lead to higher loan rates for borrowers. The rise in the loan rate gives rise to a higher external finance premium (EFP), which is the difference between the loan rate and the cost of internal funds. As a result, the movement in the EFP can signal the asymmetric information problem in the credit markets and exacerbate the downturn in economic activities. Therefore, the credit channel serves as the financial accelerator of monetary policy, as has been illustrated by many studies. Edwards and Vegh (1997), Kiyotaki and Moore (1997), Carlstrom and Fuerst (1997), Kocherlakota (2000) and Cooley and Marimon (2004) have made substantial contributions to credit channel studies.

In line with the literature on the DSGE model and credit channels, the model presented in Goodfriend and McCallum (2007) (henceforth, GM (2007)) offers a good platform to understand the causes and transmission mechanism of financial crises which initiates from the credit market. The model is essentially a combination of the DSGE model and the credit channel. While other models on

[2] In a presentation at the January 2009 meeting of the American Economic Association, Feldstein (2009) stated that big and quick spending on increasing aggregate activity and employment is required.

the credit channel include real sectors only, GM (2007) highlight the role of money in an economy with a banking sector. They argue that the omission of money would lead to the role of the demand for money in facilitating transactions, which may attenuate the effects of the financial accelerator, being neglected. On the other hand, it is also the first study to introduce the banking sector in a DSGE model.[3] In the model, the loan services that the banking sector offers require monitoring efforts and collateral consisting of bonds and capital. As a result, the interest rates on the financial services and assets, namely, the loan rate, bond rate, deposit rate and interbank rate, are endogenously determined. The external finance premium (EFP) can be generated accordingly.

In this model, two shocks exist in relation to the credit markets, in addition to the productivity shock to the production sector. One is the efficiency of the monitoring effort and the other is the effectiveness of the collaterals for loans, which resemble the causes of the current financial crisis. GM (2007) calibrates the model based on US data and finds that the EFP is generally countercyclical and that the financial shocks do raise the EFP, thus signaling the rising agency costs in the market, which is consistent with the credit channel literature. However, the calibration results also show that the EFP may be procyclical in some cases due to the "financial attenuator" caused by the demand for money.

This model is good for the analyses on policies in response to the current financial crisis for several reasons. First, the financial shocks they adopt in the model can well characterize the financial turmoil that occurred since 2007. Second, the calibrations show that the rise in the EFP with the financial shocks is in line with the data for the EFP since the beginning of this century, as shown below. Third, this framework allows us to examine alternative fiscal and monetary policies. Differing from GM (2007) which performs the analyses in order to understand the implications of the monetary policy for the shocks, this study will focus on the effects of alternative monetary and fiscal policies in the event of a financial crisis. In line with recent debates on the rescue policies in relation to the financial crises all over the world, both the expansionary monetary and fiscal policies are examined.[4]

[3] For example, Glarida, Galí and Gertler (1999, 2000, 2002) and Kollmann (2002), Schmitt-Grohé (2002), and Sutherland (2006) who use the prevalent DSGE models for monetary policy studies do not consider the role of banking in their models.

[4] In this study, I do not intend to discuss the bailouts which have brought up substantial controversy for three reasons. First, the bank in this model does not hold any financial assets and thus does not face a deteriorating balance sheet due to the decline in asset prices as is the case with many of the banks suffering nowadays. Therefore, it would be difficult to formulate such bailouts in an attempt to prevent the bank from encountering bankruptcy. Secondly, this study will focus on the macroeconomic implications of the financial crisis and related policies, instead of the rising agency cost which is the

Two fiscal policies are proposed: one that involves a small but persistent amount of public spending, and another that consists of a large amount of government spending that is less persistent. While both of them are able to help the economy recover from the recession, the first policy causes the economy to recover sooner than the second at the cost of drastic initial drops in consumption and investment. Due to the initial decline in consumption, a massive amount of financial spending that takes place quickly may be more desirable, as Feldstein (2009) points out.

Furthermore, it is worth pointing out that, while the importance of the credit channel to the monetary policy transmission mechanism has been well recognized in the literature, no studies have performed an examination of the transmission of fiscal policy based on the credit market paradigm. However, the banking sector may play a significant role in the transmission of fiscal policy, similar to what it does in the case of monetary policy. The calibration results in this model show that the EFP declines with the government expenditure, and thus may offset the crowding-out effect of expansionary fiscal policy. The decline in the EFP in this model does not imply the existence of a lower asymmetric information problem (the moral hazard problem which is one of the main concerns in regard to large bailouts) under fiscal policy, but demonstrates that the fiscal policy alters the demand for and supply of loans and deposits, causing loan and deposit rates to move divergently.

Two monetary policies are examined as well, namely, the conventional monetary policy on the control over the high-powered money and the interest rate rule. The calibrations show that the expansion in the monetary base can boost the economy. The effect essentially comes from its direct influence on the demand for money to facilitate consumption. The effect of the interest rate rule, however, strongly depends on the persistence of the financial shock. If the credit market can be restored quickly and thus more loans can be made out of the same amount of collateral, a small interest rate cut is good enough for the economic recovery. On the contrary, persistent financial shocks nullify the interest rate rule. This result may explain the fading effect of the interest rate since the crisis started.

Even if this model can serve as a good platform for policy analyses under a financial crisis, there are certain restrictions due to the massive model structure. First, there are no defaults. The model

primary concern of bailouts. Thirdly, no study has so far incorporated fiscal policies into this framework.

characterizes the credit market imperfection by the decline in the effectiveness of capital as collateral for loans, but there are no defaults for loans even if the value of the collateral has been low. While the crisis may have been triggered by the surging default rates, this assumption seems to be unrealistic and could be relaxed in future studies. Moreover, there are no investments. The capital in this model is thus assumed to remain at the steady state level and the movements in investment are completely reflected by the changes in the value of capital.

The remainder of this paper is organized as follows. In Section 2, we present the data on the EFP from the beginning of this century, and the analysis illustrates that the EFP surged when the financial crisis broke out. Section 3 outlines the specifications of the model. The dynamic analyses are listed in Section 4 to discuss the dynamic responses of the macroeconomic variables in response to shocks to policies and the financial sector, respectively. Several rescue policies for the financial crisis are examined in Section 5. This analysis centers on the effects of fiscal policies of different sizes and speeds as well as on alternative monetary policies. Section 6 concludes.

2. The significant movements in the EFP under financial crises

Fig. 1 lists the differences between the prime loan rate and the Federal funds rate[5], which constitute the external finance premium (EFP), in the early part of this century. While the EFP was fluctuating at around the 3% level, it jumped up significantly in December 2000 and September 2001 after the Internet bubble burst and the Enron scandal came to the fore. Similarly, the EFP also rose in August 2007 when the subprime crisis started to spread, followed by the sharp rise in mid-September 2008 after Lehman Brothers went bankrupt. While the Fed decided not to bail out Lehman Brothers, the EFP remained at a high level throughout the last quarter of 2008. It was because the worsening balance sheets of firms led to higher financing costs for borrowers that the EFP was forced to rise. With the higher costs of external funds, firms cut back on their production, employment and investment

[5] We use the interbank rate, instead of the short-term CD rate for two reasons. While the EFP associated with the CD rate exhibits the similar pattern as the EFP that is obtained from the Fed funds rate before 2008, the CD rate was increased abnormally to a higher level, causing the EFP down to zero, even negative in Oct. 2008. Moreover, GM (2007) uses the interbank rate instead of the deposit rate to calculate the EFP because the values of these two rates are very close.

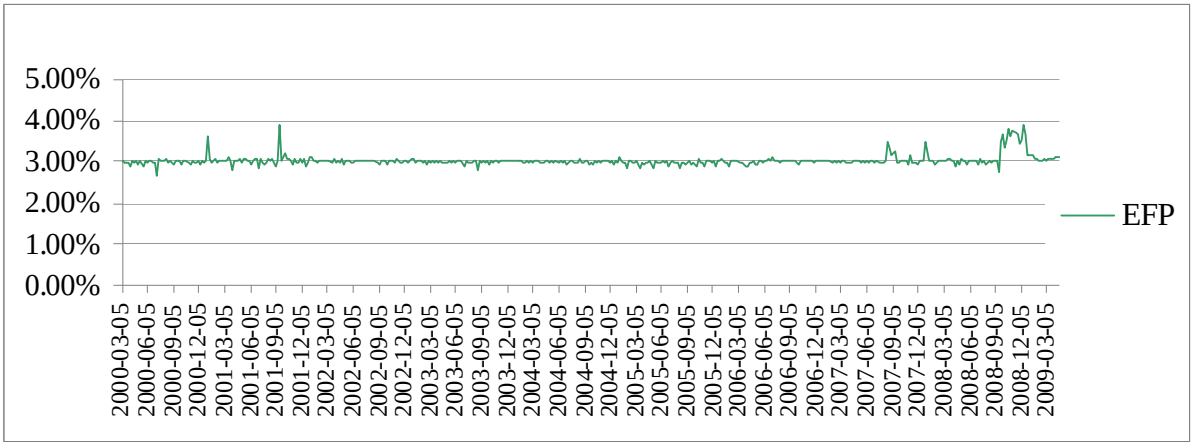

Figure 1: The External Finance Premium

projects.

It is evident that the EFP rose sharply in times of financial distress, signaling the worsening of the asymmetric information problem in the credit market. These times were

usually followed by economic recessions and thus were countercyclical as argued by Bernanke and McCallum (1995). Therefore, it is important to use a model under which the loan and interbank interest rates can be distinguished and the EFP is determined endogenously to capture the rising EFP after the financial crisis and the asymmetric information problem that may exacerbate the downturn of the economy after the financial crisis.

3. Model

The primary difference between this model and a typical DSGE specification is the inclusion of the banking sector. In this model, consumers need to hold deposits in the bank for their own consumption, and the bank can make loans. The loan services require real capital and marketable bonds as collateral, along with labor input for credit monitoring. Therefore, households supply labor in both the goods and banking sectors, and hold real capital for goods production as well as the collateral for loan services.

3.1 Goods Market

Since the goods market is assumed to be monopolistically competitive, a typical consumption bundle consists of a variety of differentiated goods, formed according to the Dixit-Stiglitz composite consumption index with υ as the elasticity of substitution. The aggregate consumption index and the associated aggregate price level are shown below:

$$C_t = \left[\int_0^1 C_t^{i\frac{\upsilon-1}{\upsilon}} di\right]^{\frac{\upsilon}{\upsilon-1}}, \quad P_t = \left[\int_0^1 P_t^{i1-\upsilon} di\right]^{\frac{1}{1-\upsilon}}$$

Accordingly, the demand function for each individual good is:

$$C_t^i = \left[\frac{P_t^i}{P_t}\right]^{-\upsilon} C_t$$

where C_t^i and P_t^i are the consumption and price of good i, and C_t and P_t are the aggregate consumption and price indices. Goods can be used for consumption, capital investment and government expenditure. The aggregate capital good, K_t, and government spending, G_t, which are also composed of a variety of goods, are assumed to follow the same composition as the consumption goods.

The firm employs labor and capital for the production of goods and its productivity is subject to exogenous shocks. Thus, under monopolistically competitive markets, the goods market clearing condition for a typical good j can be written as:

$$K_t^{j\alpha}\left(A_t^P l_t^{dj}\right)^{1-\alpha} = AD_t\left(P_t^j / P_t\right)^{-\upsilon} \qquad (1)$$

where A_t^p denotes the productivity shock and α denotes the share of capital in production. AD_t represents the aggregate demand in the economy which can be written as $C_t + q_t I_t + G_t$, where δ is the depreciation rate, $I_t = K_{t+1} - (1-\delta)K_t$ and q_t is the market price of capital. Therefore, the profit of a typical firm, Π_t^{Fj}, can be stated as:

$$\Pi_t^{Fj} = AD_t\left(\frac{P_t^j}{P_t}\right)^{1-\upsilon} - w_t l_t^{dj} - q_t K_t^j$$

where w_t states the wage rate and r_t is the rental rate on capital. l_t^d represents the labor demand of the firm.

To simplify the model, the capital stock is assumed to remain at the steady-state level, which is endogenously determined. Therefore, in each period, goods are invested simply for making up depreciation. While capital remains constant at the steady state level, q_t is the essential factor that determines the investment movements.

3.2 Households

The representative individual household obtains utility from the consumption bundle and labor supply:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\gamma \tilde{C}_t^{i(1-\rho)} / (1-\rho) + (1-\gamma) \log\left(1 - l_t^{si} - n_t^{si}\right) \right]$$

where

$$C_t = \left(\varphi C_t^{-\rho} + (1-\varphi) G_{t-1}^{-\rho}\right)^{-1/\rho}$$

l_t^s and n_t^s are labor supplies in the production and banking sectors, respectively. β is the subjective time preference. The budget constraint for the household can be written as:

$$q_t I_t^i + \frac{B_t^i}{P_t} + \Pi_t^{F_i} + \frac{\left(1+R_t^D\right) D_{t-1}^{di}}{P_t} - \frac{\left(1+R_t^L\right) L_{t-1}^{di}}{P_t} + w_t \left(l_t^{si} + n_t^{si}\right) + r_t K_t^i = \frac{B_{t+1}^i}{P_t \left(1+R_t^B\right)} + C_t^i + T_t + \frac{D_t^{di} - L_t^{di}}{P_t} \qquad (2)$$

Households hold two types of assets, bonds B_t and demand deposits D_t. The interest rates associated with the bond and deposit are R_t^B and R_t^D respectively.[6] In addition, they borrow from the bank L_t at the loan rate R_t^L. The superscript d is used to denote the demand of the assets from the households. T_t is the lump-sum tax.

Here, household faces the deposit-in-advance constraint, which is binding every period:

$$C_t^i = \frac{\nu D_t^i}{P_t} \qquad (3)$$

where ν is a constant, reflecting the assumed rigidity, and D_t denotes the nominal deposit.

[6] As shown below, the balance sheet of the bank shows that $H_t = D_t - L_t$ in equilibrium, where the central bank acts as the reserve supplier. Together with the profit functions of the firm and bank, we can obtain the individual budget constraint in GM (2007).

3.3 Bank

The balance sheet for a typical banking sector is:

$$H_t + L_t = D_t \tag{4}$$

where H_t is the reserve that the bank holds toward the deposit and L_t represents the bank loans to households. Assume θ is the reserve ratio, thus $H_t = \theta D_t$ and $L_t = (1-\theta) D_t$. The loan service is provided by using labor for monitoring and collateral, which consists of the bonds and capital that the household holds. The loan production function can be written as:

$$L_t / P_t = F\left(b_{t+1} + A_t^k m q_t k_{t+1}\right)^{\eta} \left(A_t^n n_t\right)^{1-\eta}, 0 < \eta < 1 \tag{5}$$

where $b_{t+1} = B_{t+1} / P_t \left(1 + R_t^B\right)$ and η is the fraction of the collateral takes in the loan production. F characterizes the overall efficiency of the loan production and a higher value of F stands for more efficient loan making which incurs lower marginal cost. $0 < m < 1$ indicates that real capital embeds higher risk and is less efficient than bonds as collateral.[7] A_t^k and A_t^n are shocks to the collateral and monitoring efforts, respectively. The negative A_t^k indicates the financial distress resembling the current crisis which was triggered by the decline in the housing price, the collateral for mortgage. A negative shock to A_t^n, on the other hand, describes the lack of monitoring for loans.

3.4 Government

The government budget constraint can be written as:

$$G_t - T_t = \left(H_t - H_{t-1}\right) / P_t + B_{t+1} / P_t \left(1 + R_t^B\right) - B_t / P_t \tag{6}$$

where G_t is the government expenditure which is assumed to be exogenous[8].

[7] It is because real capital usually requires greater monitoring effort to verify its physical condition and market value.

[8] G_t is assumed to be zero in GM (2007).

3.5 Optimality Conditions

Under the model specifications, household i, as a worker and firm, chooses the variables l_t^{si}, l_t^i, n_t^{si}, n_t^i, K_{t+1}^i, P_t^i and B_{t+1}^i to maximize her utility, subject to the constraints, Eq. (1) and (2), with the multiplier ς_t and λ_t respectively. The associated first-order conditions are similar to those in GM (2007), except for the nonzero G_t. With the banking sector, the first-order conditions differ from those in conventional settings in the role of bonds and capital, which function as the collaterals for loans and thus provide additional liquidity services for households. Let

$$\Lambda_t = \eta C_t \Big/ \left(b_{t+1} + A_t^k m q_t K_{t+1} \right) \tag{7}$$

Then the Euler equation associated with the bond can be derived as the equation below:

$$\left(\frac{\gamma C_t^{-\rho}}{\lambda_t} - 1 \right) \Lambda_t - 1 + \beta E_t \left(\frac{\lambda_{t+1} P_t}{\lambda_t P_{t+1}} \left(1 + R_t^B \right) \right) = 0 \tag{8}$$

The first term of the Eq. (8) stands for the loans that one unit of the bond can support. Similarly, the capital also yield similar liquidity service, and thus the condition with respect to capital possesses the additional term in the front:

$$\left(\frac{\gamma C_t^{-\rho}}{\lambda_t} - 1 \right) m \Lambda_t q_t - q_t + \beta \left(1 - \delta \right) E_t \left(\frac{\lambda_{t+1}}{\lambda_t} q_{t+1} \right) + \beta \alpha \left(\frac{\varsigma_{t+1}}{\lambda_t} \left(\frac{A 1_{t+1} l_{t+1}}{K_{t+1}} \right)^{1-\alpha} \right) = 0 \tag{9}$$

Since all the individuals are assumed to be identical, $P_t^i = P_t$ and the superscript i is dropped for all variables.

3.6 Interest rates

There are four interest rates in the overall credit markets. Because these interest rates are associated with the consumption, labor supplied, and the costs that the liquidity services incur, these corresponding interest rates are endogenously determined by the optimizing behaviors of consumers and competitive banks. In addition to the market interest rates, an uncollateralized interest rate, which

is the interest rate in the conventional general equilibrium model without banking, is treated as the benchmark rate:

$$1+R_t^T = E_t \frac{\lambda_t P_{t+1}}{\beta \lambda_{t+1} P_t} \tag{10}$$

Therefore, the difference between the bond rate and the uncollateralized rate can be obtained by combining Eq. (8) with Eq. (10)

$$1+R_t^B = \left[1-\left(\frac{\gamma C_t^{-\rho}}{\lambda_t}-1\right)\Lambda_t\right]\left(1+R_t^T\right) \tag{11}$$

Other interest rates that are associated with the operation of the banking sector will involve the real marginal costs that the operation incurs. Since the Federal funds market is the primary source of funds for the bank, the interbank rate R_t^{IB} is the cost of the fund for the bank to make loans. Therefore, when the bank loans the funds out, uncollateralized or collateralized, the interest rates have to cover the real marginal cost that the loan process requires. Without certain conditions such as collateral or credit checks, the uncollateralized rate R_t^T has to cover the interbank rate and the real marginal cost that is associated with the loan process which is $\nu w_t n_t / \left((1-\eta)(1-\theta)C_t\right)$ and thus the relationship between the interbank rate and the uncollateralized rate can be expressed as:

$$\left(1+R_t^{IB}\right)\left(1+\frac{\nu w_t n_t}{(1-\eta)(1-\theta)C_t}\right)=\left(1+R_t^T\right) \tag{12}$$

On the other hand, the real marginal cost of the collateralized loans is $\nu w_t n_t / \left((1-\theta)C_t\right)$ which is the partial derivative of the loan services with respect to n_t. The primary difference between the marginal cost of collateralized and uncollateralized loans lie in $(1-\eta)$, the share of monitoring in the loan process which can effectively reduce the marginal cost. Thus, the collateralized rate R_t^L can be written in a similar fashion:

$$\left(1+R_t^L\right)=\left(1+R_t^{IB}\right)\left(1+\frac{\nu w_t n_t}{(1-\theta)C_t}\right) \tag{13}$$

Moreover, since the bank keeps θ fraction of the deposits as the reserve without loaning out, the

relationship between the interbank rate and the deposit rate can be written as:

$$R_t^D = R_t^{IB}\left(1-\theta\right) \tag{14}$$

Thus, from Eq. (13), we can obtain the EFP, which expresses the spread between the bank's external and internal interest rates as a function of endogenous variables[9]:

$$EFP_t = R_t^L - R_t^{IB} \approx \frac{\nu w_t n_t}{\left(1-\theta\right)C_t} \tag{15}$$

The real marginal cost of loan supply, as indicated by GM (2007), is determined by the endogenous variables C_t , m_t , w_t , and the parameters associated with the loan production. Therefore, while the government's monetary and fiscal policies affect consumption, labor and the wage, they also alter the EFP that the household undertakes.

3.7 Nominal rigidity

While the prices are flexible in the long run, we assume that prices are rigid in the short run and that firms adopt Calvo staggered pricing as the pricing strategy. Without specifically specifying the firms' optimal pricing, the price adjustment process is characterized as follows:

$$\Delta p_t = \beta E_t \Delta p_{t+1} + \psi\sigma_t + u_t \tag{16}$$

where $\psi > 0$ and

$$\Delta p_t = \log(P_t) - \log(P_{t-1}) \tag{17}$$

which stands for the inflation rate of the aggregate price level. σ_t denotes the real marginal cost of goods production and can be identified as:

$$\sigma_t = \varsigma_t / \lambda_t \tag{18}$$

3.8 Exogenous shocks

The exogenous shocks, A_t^P and A_t^n, are assumed to follow a constant growth rate ϕ in the long run

[9] Since the interbank rate is only slightly lower than the deposit rate due to small θ , here the interbank rate is used for the derivation of EFP.

but to fluctuate in the short run. The shock to the efficiency of capital as the collateral, however, is assumed to be stationary. Since the cause of the financial crisis is the dysfunctional credit market caused by lower efficiency in loan production, the following analyses will focus on the impacts of the unit shocks A_t^k and A_t^n. The detrended (trendless) shocks are assumed to follow an AR(1) process:

$$e_t^k = \rho_k e_{t-1}^k + \varepsilon_t^k$$

$$e_t^n = \rho_n e_{t-1}^n + \varepsilon_t^n$$

where ε_t^k, ε_t^n are *iid* random variables and ρ_k, ρ_n indicate the persistence of these shocks, both of which are specified as 0.95 for the dynamic analyses to capture the slow recovery speed of the credit markets that is subject to financial innovations and restoration.[10] Since the effects of the shocks A_t^k and A_t^n on the economy are quite similar, we will discuss only the cases under the shock to the effectiveness of collateral e_t^k.

3.9 Policies

The crucial part of the calibration is the specification of policies. The government will respond to the financial shocks through interest rate cuts, expansion in monetary base, or expansionary government expenditure. As for the monetary policy, we propose two types of monetary rules. The central bank takes control over the interbank rate R_t^{IB}:

$$R_t^{IB} = (1-\mu_3)\left[\mu_0 + (1+\mu_1)\Delta p_t + \mu_2\sigma_t\right] + \mu_3 R_{t-1}^{IB} - D_R e_t^k + e_{R,t} \qquad (23)$$

where $\mu_1, \mu_2 > 0$ and $0 < \mu_3 < 1$, and $e_{R,t}$ is the policy shock to the interbank rate. This is essentially the Taylor rule under which the central bank raises the interest rate persistently and positively in response to inflation rate and the marginal cost σ_t to serve as the output gap.[11] Moreover, under the financial crisis, the central bank may want to reduce the interbank rate to lessen the impacts of the

[10] However, we will see that the persistence of the shocks has important implications for the interest rate rule in Section 5.3.
[11] The setup implies that the target inflation rate is equal to zero.

financial distress on the economy with the magnitude of D_R in response to a unit shock to e_t^k. The interest rate cut implies that the value of D_R should be negative.

In addition to the Taylor rule, an alternative monetary policy that involves controlling the growth rate of high-powered money is also discussed. Although most central banks all over the world regularly implement the interest rate rule, the financial crisis has forced governments to adopt the "quantitative easing" strategy by providing the markets with abundant liquidity. The rule is stated below:

$$m_t = \rho_m m_{t-1} + e_{m,t} - D_m e_t^k \tag{24}$$

where $m_t = \log(H_t) - \log(H_{t-1})$ which is the growth rate of the monetary base. Under this policy, the interbank interest rate is endogenously determined. $e_{m,t}$ is the shock to the stock of money, and D_m stands for the central bank's response to the shock which should be positive.

As for the fiscal policy, we assume that the government will respond to the shock by increasing the government expenditure, which is assumed to be an exogenous process:

$$G_t = (1-\rho_g)\bar{G} + \rho_g G_{t-1} + e_{g,t} - D_g e_t^k \tag{25}$$

where $\bar{G}$ is the steady state value of the government expenditure, ρ_g states the persistence of the temporary spending, and $e_{g,t}$ is the government spending shock. In a similar fashion, D_g characterizes the magnitude of the government spending in response to the shock and thus should be positive. The government can finance the spending by issuing bonds, money or increasing taxes. To obtain the equilibrium, we will need to exogenously specify one of the fiscal policies, the process of issuing bonds or levying taxes, leaving the other to be endogenously determined. In the calibrations below, we assume that the government maintains the ratio of bonds to consumption, φ_t, stationary:

$$\varphi_t = (1-\rho_b)\bar{\varphi} + \rho_b \varphi_{t-1} + e_{b,t} \tag{26}$$

where $e_{b,t}$ is the current shock to the bond-consumption ratio.[12]

[12] In future studies, we may relax this assumption by merely levying the income tax, thereby leaving the quantity of outstanding bonds to be endogenously determined.

3.10 Equilibrium

The sticky-price equilibrium which is constituted by C_t, l_t, n_t, P_t, w_t, q_t, B_t, T_t, D_t, L_t, R_t^B, ς_t, λ_t, σ_t, Δp_t and Λ_t can be obtained by solving Eq. (1)-(13), (20)-(22) under exogenous specifications of monetary policy (24) and the fiscal policy (25) and (26). In turn, R_t^{IB} along with all other interest rates can be determined by Eq. (15)-(18). Nevertheless, the equilibrium of an economy where the central bank exercises the interest rate rule can be characterized by replacing the monetary policy rule Eq. (24) with the interest rate rule Eq. (23).

In the calibrations, the steady state is assumed to be deterministic where shocks are absent and can be obtained by solving the system under flexible prices.[13] The dynamic analysis is performed through loglinearization with respect to the endogenous variables around the steady state, with some parameters being chosen to match certain features of the steady state values.

4 Dynamics

Before proceeding further with the examination of the policies under the financial crisis, Section 4 lists the impulse response functions for each shock: $e_{g,t}, e_{m,t}, e_t^k$, respectively. The calibration results in this section illustrate the implications of money and banking for the policies and the financial shocks. The discussion in this section will help us better understand the implications of the policies for the financial crisis, how they should be implemented and their effects.

4.1 Parameters

Since the outbreak of the financial crisis in the US, the calibrations are conducted based on US data. Therefore, most of the parameter values are chosen according to GM (2007), which is based on

[13] In a flexible-price steady state, the marginal cost is constant: $\varsigma_t/\lambda_t = (\upsilon - 1)/\upsilon$, which replaces Eq. (20).

quarterly data in the US.[14] Differing from GM (2007) in which case there was an absence of government expenditure, public spending is assumed to be 0.22 in the steady state in order to capture the share of government spending in GDP as 20%, following Schmitt-Grohe and Uribe (2002). The ratio of bonds to consumption in the steady state is assumed to be equal to 0.56. $\gamma = 0.38$ is calibrated to obtain the steady state labor supply, which is approximately equal to 1/3 after the government expenditure is added.[15] The steady-state money stock is chosen by letting the aggregate price level be equal to one. In addition, while the value of capital is allowed to fluctuate in the short run, it is assumed to be one in steady state, $q = 1$. The growth rate of exogenous shock is specified as $\phi = 0.005$.

The elasticity of substitution υ is assumed to be equal to 11 to capture the markup of 1.1 for the monopolists. Following the conventional setup, we assume $\beta = 0.99$, $\alpha = 0.36$ for the capital share in production and $\delta = 0.025$ to capture the quarterly depreciation rate. The parameters in the banking sector are specified as those calibrated in GM (2007). In the banking sector, GM (2007) calibrate US data and find that $\nu = 0.31$, $\eta = 0.65$, $m = 0.2$ and $\theta = 0.005$. $F = 9$ is calibrated to characterize the inefficient production in the banking sector which results in nonzero marginal costs. ψ is assumed to be equal to 0.02 as the recent literature indicates.

4.2 Unit shock to the government expenditure

[14] The large scale of the model is another reason and thus the choice of parameters is relatively restricted. An alternative specification of the parameters may generate negative steady-state values or multiple equilibria.

[15] With the parameter values specified here, the overall employment, $(l + n)$, is approximately 0.36 in the steady-state.

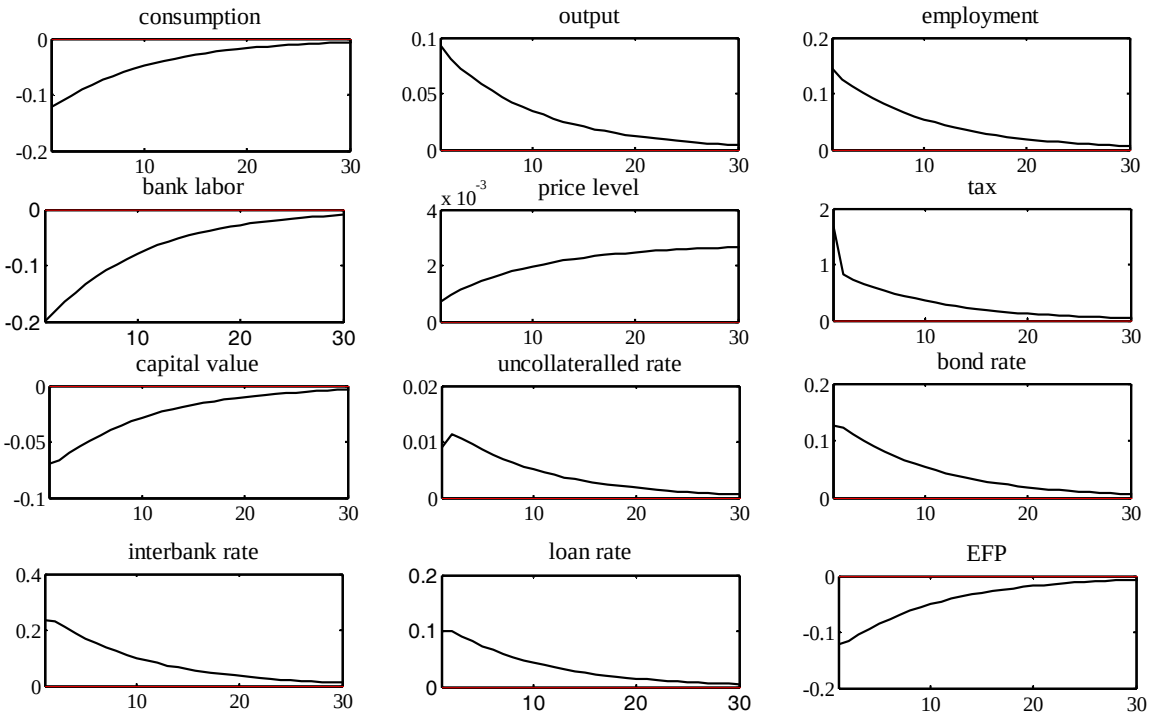

Fig. 2: 1% increase in government expenditure, $\varepsilon_{g,t} = 0.01$.

To examine the effects of fiscal policy on an economy with money and banking and highlight the role of money and banking in the dynamic responses of macroeconomic variables to expansionary government spending, here we calibrate the model with a unit shock to the government expenditure. It is conducted based on the interest rate rule with the policy parameters being specified as: $\mu_1 = 0.15$, $\mu_2 = 0.5$ and $\mu_3 = 0.95$.

Fig. 2 shows that employment in the production sector rises by 0.14% in response to a 1% point increase in the government expenditure, resulting in a 0.09% increase in output, which is slightly lower than 1%. The rising aggregate demand causes the price level and all the interest rates to increase with the expansionary government expenditure as the Keynesian theory suggests. The increased interest rates result in crowding-out effects on output by lowering consumption and the price of capital, indicating the decline in investment. However, the EFP is lowered by 0.12%. As shown in Eq. (19),

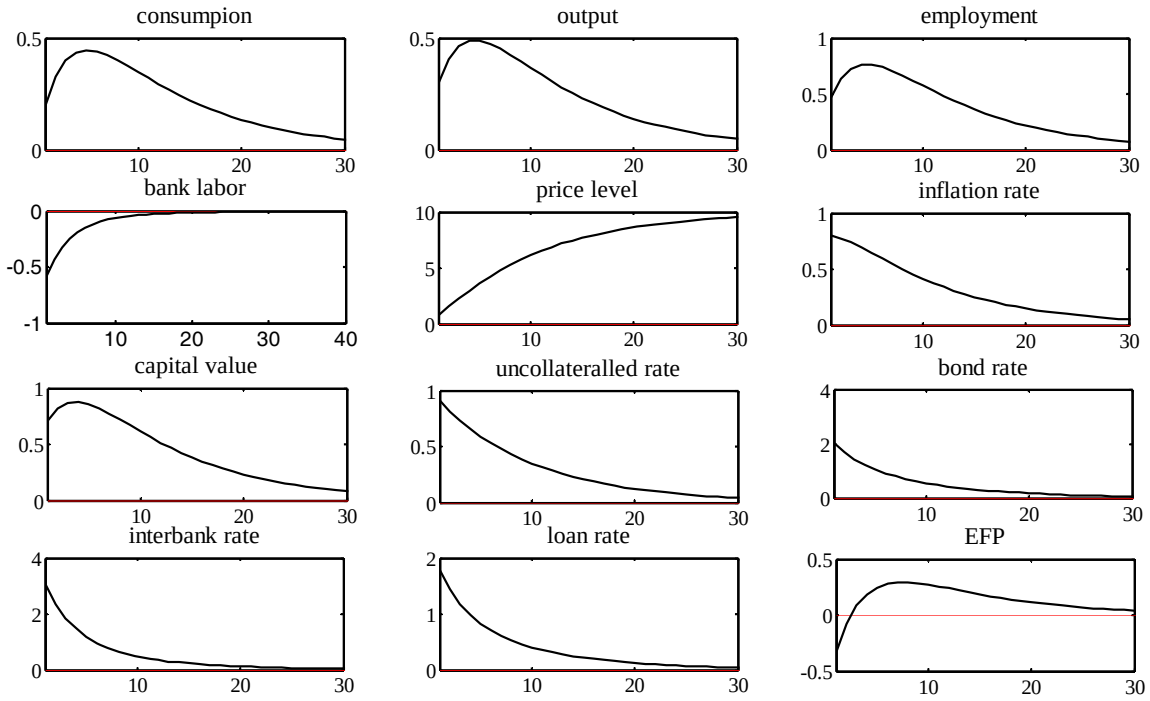

Fig. 3: 1% increase in the high-powered money, $\varepsilon_{m,t} = 0.01$.

$E\hat{F}\hat{P} = \hat{w} + \hat{m} - \hat{c}$. While m, w and c are all reduced, the decrease in consumption dominates. If the investment and consumption in the economy can be financed externally, the lower EFP will raise the level of investment as well as consumption, thereby offsetting the crowding-out effect of government expenditure. As a result, the drops in consumption and investment are relatively moderate, being 0.12% and 0.07%, respectively.

Therefore, a model which neglects banking and money may overstate the crowding-out effect of the fiscal policy. While the public spending crowds out consumption, the demand for deposits is lowered, which should be accommodated by the proportionate drop in the loan. However, the lower demand for the loan is offset partially by the decreases in investment and employment in the banking sector which are crowded out by the expansionary government spending. The smaller magnitude of the loan rate rise reduces the EFP.

4.3 Unit shock to the growth rate of high-powered money

Bernanke & Gertler (1995) argue that the EFP is countercyclical and that it plays the role of financial

accelerator in the transmission mechanism of monetary policy, which is mainly caused by the balance sheet effect. The exclusion of money in the conventional credit channel literature, however, may neglect the impact of the demand for money on the EFP that may in turn attenuate the influences of the financial accelerator, as argued by GM (2007).

The mixed effects of the expansionary monetary policy on the EFP are evident in Fig. 3. With the calibration on the high persistent growth of money $\rho_m = 0.9$, the 1% increase in the growth rate of money causes the EFP to drop initially, to rise afterward to a level above the steady state value, and then to decline gradually to the normal level. The initial drop, which is countercyclical, may be viewed as the "financial accelerator" as in Bernanke & Gertler (1995), but the positive levels in the following periods represent the "financial attenuator" as referred to by GM (2007).

Except for the movements in the EFP, all other variables are consistent with the results that GM (2007) report. Consumption increases by 0.44% and output rises by 0.48%. The economic boom drives up the inflation as well as q_t, whose effects die away gradually after 2 quarters.

4.4 Unit shock to the effectiveness of collaterals

Before implementing policies under the financial shock, we need to understand how the financial shock impacts the economy. The calibration results are listed in Fig. 4. Most of the results here coincide with the results that GM (2007) report. Consumption, output and employment decrease upon the impact of the shock. The shock causes these three variables

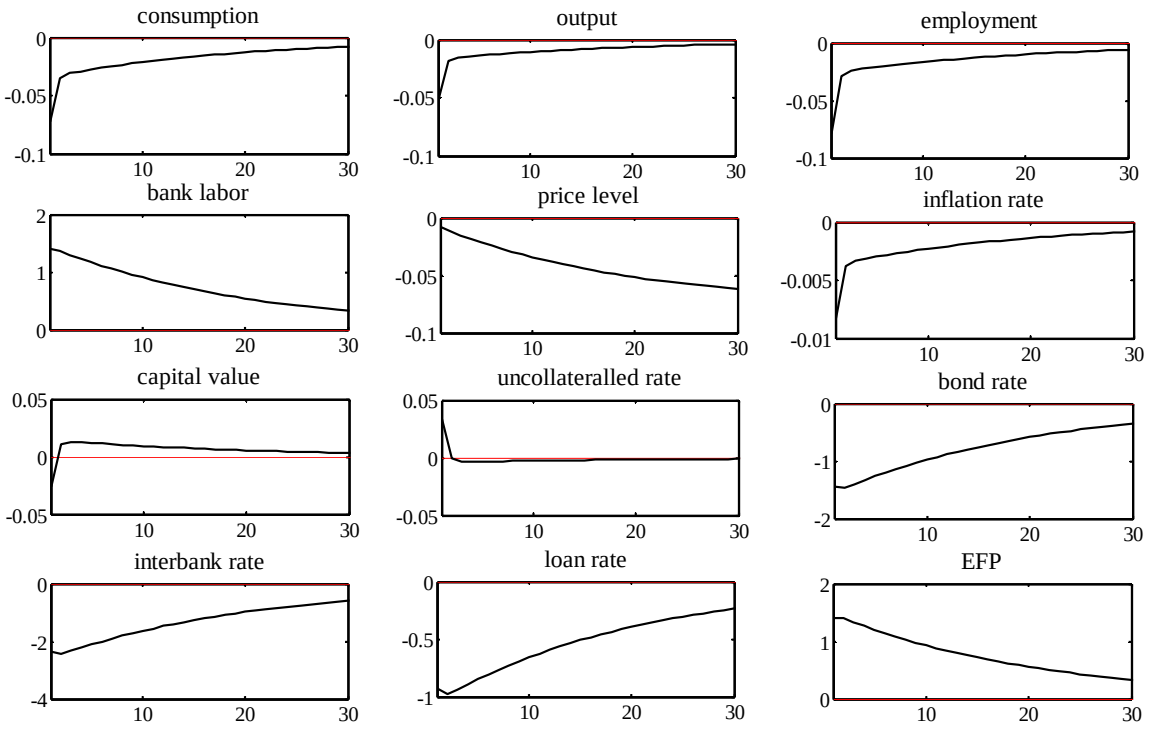

Fig. 4: 1% shock to the effectiveness of collaterals, $\varepsilon_t^k = -0.01$.

to drop sharply on impact, and then adjust gradually back to the steady state without any policy assistance. The recession is accompanied by deflation. This is consistent with what is usually observed after the financial crisis strikes. Most of the interest rates decrease as well, except for the uncollateralized rate.[16] The increase in R_t^T may, however, mislead the reactions of governments. In a model that does not distinguish between interest rates, R_t^T is the only interest rate that guides the consumption and investment decisions of households and firms. In a model where external financing for private spending is likely, however, R_t^L and R_t^B are the crucial determinants of consumption and saving behavior. While their movements diverge, the interest rate rule of the central bank that views R_t^T as the benchmark interest rate may be misleading. This finding illustrates the importance of money and banking for policy making.

The EFP rises upon the shock, consistent with the statement of Bernanke & Gertler (1995) the EFP is countercyclical and characterizes the worsening asymmetric information problem under the crisis. The

[16] The rise in EFP coincides with the data shown in Fig. 1: EFP increases significantly while the crisis strikes.

countercyclical EFP will cause the credit to contract, thereby delaying the recovery of the economy. The value of capital, q_t, decreases at the outbreak of the shock, but rebounds rapidly to a level that is greater than the steady state in one quarter, because the decline in interest rates raises the discounted sum of the future marginal product of capital. Notwithstanding the initial decline in capital value is close to that in the real world, the speed of recovery seems to be too fast. A possible reason that accounts for the rapid adjustment of q_t is the frictionless capital market where there is no price stickiness or costs that the capital adjustment may incur.

5 Policies under the financial crisis

Based on the above discussions, the policies under the financial crisis will be examined. In this section, we let $\varepsilon_t^k = -1\%$ in all cases and policies are allowed to react to the financial shock. Instead of determining the optimal monetary and fiscal policies, this section will investigate the effects of various policies on the dynamic responses of the economy and whether they can precipitate the economic recovery. In particular, the assessment in this section will center on the sizes and speeds of various policies. The results reveal that large and rapid government expenditure performs better than small and persistent government expenditure. On the other hand, while an expansionary monetary policy will help the economy recover from the crisis, the effects of the interest rate rule crucially depend on the persistence of the financial crisis. The results correspond to Feldstein's suggestions on the format of fiscal rescue policies, but casts some doubt on the effectiveness of interest rate

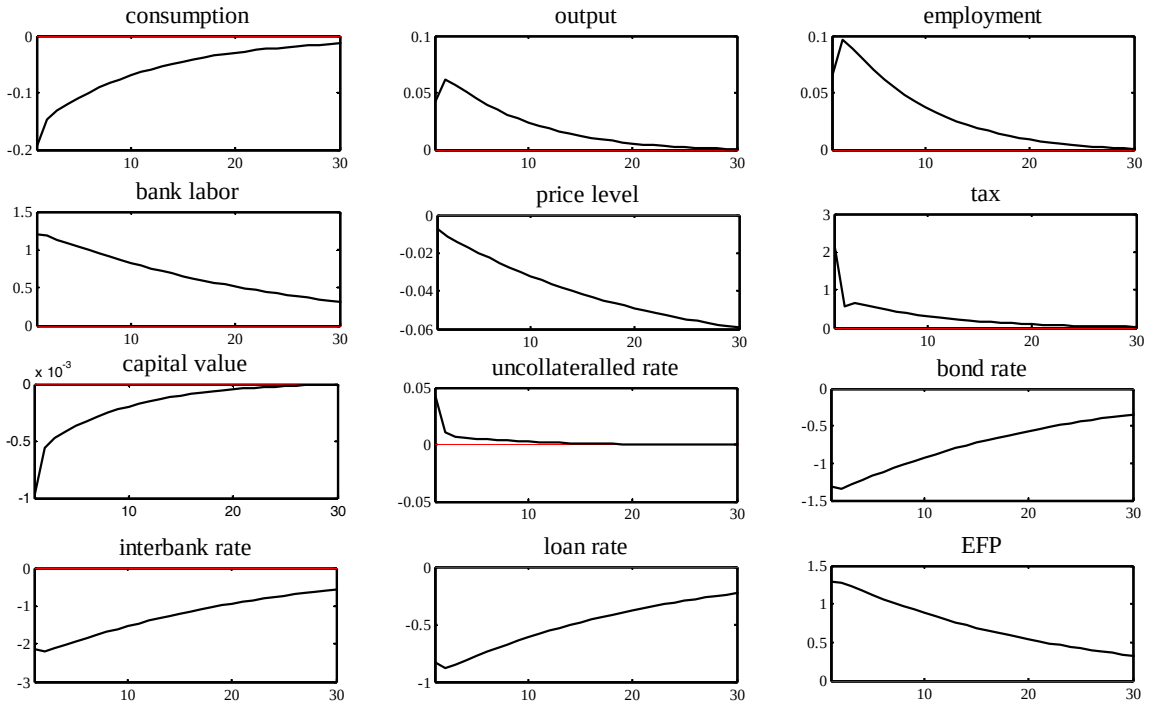

Fig. 5: small but persistent government expenditure: $D_g = 1$ and $\rho_g = 0.9$.

rules. As a result, this study can also serve as a justification for the large public spending policies that most governments all over the world are currently implementing while the effects of interest rate rules die away quickly or are even not strong enough to offset the impacts of the crisis.

5.1 Fiscal policy

Two fiscal policies are examined in this section: a stable government expenditure plan, which is small but persistent, and a drastic cure policy, which is large and less persistent. While the first one stands for normal government expenditure, the second one is conducted to find support or objections to the recent policy plans that most economists have proposed for the economy to recover from the recession following the financial distress.

5.1.1 Small and persistent government expenditure

Here we propose a highly persistent government expenditure and allow the public spending to react 100% to the financial shock. Therefore, $D_g = 1$ and $\rho_g = 0.9$. Similar to Section 4.2, the examination of the fiscal policy is conducted under the persistent interest rate rule. The effects of the expansionary fiscal policy are evident by comparing Fig. 4 and Fig. 5. As shown, the implementation of the government spending can successfully help the economy avoid recessions. Output increase by 0.06% instead of -0.05% when there is no public spending.

However, there is no free lunch. The expansionary public spending makes consumption drop, instead of increasing, by 0.19% and the investment decline by 0.1%, compared with the earlier levels before the policy was implemented of -0.07% and 0.013%, respectively. The increase in the aggregate demand leads to a rise in interest rates and the crowding-out effects.

Nevertheless as output and interest rates rise, the EFP is lowered but remains above the normal level and thereby becomes procyclical. This may dampen the crowding-out effect of expansionary fiscal poliy as discussed. Differing from the “financial attenuator” in GM (2007), the procyclical EFP is caused by the expansionary fiscal policy which drives up the output, but is not strong enough to push down the EFP to the level below the steady-state value.

5.1.2 Large and rapid government expenditure

While the more persistent policy can successfully help the economy recover, most economists urge the government to engage in “quick and large” government expenditures in

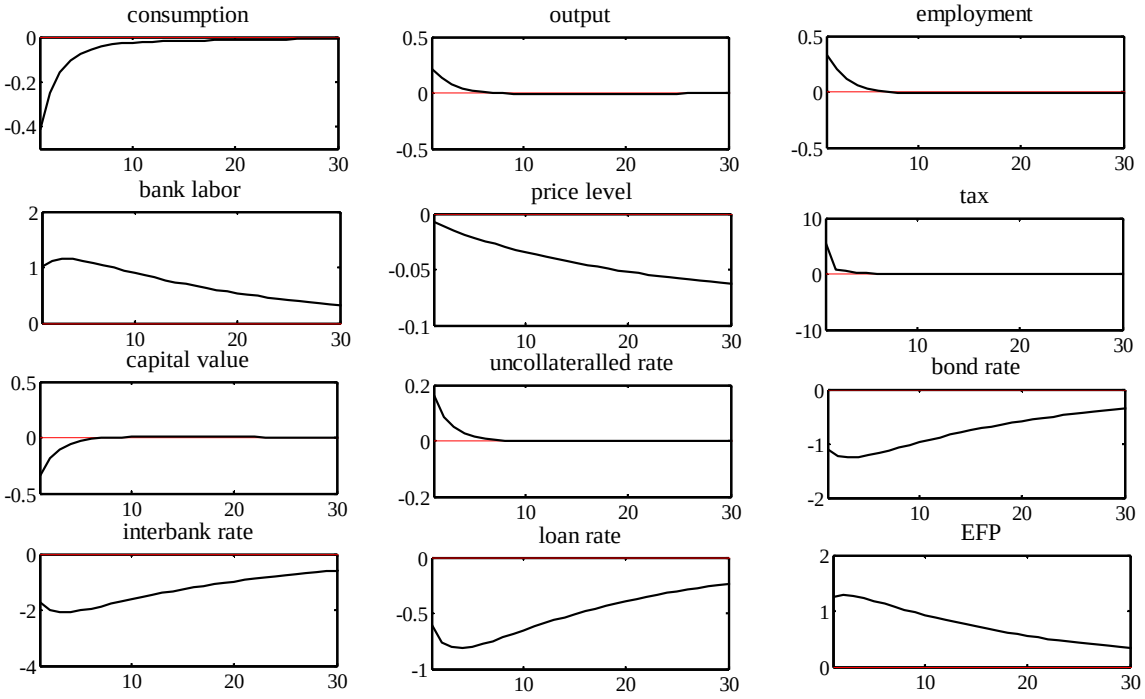

Fig. 6: large and rapid government expenditure: $D_g = 3$ and $\rho_g = 0.6$.

response to the financial crisis when there is no room for further interest rate decreases, the economy has run into recessions for more than 4 quarters, consumption and investment have fallen significantly, and there seem to be no signs for the private sector to recover on its own accord. Therefore, we propose another large and rapid government expenditure by assuming that $D_g = 3$ and $\rho_g = 0.6$, which can generate a similar price level path to that under the previous policy. With the low persistence, the 3% increase in government expenditure in response to a 1% financial shock will die out in 10 quarters approximately. Fig. 6 shows that this policy can stimulate the production immediately to 0.2%, but declines quickly with the less persistent spending. The fast adjustment speed also applies to other variables. While the large government expenditure causes drastic drops in consumption and investment initially, they rise back to the normal level in 5 quarters. Similarly, the tax increases greatly at the beginning, but falls down and remains at the steady-state level after 4 quarters. Interest rates, on the other hand, do not vary much with policies.

The quick recovery of the economy, 5 quarters before the government expenditure expires, provides strong support for the large-scale and rapid implementation of policy. As long as the economy is able or

handle the drastic drop in consumption in the early period, without being adversely affected by the current and future inflationary pressure, this enormous aggregate demand stimulus can help the private sector to accumulate enough income and capital to restore the credit market as well as the economy to its normal level before the crisis hit. Compared with the persistent but relatively small fiscal policy, this policy would be more desirable as people wish to avoid the recession sustaining.

5.2 Monetary policy

Since the monetary policy can be easily implemented, it is usually the first step that the government will take in response to the financial crisis. While the interest rate rule does not seem to be effective, control over the base money is also exercised. This finding follows along the same lines as the development of US policies after the outbreak of the financial crisis. While the Fed has consecutively cut the Fed fund rate target from 5.25% to 0.25% within 5 quarters, there do not seem to be any signs of a recovery. In March 2009, the chairman of the Fed, Ben Bernanke, announced that the Fed was planning to purchase 300 billion in bonds from the markets. While this “quantitative easing” of the environment seems to be needed for the economy, it is also accompanied by mounting worries over high inflation after the recession ends. The analysis below may help explain the limited effects of the interest rate rule, and the possible success of the quantitative easing strategy of the Fed.

5.2.1 Interest rate rule

We assume that the interbank rate will be lowered by 1% in response to a 1% shock to the

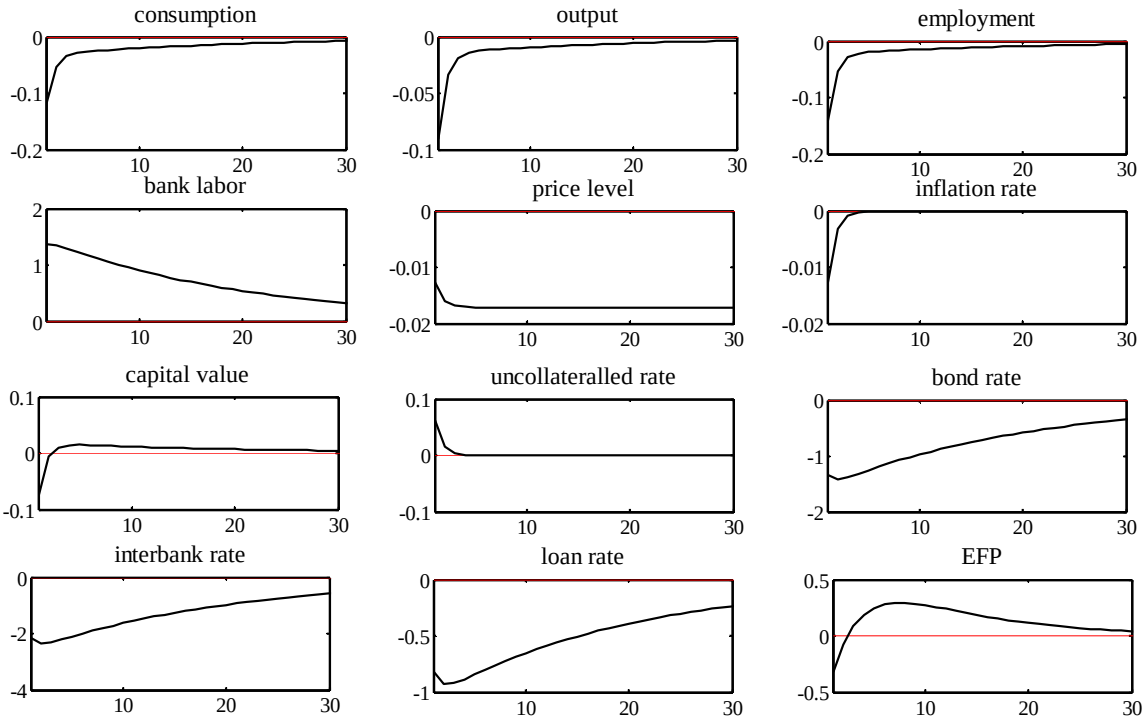

Fig. 7: interest rate rule under a persistent financial shock: $D_R = -1$, $\rho_k = 0.95$.

collateral effectiveness, and so $D_R = -1$. To characterize the persistent interest rate cut in reaction to the prolonged crisis, the persistence of the interbank rate, $\mu_3 = 0.95$, is specified. However, compared with Fig. 4, the interest rate cut does not result in much difference under the interest rate smoothing rule, but causes larger declines in consumption and output as well as slight rises in interest rates. The interest rate increases lower the discounted value of the marginal product of capital and thus reduce the value of capital, compared with Fig. 4. The decline in investment worsens the downturn in output and consumption.

This peculiar result may be caused by the relative magnitude of the interest rate rule's responses to the past interest rate and current inflation and output gap. While the 1% cut in the interest rate is not large enough, the interest rate responds more to the current output gap and inflation rate. Because the output rebounds to the normal level in only two quarters, the zero output gap prevents further interest rate cuts. This result is quite robust even under an unrealistic 5% quarterly cut in the interest rate to the shocks or inflation targeting rule with the assumption that $\mu_1 = 10$ and $\mu_2 = 0$. The calibrations of the same policies under the

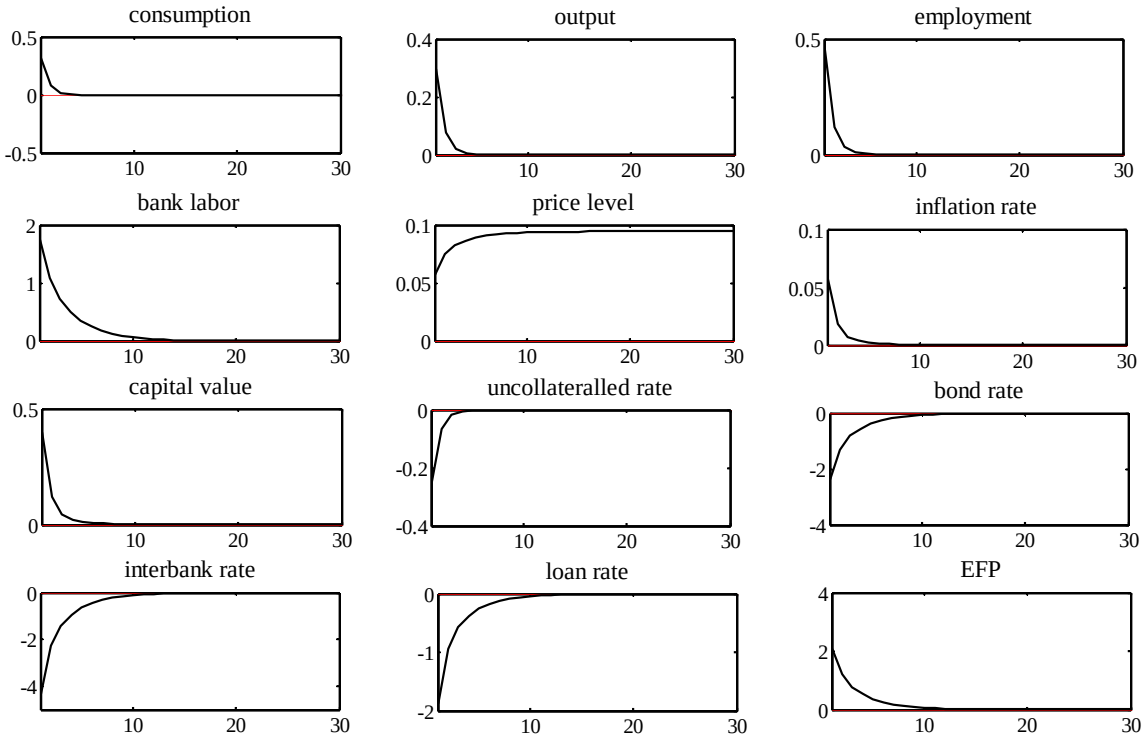

Fig. 8: interest rate rule under less persistent financial shocks: $D_R = -1$, $\rho_k = 0.7$.

shock to the monitoring in the banking sector also generate the same results.

The crucial determinant seems to be the persistence of the shocks. If the persistence of the shock is lowered to 0.7, instead of 0.95 as in previous cases, a 1% interest rate cut is enough to help the economy recover regardless of whether it is interest rate smoothing, as shown in Fig. 8. Both consumption and output rise slightly above the normal level, accompanied by an increase in investment. This implies that the interest rate rule is not effective unless the credit market efficiency is quickly restored, which in turn depends on the confidence of the banking sector in the production of loans. In Fig. 7, we can see that although the banking sector hires more people to monitor the loan making and the value of the capital goods increases, lower consumption implies that the outstanding loans remain at a low level. The lower interest rate is not able to stimulate the banking employment or restore the amount of collateral required to make the loans at the level before the shock hits. However, Fig. 8 shows that the swift rebound in the financial shock enables the economy to

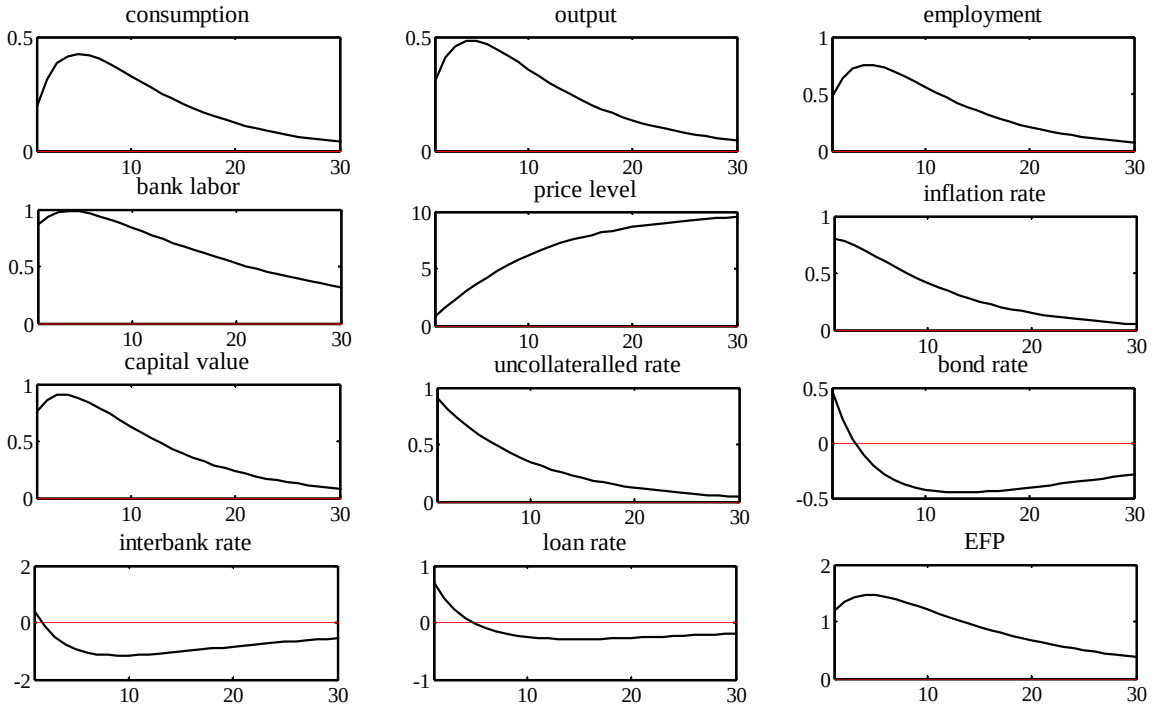

Fig. 9: expansionary high-powered money: $D_m = 1$.

rapidly recover. Therefore, the effectiveness of the interest rate rule strongly relies on the reestablishment of the credit market is crucial for the economy to recover but not the other way round.

5.2.2 Expansionary monetary base

While the interest rate rule does not seem to be effective in the face of the crisis, the expansionary base money seems to work much better. With the persistence of the high-powered money growth equaling 0.9 and responding to a 1% financial shock by a 1% increase in the growth rate of the monetary base, Fig. 9 shows that the consumption and output can grow without experiencing the initial recession. The 1% increase in the base money will cause the interbank interest rate to fall by 1.14% in each quarter, which is equivalent to 4.8% per annum. This decline does not seem to be unrealistic because the Fed has lowered the Federal funds rate by 5% within just one year.[17] The essential reason for the effectiveness of the monetary expansion is the quantitative easing environment. While a larger high-powered money growth induces a greater demand for consumption followed by higher deposit and

[17] Before the crisis, GM (2007) pointed out that the 1.2% quarterly drop in the interbank interest rate was unrealistic.

loan demand, the interest rates are lowered. A lower interest rate stimulates investments and the capital stock, and is helpful in restoring the quantity of loans to a higher level.

In particular, from the balance sheet of the bank, $H + L = D$, we can see that the bank reserves rise with the expansion in high-powered money. Deposits are increased accordingly which can facilitate consumption. This mechanism is absent from the conventional literature on monetary policy, which neglects the banking sector, as well as from the studies on credit channels without considering money. This channel is also absent in an economy with an interest rate rule which crucially depends on the interest rate elasticity of consumption and investments.

6 Conclusion

This paper investigates quantitatively the macroeconomic implications of monetary and fiscal policies under the current financial crisis based on the model in GM (2007). By using the DSGE model with the banking sector, we can successfully characterize the financial crisis that was initiated in the credit markets in terms of the shock to the loan production of banks and see how the shock impacts other sectors within the economy. With money and banking, this model allows for the endogenous determination of various interest rates and the EFP.

The effects of policies are examined quantitatively by means of calibrations based on US data where the crisis started. The calibration results show that expansionary government expenditure can successfully help the economy recover, but the timing and size of the policy's implementation may matter. When characterized by a 3% increase in government spending in response to a 1% shock to the effectiveness of collateral with an AR(1) coefficient of 0.6, this policy will enable the economy to accumulate enough wealth and recover within four quarters, though by sacrificing initial consumption. Compared with the long-lasting recessions under a 1% increase in public spending with a persistence of 0.9, a large-scale and rapid policy implementation seems to be more desirable.

Moreover, the calibration results also illustrate that the EFP declines with the implementation of fiscal policy. Since the decrease in the EFP will be an additional force that stimulates investment, the

crowding-out effect of fiscal policy due to rising interest rates will be attenuated. Therefore, a model without distinct interest rates may overstate the crowding-out effects and the effects of the fiscal policy may be stronger than was thought. While the credit channel literature focuses on the examination of monetary policies, the implications of credit channels for fiscal policy have not been noted before.

The effects of monetary policy also strongly rely on the way the policy is applied. A 1% expansion in the growth rate of base money in response to a unit shock to the effective collateral can successfully stimulate the economic recovery. The increase in the monetary base can raise the demand for consumption as well as deposits, thereby boosting the economic growth. However, with the high persistence of the financial shock of 0.9, as in all other cases, a 4% p.a. interbank rate reduction by the Fed will fail to pull the economy out of the recession, no matter how persistent the interest rate rule is or how large the initial cut is (interest rate smoothing or inflation targeting). It will only be effective if the financial shock is less persistent. That is, the effectiveness of the collateral needs to be restored soon and thus the banking sector will be able or will be willing to provide enough loans for consumption. This finding coincides with the fading effects of the interest rate rule since the financial crisis broke out which has led to an emphasis on “quantitative easing” policy or massive government spending. It shows that it is the effectiveness of the interest rate relies on the credit market restoration, but not the other way round.

However, the policies in this model are relatively simple: the government expenditure focuses on goods without contributing to productivity or consumption directly in the economy. There will be differences if the emphasis is on productive spending or consumables. The way to finance the government expenditure also matters. Whether the funds for the spending are raised by issuing bonds, money or by taxes will result in different interest rate movements and the EFP, and these will have different effects on the economy.

References

Bernanke, B. S. and A. S. Blinder (1988) "Credit, Money and Aggregate Demand" *American Economic Review, 78(2), 435-439.*

Bernanke, B. S. and M. Gertler (1989) "Agency Costs, Net Worth, and Business Fluctuations" *American Economic Review*, 79, 14-31.

Bernanke, B. S. and M. Gertler (1995) "Inside the Black Box: The Credit Channel of Monetary Policy Transmission" *Journal of Economic Perspectives, 9, 27-48.*

Bernanke, B., Gertler, M. and Gilchrist, S. (1998) "The Financial Accelerator in a Quantitative Business Cycle Framework" *NBER Working Papers, No.6455*

Carlstrom, C. T. and T. S. Fuerst (1997) "Agency Costs, Net Worth, and Business Fluctuations: a Computable General Equilibrium Analysis" *American Economic Review*, 87(5), 893-910.

Clarida, R., J. Galí and M. Gertler (1999) "The Science of Monetary Policy: A New Keynesian Perspective" *Journal of Economic Literature*, 37, 1661-1707.

Clarida, R., J. Galí and M. Gertler (2000) "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory" *Quarterly Journal of Economics*, 105(1), 147-180.

Clarida, R., J. Galí and M. Gertler (2002) "A Simple Framework for International Monetary Policy Analysis" *Journal of Monetary Economics*, 49(5), 879-904.

Cooley T. and R. Marimon (2004) "Aggregate Consequences of Limited Contract Enforceability" *Journal of Political Economy*, 112, 817-847.

Edwards, S. and C. A. Végh. (1997) "Banks and Macroeconomic Disturbances under Predetermined Exchange Rates" *Journal of Monetary Economics*, 40, 239-278.

Goodfriend, M. and McCallum B. T. (2007) "Banking and Interest Rate in Monetary Policy Analysis: A Quantitative Exploration" *Journal of Monetary Economics*, 54, 1480-1507.

Feldstein M. (2009) "Rethinking the Role of Fiscal Policy" *presented at the AEA meetings , January, 2009.* Retrieved April 24, 2009 from the World Wide Website: http://www.nber.org/feldstein/RethinkingtheRoleofFiscalPolicy.html

Kiyotaki, N. and J. Moore (1997) "Credit Cycles" *Journal of Political Economy*, 105, 211-248.

Kocherlakota, N. (2000) “Creating Business Cycles through Credit Constraints” *Federal Reserve Bank of Minneapolis Quarterly Review*, 24(3), 2-10.

Kollmann, R. (2002) “Monetary Policy Rules in the Open Economy: Effects on Welfare and Business Cycles” *Journal of Monetary Economics*, 49, 989-1015.

Schmitt-Grohé, S. and Martín Uribe (2002) “Optimal Fiscal and Monetary Policy Under Sticky Prices” *NBER Working Paper No. 9220*

Sutherland, A. 2006. “The expenditure switching effect, welfare and monetary policy in a small open economy,” *Journal of Economic Dynamics and Control*, vol. 30, no. 7, pp. 1159~1182.

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

   √ 達成目標

   □ 未達成目標（請說明，以 100 字為限）

   □ 實驗失敗

   □ 因故實驗中斷

   □ 其他原因

   說明：

2. 研究成果在學術期刊發表或申請專利等情形：

   論文：□已發表 √未發表之文稿 □撰寫中 □無

   專利：□已獲得 □申請中 □無

   技轉：□已技轉 □洽談中 □無

   其他：（以 100 字為限）本研究主題”macroeconomic implications of policies under financial crisis” 一文已刊登於「世紀初金融風暴學術研討會」會議論文集中，並已準備投稿學術期刊。相關研究 “Implications of Economic Openness for Financial Crisis” 已發表於社會科學論叢中(第四卷第一期, 51-74 頁)。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）

本研究是在一包括金融中介機構的動態隨機一般均衡模型（DSGE）下探討金融部門所造成的金融危機對於總體經濟的影響，以及貨幣政策與財政政策在這樣的金融衝擊下對於促進總體經濟復甦的有效性。研究的結果發現，財政政策與量化寬鬆的貨幣政策是有效的，但降息是無效的。此一研究，可以幫助我們瞭解金融危機對於總體經濟的衝擊，以及金融風暴下，較為適當的政策措施。於學術面，此一模型可以更進一步幫助我們瞭解貨幣政策的傳遞效果；於政策面，我們可以更清楚，政府應採取什麼樣的措施來因應金融風暴，協助總體經濟的復甦。

本人並已將此研究延伸到小型開放經濟體系的架構下來探討金融風暴對於匯率，乃至總體經濟的影響，亦藉此模型來探討台灣最適的貨幣政策。本次次級房貸風暴發生之後，國際間對於金融中介機構與貨幣政策的研究於質與量上皆有大幅度的成長，因此，包含了金融中介機構的 DSGE 模型在未來具有相當大的發展潛力。

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：99 年 7 月 20 日

計畫編號	NSC 98－ 2410 － H － 004 － 058 －		
計畫名稱	信用傳遞機制，金融風暴與政府政策之總體經濟意涵		
出國人員 姓名	黃俞寧	服務機構 及職稱	政治大學經濟系助理教授
會議時間	99 年 7 月 15 日至 99 年 7 月 17 日	會議地點	英國倫敦
會議名稱	（中文） （英文）16th CEF Annual Conference, July15-July17, 2010, City University of London		
發表論文 題目	（中文）美元本位制下的福利與貨幣政策分析 （英文）Welfare and Monetary Policy under a Dollar Standard		

一、參加會議經過

本人於 7 月 14 日晚抵達英國倫敦。15 日與 Stephen Turnovsky 教授與夫人，以及 Paul McNelis 教授相聚，並遇見多位去年在雪梨 CEF 年會相識的學者，相談甚歡。接下來兩天，與 Stephen Turnovsky 交換了許多想法，並與 Paul McNelis 教授就我們的合作計畫做更進一步的探討。16 日晚間，會議晚宴在英國皇家科學院 (the Royal Society) 舉行，與 The Federal Reserve Bank of Minneapolis 的知名經濟學家 Ellen McGrattan、德國央行、國際清算銀行等研究機構的經濟學者同席，交換本次金融風暴與歐債風暴的看法。本系陳樹衡老師並於席間當面邀請國際知名學者 Michel Juillard 教授來台訪問，Michel Juillard 教授也當面承諾將於今年四月間來台，目前本系正在積極安排中。本人則於 7 月 17 日上午發表”Welfare and Monetary Policy under a Dollar Standard”一文，當天晚間即啟程返回台灣。

二、與會心得

參與此次會議使我獲益良多，除了可與 Stephen Turnovsky 教授伉儷敘舊之外，與 Paul McNelis 教授的合作計畫上並有所進展。除此之外，並與德國央行的 Felix Hammermann 與國際清算銀行的經濟學家就實務上交換了許多意見，更進一步了解歐洲央行與國際清算銀行的運作。整體來說，因為此一會議與我的研究有高度相關, 參與此一會議，不論是對於目前的學術研究或是未來的研究規劃，皆有相當的助益。而對於此次在研討會上所認識的國際學者，我們仍保持密切聯繫，未來當能有更進一步的交流與討論，在學術研究上得有更深更廣的發展。

三、考察參觀活動(無是項活動者略)

四、建議

因為本次報告排在最後一天，參加的人數較少，而獲得較少回應。若能排在會議前兩天，當可獲得更多寶貴的建議，而對本篇論文未來的研究進展有所幫助。

五、攜回資料名稱及內容

因為所有論文都有電子檔，因此並未攜回書面資料，需要時上網下載即可。

六、其他

國科會補助計畫衍生研發成果推廣資料表

日期:2011/01/20

國科會補助計畫	計畫名稱: 信用傳遞機制, 金融風暴與政府政策之總體經濟意涵
	計畫主持人: 黃俞寧
	計畫編號: 98-2410-H-004-058- 學門領域: 總體經濟學與貨幣經濟學

無研發成果推廣資料

98 年度專題研究計畫研究成果彙整表

計畫主持人：黃俞寧	計畫編號：98-2410-H-004-058-
計畫名稱：信用傳遞機制, 金融風暴與政府政策之總體經濟意涵	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	1	1	100%	篇	
		研究報告/技術報告	1	1	100%		
		研討會論文	3	2	150%		本研究主題’macroeconomic implications of policies under financial crisis’ 一文已刊登於「世紀初金融風暴學術研討會」會議論文集中，並已準備投稿學術期刊。
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	3	3	100%	人次	
		博士生	2	2	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	1	1	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	透過此模型，本人得以進一步探討金融中介機構對於總體經濟的影響。也因此而與美國 Fordham University 的 Paul McNelis 教授合作，以類似的想法與方法，進行台灣貨幣政策的研究。

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 ■未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：(以 100 字為限)

本研究主題’macroeconomic implications of policies under financial crisis’ 一文已刊登於「世紀初金融風暴學術研討會」會議論文集中，並已準備投稿學術期刊。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)

本研究是在一包括金融中介機構的動態隨機一般均衡模型（DSGE）下探討金融部門所造成的金融危機對於總體經濟的影響，以及貨幣政策與財政政策在這樣的金融衝擊下對於促進總體經濟復甦的有效性。研究的結果發現，財政政策與量化寬鬆的貨幣政策是有效的，但降息是無效的。此一研究，可以幫助我們瞭解金融危機對於總體經濟的衝擊，以及金融風暴下，較為適當的政策措施。於學術面，此一模型可以更進一步幫助我們瞭解貨幣政策的傳遞效果；於政策面，我們可以更清楚，政府應採取什麼樣的措施來因應金融風暴，協助總體經濟的復甦。

本人並已將此研究延伸到小型開放經濟體系的架構下來探討金融風暴對於匯率，乃至總體經濟的影響，亦藉此模型來探討台灣最適的貨幣政策。本次次級房貸風暴發生之後，國際間對於金融中介機構與貨幣政策的研究於質與量上皆有大幅度的成長，因此，包含了金融中介機構的 DSGE 模型在未來具有相當大的發展潛力。