Business Cycles and Macroeconomic Policies in China: Evidence from an Estimated DSGE Model

June 13, 2012

Tao Peng\textsuperscript{a}

Southwestern University of Finance and Economic

Abstract

In a new Keynesian model with interest rate control, endogenous leverage and credit constraints, we study the sources of business cycles in China and the roles of credit policies. We find that credit shocks are the main driving force of economic fluctuations, while productivity shocks and inflation shocks are non-negligible impetus to business cycles. The countercyclical credit policy implemented by the central bank of China plays some role in stabilizing the economy.

1. Introduction

Since China launched the economic reform at the end of 1970s, China has experienced tremendous economic growth. Yet, the growth is not perfectly smooth and is accompanied by certain degree of economic fluctuations. Figures 1(a)- 1(e) plot several time series of macroeconomic variables from 1998Q1-2010Q4. Figure 1(a) shows the linear detrended logarithm of real GDP. Real GDP was above its trend by about 5 percentage points in the second quarter of 2007 and was below its trend by 7 percentage points in the fourth quarter of 2003. Figure 1(b) shows the inflation rate using 1997Q4 as the base period. Between 1998 and 2003, the Chinese economy experienced a period of deflation. The inflation reemerged since 2004 and continued

\textsuperscript{a} Tao Peng, Research Institute of Economics and Management, Southwestern University of Finance and Economics, Chengdu, China. pengtao@swufe.edu.cn

I thank Jianjun Miao, Yi Wen and seminar participants at Australasia Meeting of the Econometric Society (Adelaide), Shanghai University of Finance and Economics, Singapore Economic Review Conference, Tsinghua Workshop in Macroeconomics for Young Economists 2011 (Beijing) for useful comments. I appreciate Matteo Iacoviello for answering several questions on technical issues. All remaining errors are mine.
to rise to more than 10% after 2007. Figures 1(c)-1(e) display the behavior of housing prices, investment and credit, which were also volatile.

![Figure 1](image-url)
On the other hand, although the Chinese economy exhibited non-negligible business cycles, the economic fluctuations were not as drastic as those in Latin American countries and other developing economies. This is not because China was lucky to have a good time. On the contrary, in the recent two decades, China experienced several severe natural disasters and a few important economic events: the catastrophic flood in 1998, the Severe Acute Respiratory Syndrome (SARS) in 2003, the Sichuan earthquake in 2008, the accession to the WTO at the end of 2001 which gave China the opportunity to share the benefits of low tariff trade but also put forward a challenge for its immature or low efficiency industries to compete with strong foreign enterprises in China, the Asian financial crises at the end of 1990s and the recent global great recession, etc. It seems that any of the above events had a potential to bring a recession to China, but this is not the case.

The goal of this paper is two-fold: to identify the sources of China’s economic fluctuations and to discuss the macroeconomic policies that the Chinese government implements to stabilize the economy. We show that credit shocks are the main driving force of business cycles and that the countercyclical credit policy employed by the central bank of China plays a role in alleviating economic fluctuations.

We use a model based on Iacoviello (2005) to address the above issues. To capture the features of the Chinese economy, we modify the model by Iacoviello (2005) in several aspects. First, we impose an endogenous leverage (loan to value ratio) in the model. In particular, we assume that the leverage is negatively related to output. This modeling aims to capture that the central bank of China has significant power in regulating the supply of credit. Since most enterprises in China rely on bank loans as their major source of external finance, the amount of credit and the allocation of credit have always been the concerns of the central bank of China. The total supply of credit is the variable the central bank of China aims to regulate through legal reserve requirement, open market operation, window guidance, and is the key issue discussed at the quarterly regular meeting of the central bank’s monetary policy.
committee. The negative relationship between loan to value ratio and output is based on two observations. First, inspecting figure 1(a) and figure 1(e), we find that credit is countercyclical in some periods. For instance, in the middle of 2003, when output was significantly below its trend, credit was above its trend by about 13%. In the first quarter of 2008, when the economy was above its trend by about 4%, credit was below its trend by 10%. In fact, the Chinese economy was affected by the Asia financial crisis, the recent global financial crisis and other events mentioned above, especially in their initial stages, but the Chinese government coped with the crises by taking various measures. The Asian financial crisis was followed by the Great Western Expansion, the recent world financial crisis was followed by various programs for expanding domestic demand, all these were associated with an increase of credit supply. Second, as figure 2(a) indicates, the loan to capital ratio and output are negatively correlated. If we use the loan to capital ratio as a proxy for the loan to value ratio, then the loan to value ratio or the leverage is negatively related to output. In our model, we assume that the central bank can regulate the supply of credit by manipulating leverage and we call this relationship as the countercyclical credit policy.

Figure 2(a)

Second, we impose a constant interest rate rule in the model to reflect the interest rate control policy implemented in China. Although the economic reform has undergone for 30 years in China, the Chinese government is very cautious about liberalizing interest rates. Commercial banks have been permitted to use their own
judgment in setting the lending rate since October 2004, but most banks extend loans at the benchmark rates or at rates close to the benchmark rates due to strong competition in the credit market. Figure 2(b) shows the quarterly benchmark short term lending rate set by the People’s Bank of China from 1998Q1-2010Q4. A significant feature of the benchmark rates is that they were adjusted very slowly and did not respond to changes in macroeconomic conditions actively. For instance, between June 1999 and January 2002 (32 months), the benchmark lending rate was constant at 5.85 (annual rate) despite the economy experienced deflation and output fluctuations. Similarly, between December 2008 and October 2010 (22 months), the lending rate was kept at 5.31 despite the economy had high inflation and volatile output. In our model, this interest rate policy is modeled as a constant interest rate rule, as in Collard and Dellas (2005). Third, to investigate the driving forces of economic fluctuations, we add four more types of shocks in the model: credit shocks, housing demand shocks, investment shocks, and government spending shocks.

We parameterize the model by calibration and Bayesian estimation using data on China’s economy from the period 1998Q1 – 2010Q4. We select this period due to data availability. We find that credit shocks and government spending shocks are the main driving forces of economic fluctuations in the short run, while productivity shocks and inflation shocks become important in the long run. The credit shocks affect the economy through their effects on the tightness of the credit constraints and on asset prices. We find that the countercyclical credit policy can reduce
economic fluctuations in response to all types of shocks.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature. Section 3 sets up the model and characterizes the equilibrium. Section 4 parameterizes the model by calibration and Bayesian estimation. Section 5 presents the results and Section 6 concludes.

2. Related Literature

An increasing body of literature has recently explored the sources of economic fluctuations in the U.S. and European economies using Bayesian Estimation. Smets and Wouters (2005) compare shocks and frictions for both the US and the euro area economy. Smets and Wouters (2007) estimated a new Keynesian model to address what the main driving forces of output developments in the United States. Jermann and Quadrini (2011) show that when debt and equity are not perfect substitutes, financial shocks will have significant effects on the firm’s labor demand and thus on the production decision of firms. Justiniano, Primiceri and Tambalotti (2010) find that most of the variability of output and hours in the U. S. economy is due to investment shocks and imperfect competition is the key to their transmission.

Gertler and Kiyotaki (2011) study how credit policies might mitigate economic downturn by stabilizing the financial sector of the economy. By explicitly modeling the banking sector and introducing the agency problem in the retail and wholesale financial markets, Gertler and Kiyotaki (2011) show that the ability of financial intermediaries to obtain funds is constrained by their balance sheet, which creates a wedge between loan rates and deposit rates in the retail financial market and a wedge between loan rates offered in the interbank market. In the event of crisis, the deteriorated banks’ balance sheets worsen their ability to obtain funds and increase the cost of borrowing of nonfinancial firms. By employing credit policies such as direct lending, discount window lending and equity injection, the central bank can increase the supply of funds available to banks, facilitate credit flows and thus stabilize the financial sector and mitigate the contraction of the real economy. While Gertler and Kiyotaki (2011) focus on the role of credit...
policies in stabilizing the aggregate economy in the crisis periods, we focus on the role of credit policies in fine-tuning the aggregate economy.


3. The Model

In this section, we present a new Keynesian DSGE model with interest rate control, endogenous credit shocks and credit constraints in to explain some features of the Chinese macroeconomy. Time is discrete and infinite. The economy consists of households, entrepreneurs, retailers, and the government. Households, entrepreneurs and retailers are of measure one, respectively. Households supply labor to entrepreneurs, demand real estate and money and consume the final goods. Entrepreneurs produce a homogenous intermediate good by combining labor, capital and real estate. Besides money, there is another financial asset, bonds, which can be traded between households and entrepreneurs. Retailers purchase intermediate goods from entrepreneurs in a competitive market, and transform them into composite final goods. The government conducts monetary and credit policies, collects taxes and makes government purchases.

3.1. Households

Households derive utility from consumption, housing, money and leisure. The representative household discounted lifetime utility is given by
\[ E_0 \sum_{t=0}^{\infty} \beta^t \left( \ln c_t' + \varphi_t \ln h_t' - \frac{1}{\eta} (L_t')^\eta + \chi \ln \left( \frac{M_t'}{P_t} \right) \right) \]  \hspace{1cm} (1)

where \( E_0 \) is the expectation formed at period 0, \( \beta \in (0,1) \) is the subjective discount factor, \( c_t' \) is consumption, \( h_t' \) is the real estate holdings by the household, \( L_t' \) is the labor input, \( M_t'/P_t \) are real money balances and \( \eta \) is the labor supply aversion, \( \varphi_t \) is the household’s utility weight of real estate and we use it to represent housing demand shocks. The housing demand shocks capture social and institutional changes that shift preferences on housing or cyclical changes in resources needed to purchase housing relative to other goods (Iacoviello and Neri, 2010). The former is particular relevant to Chinese economy as the reform on housing institutions implemented in China in the recent two decades has significant effects on Chinese households’ demand for housing. Following the literature, we assume that the housing demand shocks follow an AR(1) process

\[ \ln \varphi_t = (1 - \rho_\varphi) \ln \varphi + \rho_\varphi \ln \varphi_{t-1} + \varepsilon_{\varphi_t} \]  \hspace{1cm} (2)

where \( \varphi > 0 \) is a constant, \( 0 < \rho_\varphi < 1 \), and \( \varepsilon_{\varphi_t} \) is i.i.d. \( N(0, \sigma_\varphi^2) \).

Assume that households lend (borrow) in real terms \( b_t' ( - b_t' ) \) to (from) entrepreneurs. The household period budget constraint is

\[ c_t' + q_{h,t} (h_t' - h_{t-1}') + b_t + \frac{M_t' - M_{t-1}'}{P_t} + T_t = w_t L_t' + \frac{R_{t-1} b_{t-1}'}{\pi_t} + F_t \]  \hspace{1cm} (3)

where \( q_{h,t} = Q_t/P_t \) is the real housing price, \( T_t \) is lump-sum taxes, \( w_t' = W_t'/P_t \) is the real wage, \( \pi_t = P_t/P_{t-1} \) denotes the gross inflation rate and \( F_t \) are lump-sum profits received from retailers. The right hand side of equation (3) is the inflow of funds for the household, which includes wage income, gross returns from lending in real terms and lump-sum profits. The left hand side of equation (3) is the outflow of
funds for the household, which consists of consumption, housing investment, lending, changes in real money balances and tax payments.

The household’s problem is choosing consumption, the holdings of real estate, money and bonds to maximize its lifetime utility subject to (2) and (3). The first order conditions are

\[
\frac{1}{c_t} = E_t \left( \frac{\beta R_t}{\pi_{t+1} c_{t+1}} \right) \quad (4)
\]

\[
\frac{q_{h,t}}{c_t} = \frac{\varphi_t}{h_t} + \frac{\beta}{c_{t+1}} q_{h,t+1} \quad (5)
\]

\[
(L_t')^{\theta-1} = \frac{1}{c_t} w_t \quad (6)
\]

Equation (4) is the household’s Euler condition for consumption. Equations (5) is the necessary condition for choosing real estate holdings optimally. It states that in equilibrium, the marginal utility loss of holding real estate should be equal to the marginal utility gain of holding real estate. The marginal utility gain consists of the utility gain from consuming the real estate services and the discounted utility gain from changes in the value of one unit of real estate. Equation (6) is the optimal condition for labor supply. The first-order condition for money demand is standard and can be ignored because we will introduce the interest rate rule and the utility is separable in money balances.

3.2. Entrepreneurs

Entrepreneurs produce intermediate goods according to a Cobb-Douglas production function,

\[
Y_t = A_t k_{t-1}^\alpha h_{t-1}^\beta L_t^{1-\alpha-\beta} \quad (7)
\]

where \(Y_t\) is output, \(A_t\) is technology, \(k_{t-1}\) is capital, \(h_{t-1}\) is real estate and \(L_t\) is labor input. The aggregate technology shock \(A_t\) follows the autoregressive process
\[
\ln A_t = \rho_A \ln(A_{t-1}) + \varepsilon_{A_t}
\]

where \(0 < \rho_A < 1\) and \(\varepsilon_{A_t}\) is i.i.d. \(N(0, \sigma_A^2)\).

The representative entrepreneur derives utility from consumption. His expected lifetime utility is given by

\[
E \sum_{t=0}^{\infty} y^t \ln c_t
\]

and his period budget constraint is given by

\[
\frac{Y_t}{X_t} + h_t = c_t + q_{b_t} (h_t - h_{t-1}) + \frac{R_{t-1} b_{t-1}}{\pi_t} + w_t L_t + I_t
\]

where \(X \equiv P/P''\) denotes the markup of final over intermediate goods, \(b_t\ (b_t)\) is the entrepreneur’s borrowing (lending) from (to) the household, \(h_t\) is the entrepreneur’s holdings of real estate and \(I_t\) is investment. The left hand side of equation (10) is the inflow of funds to the entrepreneur, which includes output and borrowed funds. The right hand side of equation (10) is the outflow of funds to the entrepreneur, which consists of consumption, real estate investment, debt repayment, wage payment and capital investment.

The law of motion for capital is given by

\[
k_t = (1 - \delta) k_{t-1} + \phi_t (1 - S(I_t/I_{t-1})) I_t
\]

where \(\delta\) is the depreciation rate. The function \(S(I_t/I_{t-1})\) represents the adjustment costs in investment. We assume \(S(I_t/I_{t-1}) = \frac{1}{2} \psi (I_t/I_{t-1} - 1)^2\), which satisfies the conditions that in steady state \(S = S' = 0\), and \(S'' = \psi > 0\).

The investment shock, \(\phi_t\), which represents shocks to the marginal productivity of investment, follows the process

\[
\ln \phi_t = \rho_\phi \ln(\phi_{t-1}) + \varepsilon_{\phi,t}
\]

where \(0 < \rho_\phi < 1\) and \(\varepsilon_{\phi,t}\) is i.i.d. \(N(0, \sigma_\phi^2)\).
When entrepreneurs borrow from households, we assume that they face a borrowing constraint. We introduce a borrowing constraint into the model to capture the fact that in China, financial resources are limited. Thus, the entrepreneur’s borrowing constraint is modeled as:

\[ b_t \leq \xi_t E_t \left[ \frac{1}{R} q_{s,t+1} h_t \pi_{t+1} + q_{k,t} k_{t+1} \right] \]  \hspace{1cm} (13)

where \( q_{s,t} \) is the shadow price of capital in terms of consumption goods, \( \xi_t \) is the time-varying leverage and we use it to represent credit shock, which reflects uncertainty in the tightness of the credit market. We consider two ways of modeling the credit shocks. One is that we assume that the credit shocks are an AR(1) stochastic process.

\[ \log \xi_t = (1 - \rho_{\xi}) \log \bar{\xi} + \rho_{\xi} \log \xi_{t-1} + \epsilon_{\xi,t} \]

where \( 0 < \rho_{\xi} < 1 \), \( \epsilon_{\xi,t} \sim i.i.d. N(0, \sigma_{\xi}) \). This is the commonly used approach in the literature (Jermann and Quadrini, 2011, Liu, Wang and Zha, 2010). Another way to model the credit shocks is that we assume that they are related to the central bank’s credit policy, which will be presented in section 3.4.

The borrowing constraint states that the amount of loans the entrepreneur obtains cannot exceed a fraction of the expected discounted value of collateral assets (including real estate and non-real estate capital). To make our analysis interesting, we assume that \( \beta > \gamma \), that is, the household’s subjective discount factor is bigger than the entrepreneur’s subjective discount factor. This assumption ensures that the entrepreneur will borrow from the household in equilibrium. This assumption also ensures that in steady state, the borrowing constraint is binding. In non-steady state equilibrium, the borrowing constraint might not be binding if there exists large uncertainty in the economy. In this case, the entrepreneur’s precautionary saving motive might outweigh impatience and the borrowing limit will not be hit. To rule out this possibility, we follow Iacoviello (2005) to assume that uncertainty is “small
enough" relative to degree of impatience so that the borrowing constraint is binding in any equilibrium.

The entrepreneur’s problem is choosing the amount of labor, capital stock, capital investment, real estate investment, the amount of borrowing (lending) and consumption to maximize his expected lifetime utility subject to the constraints (7), (8), (10), (11), (12) and (13). Let $\chi_i$ be the Lagrangian multiplier associated with the budget constraint. Let $\lambda_i$ be the Lagrangian multiplier associated with the borrowing constraint. Let $Q_i$ be the Lagrangian multiplier associated with the law of motion of capital. The first order conditions are

$$\frac{1}{c_i} = \frac{\lambda_i}{c_i} + \gamma \frac{R_i}{c_{r+1} \pi_{r+1}} \quad (14)$$

$$\frac{q_{k,i}}{c_i} = \gamma \frac{\mu Y_{r+1}}{X_{r+1} k_i} + \frac{q_{k,i+1}}{c_{r+1}} \gamma (1-\delta) + \nu \lambda_i \xi q_{r+1} q_{r+1,k} \quad (15)$$

$$\frac{1}{c_i} = \frac{q_{k,i}}{c_i} \phi (1 - \frac{1}{2} \psi (I_t - 1)^2) - \frac{q_{k,i}}{c_i} \phi \psi (I_t / I_{r-1} - 1) I_t / I_{r-1} + \gamma \frac{q_{k,i+1}}{c_{r+1}} \phi \psi (I_{r+1} / I_t - 1) (I_{r+1} / I_t)^2 \quad (16)$$

$$\frac{1}{c_i} q_{k,i} = \gamma \frac{1}{c_{r+1}} (\nu Y_{r+1} / X_{r+1} h_t + q_{k,r+1}) + \lambda_i \xi q_{k,i} R_i \quad (17)$$

$$\frac{(1-\mu-\nu)Y_t}{X_t L_t} = w_t \quad (18)$$

where $q_{k,i} = \frac{Q_i}{\chi_i}$ implying $Q_i = \frac{q_{k,i}}{c_i}$. Equation (14) is the Euler condition for consumption. Equations (15) and (16) are the necessary conditions for optimal capital stock and optimal investment, respectively. Equation (17) is the first order condition for entrepreneur’s real estate holdings. It states that in equilibrium, the marginal utility loss of holding real estate, $q_{k,i} / c_i$, should be equal to the marginal gain from holding real estate. The latter consists of the discounted future marginal product of real estate, the discounted resale price, and the shadow value of real
estate as a collateral asset. Equation (18) is the optimal condition for labor demand.

3.3. Retailers

A continuum of retailers of mass 1, indexed by \( j \), purchase intermediate goods \( Y_i \) from entrepreneurs at \( P_i^e \) in a competitive market, differentiating the goods at no cost into \( Y_i(j) \) and sell \( Y_i(j) \) at the price \( P_i(j) \). Final goods are composites of the differentiated goods according to the constant-returns-to-scale technology described by

\[
Y_i = \left[ \int_0^1 (Y_i(j))^{\frac{1}{1+\theta}} \, dj \right]^{1+\theta}
\]

where \( \theta_i \) is a stochastic parameter which will introduce time-varying mark-up in the retail goods market. We assume it following the autoregressive process

\[
\log \theta_i = (1 - \rho) \bar{\theta} + \rho \log \theta_{i-1} + \varepsilon_{\theta,i} \tag{19}
\]

Where \( \bar{\theta} > 0 \), \( 0 < \rho < 1 \) and \( \varepsilon_{\theta,i} \sim i.i.d. N(0, \sigma_\theta) \).

Consumers minimize the cost of the bundle of differentiated goods for a given level of composite consumption. This gives us the demand for good \( j \) as

\[
Y_i(j) = \left( \frac{P_i(j)}{P_i} \right)^{-\frac{1+\theta}{\theta}} Y_i \]

and the aggregate price index \( P_i = \left( \int_0^1 P_i(j)^{-\frac{1+\theta}{\theta}} \, dj \right)^{-\bar{\theta}} \).

Following Calvo (1983), we assume that each period a fraction \( 1 - \omega \) of all retailers resets prices optimally while the remaining \( \omega \) fraction does not. As in Smets and Wouters (2003), we augmented the Calvo model by assuming that retailers who cannot reset prices optimally adjust their prices according to an indexation rule

\[
P_{c+1}(j) = P_i(j) \left( \frac{P_{i+1}}{P_i} \right)^{\delta_p} \quad k = 0, 1, 2, ... \tag{20}
\]

where the coefficient \( \delta_p \in [0, 1] \) indicates the degree of indexation to past prices. If \( \delta_p = 1 \), we get a full price indexation. If \( \delta_p = 0 \), we get the original Calvo price
The retailers that adjust their prices at time \( t \) choose optimal price \( P_t^*(j) \) to maximize the expected discounted value of current and future profits. Since profits at some future date \( t+k \) are affected by the choice of price at time \( t \) only if the retailer has not received another opportunity to optimally adjust his price between \( t \) and \( t+k \), the probability of this is \( \omega^k \). The problem of the retailer who resets his price optimally is

\[
\max_{P_t(j)} E_t \sum_{k=0}^{\infty} (\omega \beta)^k \Lambda_{t+k} \left[ P_t(j) \left( \frac{P_{t+k}}{P_{t-1}} \right)^{\delta_p} Y_{t+k}(j) - \frac{1}{X_{t+k}} Y_{t+k}(j) \right] \\
\text{s.t. } Y_{t+k}(j) = \left( \frac{P_t(j)}{P_{t+k}} \right)^{\delta_p} \frac{1}{\omega} Y_{t+k}^f
\]

where \( \Lambda_{t+k} = c_t c_{t+k}^\top, \beta^k \Lambda_{t+k} \) is the stochastic discount factor. The first order condition with respect to \( P_t(j) \) is

\[
E_t \sum_{k=0}^{\infty} (\omega \beta)^k \Lambda_{t+k} Y_{t+k}(j) \left[ \frac{P_t^*(j)}{P_{t+k}} \left( \frac{P_{t+k}}{P_{t-1}} \right)^{\delta_p} - (1 + \theta_t) \frac{P_{t+k}^w}{P_{t+k}} \right] = 0 \tag{21}
\]

The aggregate price index is an average of the price charged by the fraction \( 1 - \omega \) of retailers setting their prices optimally in period \( t \) and the average of the average of the remaining fraction \( \omega \) of all retailers that do not reset their prices optimally in period \( t \). Since we assume that adjusting retailers were selected randomly, the average price of the non-adjusters is just the average price of all retailers that prevail in period \( t-1 \), augmented by partial price indexation. Thus the average aggregate price index in period \( t \) satisfies

\[
P_{t-1}^{1-\theta_t} = (1-\omega)(P_{t-1})^{1-\theta_t} + \omega(P_{t-1} \left( \frac{P_{t-2}}{P_{t-1}} \right)^{\delta_p})^{1-\theta_t} \tag{22}
\]

Log-linearizing equations (21) and (22) leads to the Phillips curve

\[
\hat{\pi}_t = \frac{\beta}{1 + \beta \delta_p} E \pi_{t+1} + \frac{\delta_p}{1 + \beta \delta_p} \hat{\pi}_{t-1} + \frac{(1-\omega)(1-\omega \beta)}{\omega} \frac{1}{1 + \beta \delta_p} (\hat{X}_t + \hat{\theta}_t) \tag{23}
\]
A hat stands for log-deviations from the deterministic steady state. As in the traditional Phillips curve, inflation depends positively on expected inflation and negatively on the markup $\hat{X}_t$ of final over intermediate goods. Unlike the traditional Phillips curve, inflation also depends positively on past inflation. This is due to the presence of partial price indexation. Inflation is also positively affected by inflation shocks, which is captured by $\hat{\theta}_t$.

3.4. The Government

The central bank implements a (an almost) constant nominal interest rate rule. In order to avoid the indeterminacy problems, we follow Collard and Dellas (2005) to specify the rule as follows

$$\hat{R}_t = r_g \hat{R}_{t-1} + (1-r_g) r_x \hat{\pi}_{t-1}$$

with $r_g = 0.999$ and $r_x = 1.01$. This way, the nominal interest rate will hardly respond to any change in economic conditions.

The central bank also implements credit policy to influence the economy. As we stated in the introduction section, the central bank of China usually undertakes a countercyclical credit policy. We incorporate this feature into the model by assuming that the central bank can affect the tightness of the credit market. In other words, the leverage are endogenously determined as follows

$$\hat{\xi}_t = \rho_{\xi} \hat{\xi}_{t-1} + \rho_y \hat{\gamma}_{t-1} + \xi_{\xi,t}$$

where $\rho_y < 0$ means that the central bank conducts a contractionary credit policy when the economy is in boom, and $\xi_{\xi,t} \sim i.i.d. N(0, \sigma_{\xi})$. We regard this endogenous leverage as our benchmark case.

The government expenditures are financed by lump-sum taxes and money creation:

$$G_t = T_t + \frac{M_t - M_{t-1}}{P_t}$$

(25)
We assume that government purchases follow the stochastic process
\[ \ln G_t = (1 - \rho_G) \ln G_{t-1} + \ln G_{t-1} + \epsilon_{G,t} \]

where \( G > 0, \ 0 < \rho_G < 1, \ \epsilon_{G,t} \sim i.i.d. N(0, \sigma_G) \) (26)

3.5. Equilibrium

Given \( \{k_{t-1}, h_{t-1}, R_{t-1}, b_{t-1}, P_t\} \) and the sequences of productivity, housing demand, credit, inflation, and government expenditure shocks \( \{A_t, \phi_t, \xi_t, \phi_t, \theta_t, G_t\}_{t=0}^\infty \), the equilibrium of the economy is characterized by allocations for households \( \{c_t, h_t, L_t, b_t\}_{t=0}^\infty \), allocations for entrepreneurs \( \{c_t, h_t', L_t', b_t'\}_{t=0}^\infty \) and the sequence of values \( \{w_t, R_t, P_t, P_t', X_t, q_t, \lambda_t\}_{t=0}^\infty \) such that households and entrepreneurs solve their optimization problem, and the labor market clears \( (L_t = L_t') \), the real estate market clears \( (h_t + h_t' =1) \), the goods market clears \( (c_t + c_t' + I_t + G_t = Y_t) \), the credit market clears \( (b_t = b_t') \), the government budget is balanced \( (G_t = T_t + \frac{M_t - M_{t-1}}{P_t}) \) and the relevant transversality conditions.

4. Calibration and Estimation

To quantitatively analyze the model, we parameterize the model by calibration and Bayesian estimation using date during the period 1998 Q1 – 2010 Q4. We need to pin down 26 parameter values: the discount factors \( \beta \) and \( \gamma \); the technology parameters \( \mu, \nu \) and \( \delta \); the household’s preference parameters \( \phi \) and \( \eta \); the steady state (net) price mark-up \( \bar{\theta} \), the degree of price rigidity \( \epsilon \), the degree of partial indexation \( \bar{\theta} \), the parameter determining the investment adjustment cost \( \psi \), the steady state loan to value ratio \( \bar{\xi} \), the steady state ratio of government
expenditures over output $\bar{G}/\bar{Y}$, and the parameters characterizing the shock processes $\rho_A, \rho_u, \rho_\phi, \rho_\zeta, \rho_\gamma, \rho_G, \sigma_A, \sigma_u, \sigma_\phi, \sigma_\zeta, \sigma_G$.

Following the monetary business cycle literature we set $\varepsilon = 0.67$, meaning that in each period, two thirds of entrepreneurs adjust their prices. This value is similar to those used in the study of Chinese economy. For example, when using the Chinese data to simulate the stick-price model, Chen and Gong (2006) set this parameter at 0.6. In studying the factors that affect Chinese aggregate economy, Wang (2010) use a value of 0.75 for this parameter.

In the steady state $R\beta = 1$. During the period of our study, the average annual lending rate is 5.93%, which implies a quarterly rate of 1.014%. This gives us $\beta = 0.99$. Following Iacoviello (2005), we use the reciprocal of $\gamma$ to proxy for the firm’s internal rate of return. We assume that this is twice as big as the equilibrium interest rate, which leads to $\gamma = 0.98$. We set $\delta = 0.025$ implying an annual depreciation rate of 10%.

We set the (non-real estate) capital share $\mu = 0.46$. The elasticity of output to entrepreneurial real estate is set at 0.04. This number (in conjunction with the estimated $\phi$) implies that the entrepreneurs’ real estate holdings are about 35% of total real estate asset. These two numbers imply that the aggregate capital share is 0.5, which is align with the calibrated value of aggregate capital share in the literature on Chinese economy (Xu and Chen, 2007, Hu and Liu, 2007, etc.). The steady state $\xi$ is set at 0.6 to match that the steady state ratio of debt over capital. The steady state ratio of government spending to output is 0.18 over the range of our data set. Table 1 presents the calibration results.

It remains to pin down the parameters that characterize the shock processes and the
structural parameters $\bar{\phi}, \eta, \psi, \bar{\theta}, \delta^p$. We estimate these parameters using Bayesian method. The Bayesian method takes the parameters as random variables and computes the relevant statistics based on the posterior distribution. The posterior distribution is obtained by coupling the likelihood function with a prior distribution using Bayes’ Rule. The likelihood function, which is associated with a given state-space representation of the model and a distributional assumption about shocks in the model, is evaluated using the Kalman filter. The posterior distributions of parameters are then used to calculate conditional expectation value of a function of the parameters, such as mean and mode. Because taking integration analytically is usually hard, numerical integration procedures, in particular, the Markov Chain Monte Carlo method is used.

We use six time series as observable variables: the demeaned log difference of real GDP, CPI, real credit, real housing price, real investment and real government spending. All the data are seasonally adjusted.

We impose prior distributions on the parameters so that the prior distributions can cover reasonable values taken by the parameters. Specifically, we impose beta prior distribution with mean 0.06 and standard deviation 0.02 on $\bar{\phi}$, the steady state utility weight of housing. This distribution covers the values taken by this parameter in the literature (e.g. Iacoviello, 2005 and Iacoviello and Neri, 2010). The prior distribution of $\psi$ is gamma with mean 4 and standard deviation 1 as in Justiniano, Primiceri and Tambalotti (2010). Following Smets and Wouters (2005) and Jermann and Quadrini (2011), the prior distributions of $\bar{\theta}$, $\delta^p$ and $\eta$ are normal (0.2, 0.05), beta (0.7, 0.1) and normal (1.6, 0.1), respectively. We assume that the prior distribution of $\rho_y$ is normal with mean -0.6 and standard deviation 0.1\(^b\).

As commonly applied in the literature, the prior distributions for the shock processes are agnostic and harmonized. The persistence of the shock processes is beta with

\(^b\) We regress linear detrended loan to value ratio on its one period lag and one period lag of linear detrended GDP, the coefficient on GDP is -0.42. Our prior distribution on $\rho_y$ covers this value.
mean 0.70 and standard deviation 0.1. All shocks are assumed to follow a inverse gamma distribution with mean 0.1 and standard deviation of infinity. The reported posterior statistics are computed from a 20,000 MCMC chain from which the first 10,000 draws were discarded.

Table 2 presents key statistics of the prior and posterior distributions. For the structural parameters and the persistence coefficients of shocks, the mean of the posterior distribution is close to the mean of the prior assumptions. All the stochastic processes are moderate persistent. Regarding the persistence of the neutral technology and government spending, our results are consistent with those studies of the Chinese economy (Xu and Chen, 2007, Hu and Liu, 2007, etc.). For standard deviations of shocks, The mean of the posterior distribution is much less than the prior assumptions. The estimated standard deviations of shocks have similar levels with housing demand shocks being relatively more volatile.

Table 1. Calibrated Parameters

<table>
<thead>
<tr>
<th>Description</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household's discount factor</td>
<td>( \beta )</td>
<td>0.99</td>
</tr>
<tr>
<td>Entrepreneur's discount factor</td>
<td>( \gamma )</td>
<td>0.98</td>
</tr>
<tr>
<td>Capital share</td>
<td>( \mu )</td>
<td>0.46</td>
</tr>
<tr>
<td>Real estate share</td>
<td>( \nu )</td>
<td>0.04</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>( \delta )</td>
<td>0.025</td>
</tr>
<tr>
<td>Degree of price rigidity</td>
<td>( \omega )</td>
<td>0.67</td>
</tr>
<tr>
<td>Steady state loan to value ratio</td>
<td>( \bar{\xi} )</td>
<td>0.60</td>
</tr>
<tr>
<td>Steady state ratio of government expenditure over output</td>
<td>( \bar{G}/\bar{Y} )</td>
<td>0.18</td>
</tr>
<tr>
<td>Parameters</td>
<td>prior distribution</td>
<td>prior mean</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------</td>
<td>------------</td>
</tr>
<tr>
<td>$\eta$</td>
<td>normal</td>
<td>1.6</td>
</tr>
<tr>
<td>$\bar{\varphi}$</td>
<td>beta</td>
<td>0.06</td>
</tr>
<tr>
<td>$\psi$</td>
<td>gamma</td>
<td>4</td>
</tr>
<tr>
<td>$\Theta$</td>
<td>normal</td>
<td>0.20</td>
</tr>
<tr>
<td>$\delta^p$</td>
<td>beta</td>
<td>0.70</td>
</tr>
<tr>
<td>$\rho_A$</td>
<td>beta</td>
<td>0.70</td>
</tr>
<tr>
<td>$\rho_\theta$</td>
<td>beta</td>
<td>0.70</td>
</tr>
<tr>
<td>$\rho_\psi$</td>
<td>beta</td>
<td>0.70</td>
</tr>
<tr>
<td>$\rho_\phi$</td>
<td>beta</td>
<td>0.70</td>
</tr>
<tr>
<td>$\rho_\xi$</td>
<td>beta</td>
<td>0.70</td>
</tr>
<tr>
<td>$\rho_\eta$</td>
<td>beta</td>
<td>0.70</td>
</tr>
<tr>
<td>$\rho_\eta$</td>
<td>normal</td>
<td>-0.6</td>
</tr>
<tr>
<td>$\sigma_A$</td>
<td>inverse gamma</td>
<td>0.1</td>
</tr>
<tr>
<td>$\sigma_\theta$</td>
<td>inverse gamma</td>
<td>0.1</td>
</tr>
<tr>
<td>$\sigma_\psi$</td>
<td>inverse gamma</td>
<td>0.1</td>
</tr>
<tr>
<td>$\sigma_\phi$</td>
<td>inverse gamma</td>
<td>0.1</td>
</tr>
<tr>
<td>$\sigma_\xi$</td>
<td>inverse gamma</td>
<td>0.1</td>
</tr>
<tr>
<td>$\sigma_\eta$</td>
<td>inverse gamma</td>
<td>0.1</td>
</tr>
</tbody>
</table>
5. Results

In this section we examine the relative importance of different shocks, report the impulse response functions and discuss the role of the central bank’s policies.

5.1. The relative importance of shocks

Table 3 reports the variance decomposition results, which shows the contribution of each shock to the variance of key macroeconomic variables at different frequencies. In the very short run (one-quarter horizon), output fluctuations are mainly driven by credit shocks and government spending shocks. Credit shocks and government spending shocks explain 30% and 47% of output fluctuations, indicating that demand shocks have immediate impact on the aggregate economy. At the one-year horizon, technology shocks and inflation shocks become relatively important. They account for 38% and 27% of output movements. However, credit shocks remain one of the main driving forces of output fluctuations. Around 23% of output fluctuations is contributed by credit shocks, while the contribution of government spending shocks reduces to about 10%. Over the medium to the long run, the contribution of inflation shocks increases further, while the contributions of credit shocks and technology shocks decrease slightly. At the 30 quarters horizon, credit, technology and inflation shocks explain 18%, 30% and 40% of output fluctuations, respectively.

Turning to other variables, the volatility of investment is mainly driven by investment shocks, which is a reasonable result. Investment shocks explain about 55% of investment movement in the short run and about 35% of investment movement in the long run. Credit shocks turn out to be a non-negligible source of investment fluctuations. This is consistent with the fact that in China bank credit is the major source of external financing for firms’ investment. At one-quarter horizon, credit shocks explain around 30% of investment fluctuations, while at 30-quarter horizon, 16% of the volatility of investment is contributed by credit shocks.
Consumption is mainly driven by productivity shocks both in the short run and in the long run. Credit shocks, inflation shocks and investment shocks have moderate effects on consumption in the short run. In the long run, inflation shocks become one of the main contributions to the volatility of consumption.

The volatility of real estate prices are significantly influenced by productivity shocks, both in the short run and in the long run. They account for 50% -- 70% fluctuations of real estate prices. In the short run, credit shocks and inflation shocks also play some role in affecting real estate prices. These two shocks account for about 35% fluctuations of real estate prices at the one-quarter horizon and these effects decreases gradually in the long run.

Productivity shocks are the most important determinants of employment and real wage fluctuations, both in the short run and in the long run. Given that the supply of labor is almost perfectly elastic in China, these results are reasonable. A puzzling result is that productivity shocks explain most of the movements in inflation, which is expected to be influenced primarily by the inflation or markup shocks.

In summary, we find that credit shocks are an important source of economic fluctuations in the short run and their influence persist over time. Technology shocks are important source of economic fluctuations in the medium and long run. This result is reasonable given that technology shocks can affect the economy from both the demand side and the supply side. Inflation shocks become important in the long run. This may be because partial indexation makes inflation inertia and thus the inflation shock has a long run effects on the economy.

Housing demand shocks turn out to be not important in determining economic fluctuations both in the short run and in the long run. Government spending shocks are important in explaining the volatility of output in the short run but not in the
long run. Their contribution to the movements of other variables is negligible..
Our results imply that the size and persistence of an economic shock are not the only
determinant of the impact of the shock on the economy. For instance, the estimated
housing demand shocks have the largest standard deviation and they are almost the
same as moderate persistent as credit shocks, which have smaller standard
deviations. However, the impacts of these two shocks are quite different. Credit
shocks are important in explaining economic fluctuations both in the short run and
in the long run. By contrast, the contribution of housing demand shocks is almost
null. These results manifest that besides the size and persistence of an economic
shock, the contribution of the shock on the aggregate economy also depends on the
economic mechanism which relates economic variables.
Table 3. Variance decomposition of aggregate variables

<table>
<thead>
<tr>
<th>Period</th>
<th>Output</th>
<th>Technology</th>
<th>inflation</th>
<th>housing</th>
<th>investment</th>
<th>credit</th>
<th>government</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>3.54</td>
<td>17.88</td>
<td>0.49</td>
<td>0.23</td>
<td>30.48</td>
<td>47.38</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>6.82</td>
<td>8.48</td>
<td>0.46</td>
<td>54.08</td>
<td>29.56</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>Credit</td>
<td>12.64</td>
<td>0.13</td>
<td>0.18</td>
<td>3.03</td>
<td>83.97</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Real estate price</td>
<td>51.06</td>
<td>16.89</td>
<td>2.35</td>
<td>10.84</td>
<td>17.18</td>
<td>1.68</td>
</tr>
<tr>
<td></td>
<td>Inflation</td>
<td>89.83</td>
<td>7.38</td>
<td>0.00</td>
<td>0.36</td>
<td>1.19</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td>Consumption(E)</td>
<td>68.95</td>
<td>1.68</td>
<td>0.59</td>
<td>12.61</td>
<td>15.97</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Consumption (H)</td>
<td>89.83</td>
<td>7.38</td>
<td>0.00</td>
<td>0.36</td>
<td>1.19</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td>Labor</td>
<td>94.67</td>
<td>0.99</td>
<td>0.03</td>
<td>0.01</td>
<td>1.69</td>
<td>2.62</td>
</tr>
<tr>
<td></td>
<td>Wages</td>
<td>83.36</td>
<td>7.74</td>
<td>0.05</td>
<td>0.02</td>
<td>5.76</td>
<td>3.07</td>
</tr>
<tr>
<td>4</td>
<td>Output</td>
<td>38.84</td>
<td>27.72</td>
<td>0.16</td>
<td>0.42</td>
<td>22.91</td>
<td>9.95</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>4.01</td>
<td>19.15</td>
<td>0.30</td>
<td>54.65</td>
<td>20.32</td>
<td>1.57</td>
</tr>
<tr>
<td></td>
<td>Credit</td>
<td>22.57</td>
<td>0.74</td>
<td>0.14</td>
<td>5.10</td>
<td>70.56</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>Real estate price</td>
<td>70.32</td>
<td>10.65</td>
<td>0.31</td>
<td>6.21</td>
<td>10.69</td>
<td>1.82</td>
</tr>
<tr>
<td></td>
<td>Inflation</td>
<td>81.28</td>
<td>7.65</td>
<td>0.01</td>
<td>1.09</td>
<td>8.81</td>
<td>1.16</td>
</tr>
<tr>
<td></td>
<td>Consumption(E)</td>
<td>60.52</td>
<td>8.29</td>
<td>0.40</td>
<td>19.06</td>
<td>11.43</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>Consumption (H)</td>
<td>82.19</td>
<td>6.71</td>
<td>0.00</td>
<td>1.48</td>
<td>8.02</td>
<td>1.61</td>
</tr>
<tr>
<td></td>
<td>Labor</td>
<td>80.20</td>
<td>7.65</td>
<td>0.03</td>
<td>0.98</td>
<td>8.70</td>
<td>2.43</td>
</tr>
<tr>
<td></td>
<td>Wages</td>
<td>65.08</td>
<td>25.38</td>
<td>0.03</td>
<td>0.29</td>
<td>7.82</td>
<td>1.41</td>
</tr>
<tr>
<td>10</td>
<td>Output</td>
<td>35.55</td>
<td>33.30</td>
<td>0.21</td>
<td>1.38</td>
<td>21.05</td>
<td>8.57</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>4.88</td>
<td>32.28</td>
<td>0.09</td>
<td>45.01</td>
<td>16.15</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>Credit</td>
<td>29.36</td>
<td>2.28</td>
<td>0.13</td>
<td>5.31</td>
<td>62.13</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>Real estate price</td>
<td>70.67</td>
<td>10.07</td>
<td>0.28</td>
<td>6.97</td>
<td>10.02</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td>Inflation</td>
<td>78.78</td>
<td>8.21</td>
<td>0.01</td>
<td>1.74</td>
<td>10.07</td>
<td>1.19</td>
</tr>
<tr>
<td></td>
<td>Consumption(E)</td>
<td>47.25</td>
<td>21.10</td>
<td>0.32</td>
<td>16.13</td>
<td>13.57</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>Consumption (H)</td>
<td>81.77</td>
<td>6.55</td>
<td>0.01</td>
<td>1.93</td>
<td>7.79</td>
<td>1.95</td>
</tr>
<tr>
<td></td>
<td>Labor</td>
<td>76.72</td>
<td>11.24</td>
<td>0.03</td>
<td>0.96</td>
<td>8.71</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>Wages</td>
<td>64.08</td>
<td>25.79</td>
<td>0.02</td>
<td>0.54</td>
<td>8.12</td>
<td>1.45</td>
</tr>
<tr>
<td>30</td>
<td>Output</td>
<td>29.96</td>
<td>40.37</td>
<td>0.12</td>
<td>4.26</td>
<td>17.87</td>
<td>7.42</td>
</tr>
<tr>
<td></td>
<td>Investment</td>
<td>7.08</td>
<td>39.14</td>
<td>0.17</td>
<td>35.61</td>
<td>15.55</td>
<td>2.45</td>
</tr>
<tr>
<td></td>
<td>Credit</td>
<td>29.33</td>
<td>2.44</td>
<td>0.13</td>
<td>5.32</td>
<td>61.97</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>Real estate price</td>
<td>66.43</td>
<td>10.39</td>
<td>0.27</td>
<td>11.43</td>
<td>9.59</td>
<td>1.90</td>
</tr>
<tr>
<td></td>
<td>Inflation</td>
<td>78.66</td>
<td>8.24</td>
<td>0.01</td>
<td>1.78</td>
<td>10.12</td>
<td>1.19</td>
</tr>
<tr>
<td></td>
<td>Consumption(E)</td>
<td>33.11</td>
<td>37.62</td>
<td>0.21</td>
<td>16.50</td>
<td>10.56</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td>Consumption (H)</td>
<td>78.61</td>
<td>6.50</td>
<td>0.01</td>
<td>5.12</td>
<td>7.80</td>
<td>1.96</td>
</tr>
<tr>
<td></td>
<td>Labor</td>
<td>76.03</td>
<td>11.78</td>
<td>0.03</td>
<td>1.03</td>
<td>8.75</td>
<td>2.39</td>
</tr>
<tr>
<td></td>
<td>Wages</td>
<td>62.58</td>
<td>25.77</td>
<td>0.02</td>
<td>2.23</td>
<td>7.97</td>
<td>1.43</td>
</tr>
</tbody>
</table>
5.2. Impulse Response Functions

Given that credit shocks are the main driving force of business cycle in China’s economy, we focus on the propagation mechanism of credit shocks to the economy implied in our model. In Figures 3(a) – 3(h), the solid lines with stars display the impulse response functions of several key macroeconomic variables to a positive credit shock in our benchmark model. A positive credit shock increases output (panel a). This is mainly due to the increased responses of investment to credit shocks (panel b). A positive credit shock reduces inflation in the very short run (panel g). Because nominal interest rate almost does not respond to the shock (panel h), the cost of debt actually increases, which will not contribute to the expansion of investment and production. However, the positive credit shock relaxes the borrowing constraint, which can be seen from a decrease in the Lagrangian multiplier for the borrowing constraint (panel f) and an increase in credit (panel e). Housing prices and the shadow price of capital increase in response to the shock, which further relaxes the borrowing constraint. The relaxation of the borrowing constraint enables the entrepreneur to expand production by increase factors of production. The increase in the shadow price of capital also raises the marginal benefit of investment (see equation (16)). Thus, it pays entrepreneurs to increase investment to a large extent, resulting an increase in output.

The solid lines of Figures 4(a) – 4(e) display output responses to a positive technology shock, a positive inflation shock, a positive housing demand shock, a positive investment shock and a positive government spending shock. Generally speaking, the results are reasonable. A positive technology, housing demand, investment and government spending shock increases output. A positive inflation shock can lead to an increase or decrease in output, depending on whether the inflation shock arises from the supply side or the demand side. Since in our model, the inflation shock affects cost, they negatively affect the output.
Figure 3 Impulse responses to a positive credit shock
Figure 4 Impulse responses of output to technology shocks
The dashed lines of Figures 3(a)-3(h) and Figures 4(a)-4(e) show the impulse responses of macroeconomic variables to shocks when we shut down the countercyclical response of credit policy, i.e. when $\rho_y = 0$. In this case, the responses of macroeconomic variables to credit shocks and other types of shocks are generally larger than those in the benchmark case, which implies that the volatility of these variables are bigger in the later case. Thus, countercyclical credit policy can reduce macroeconomic volatility. Of course, in reality, the People’s Bank of China does not implement a countercyclical credit policy constantly, as specified in our model. In some periods, the central bank applies a procyclical credit policy to meet the demand for credits in the economy. However, our model shows that the central bank’s countercyclical credit policy does play a role in alleviating the economic fluctuations.

6. Conclusion

In this paper, we study the sources of business cycles in the Chinese economy in a model with a constant interest rule, endogenous leverage and credit constraints. We find that credit shocks are the main driving force of economic fluctuations. The countercyclical credit policy is effective in reducing macroeconomic volatility. However, we think this credit policy and its effects may be unique to China and its effectiveness may be curtailed in the long run. First, the central bank of China is less independent compared to other countries’ central banks. The People’s Bank of China is currently affiliated with the State Council. Thus, it is very possible that the central bank’s monetary policy and credit policy are made under government interventions in some circumstances. Second, the effectiveness of countercyclical credit policy depends on the capacity of the central bank to regulate the credit supply. One reason that the central bank of China can easily regulate the credit supply is that China has not opened its capital market. Once the capital market is opened in the future, the central bank of China may lose some power in affecting the credit supply. Third, a drawback of credit policy is
that it directly affects the availability of loans for all firms in the economy and this may result in resource misallocation. Thus, despite the successful stabilization policies, it is still necessary for the central bank of China to liberalize the interest rates. Studies have found that changes in the economic environment, including the profound reforms of the state owned entrepreneurs, as well as the expansion of the private sector and the foreign sector, have made the Chinese real economy respond to changes in interest rates (Koivu, 2009). We expect a combination of leverage management and an active interest rule will be a better policy for stabilizing the Chinese economy in the future.

References


Appendix A: Derivation of the Phillips Curve

The first order condition of the retailers’ optimization problem is

\[
E_t \sum_{k=0}^{\infty} (\omega \beta)^k \Lambda_{t+k} Y_{t+k} (j) \frac{P_t^w(j) (P_{t+k-1}^w)}{P_{t-1}} \delta_p = E_t \sum_{k=0}^{\infty} (\omega \beta)^k \Lambda_{t+k} Y_{t+k} (j)(1 + \theta) \frac{P_{t+k}^w}{P_{t+k}} \tag{A.1}
\]

Log-linearize equation (A.1) we have

\[
\hat{P}_t^*(j) + (1 - \omega \beta) \sum_{k=0}^{\infty} (\omega \beta)^k (\hat{Y}_{t+k} (j) - \hat{P}_t^w + \hat{\delta}(\hat{P}_{t+k-1}^w - \hat{P}_{t-1}) + \hat{\Lambda}_{t+k})
\]

\[
-(1 - \omega \beta) \sum_{k=0}^{\infty} (\omega \beta)^k (\hat{Y}_{t+k} (j) + \hat{P}_t^w - \hat{P}_{t+k} + \hat{\theta}_t + \hat{\Lambda}_{t+k}) \tag{A.2}
\]

(A.2) can be simplified as

\[
\hat{P}_t^*(j) = (1 - \beta \omega) \sum_{k=0}^{\infty} (\omega \beta)^k [\hat{P}_{t+k}^w + \hat{\theta}_t - \delta_p (\hat{P}_{t+k-1} - \hat{P}_{t-1})] \tag{A.3}
\]

(A.3) can be rewritten as

\[
\hat{P}_t^*(j) - \delta_p \hat{P}_{t-1} = (1 - \beta \omega)(\hat{P}_{t+k}^w + \hat{\theta}_t - \delta_p \hat{P}_{t-1}) + \omega \beta (\hat{P}_{t+1}^w (j) - \delta_p \hat{P}_t) \tag{A.4}
\]

Log-linearize the equation

\[
P_t^{\omega} = (1 - \omega)(P_t^*(j))^{\omega} + \omega(P_{t-1} \frac{P_{t-1}}{P_{t-2}})^{\omega}
\]

we obtain

\[
\hat{P}_t^*(j) = \frac{1}{1 - \omega} (\hat{P}_t - \omega \delta_p \hat{P}_{t-1} - \omega \delta_p \hat{\pi}_{t-1}) \tag{A.5}
\]

Substituting (A.5) into (A.4) and after some manipulations (e.g. collecting terms), we have the Phillips curve given by

\[
\hat{\pi}_t = \frac{\beta}{1 + \beta \delta_p} \hat{\pi}_{t+1} + \frac{\delta_p}{1 + \beta \delta_p} \hat{\pi}_{t-1} + \frac{(1 - \omega)(1 - \omega \beta)}{\omega} \frac{1}{1 + \beta \delta_p} (-\hat{X}_t + \hat{\theta}_t)
\]

Appendix B. Data Description

<table>
<thead>
<tr>
<th>Variables</th>
<th>Data Source</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>China Economic Information Network</td>
<td>1998Q1 – 2010Q4</td>
</tr>
<tr>
<td>CPI</td>
<td>China Economic Information Network</td>
<td>1998Q1 – 2010Q4</td>
</tr>
<tr>
<td>Lending rate</td>
<td>The People’s Bank of China</td>
<td>1998Q1 – 2010Q4</td>
</tr>
<tr>
<td>Credit</td>
<td>The People’s Bank of China</td>
<td>1998Q1 – 2010Q4</td>
</tr>
</tbody>
</table>

Notes

1. Investment refers to fix capital investment.
2. Consumption per capita is the average of urban consumption per capita and rural consumption per capita.
3. Housing prices refers to national average housing price/m². Data on housing prices during the period of our study are not directly available. We calculated housing prices in the following way: First, we calculate one year’s housing prices by dividing the value of sales on housing by sale volume on housing. Then we back out the remaining housing prices by using the house price index.
4. Annual lending rate is adjusted to have a quarterly frequency.
5. Credit means the total loans extended to non-financial institutions.