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The Bank Capital Regulation and Monetary Policy

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Abstract

Bank capital regulation under Basel Accord has changed the allocation of credit funds and the operation rule of the economy in great degree, and subsequently affected the foundation condition and transmission mechanism of the monetary policies. Given the business cycle, this paper makes the extended analysis of the IS-LM model under capital regulation, and finds that capital regulation will induce the asymmetric effects of monetary policy through the bank lending channel, so theoretically demonstrates that the operation of monetary policy must consider the bank capital regulation. This paper also employs Stochastic Frontiers Analysis to test the joint effectiveness of monetary policy and Bank capital regulation in china from 2000-2009. This test shows that the effectiveness of the monetary policy on realizing economic objective would be weakened by bank capital regulation in China. Therefore, to achieve the objectives of stable price and output, the authority must consider the capital requirement of the banks when enacting the monetary policy.

Key words: Bank capital regulation; Monetary policy; Joint effectiveness

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INTRODUCTION

The goal of monetary policy is to stabilize the general price level and output in the economy, while the objective of capital regulatory is to stabilize the individual financial institutions. The capital regulation under Basel Accord is gradually strengthened, and the sensitivity between the risk of bank asset and the capital condition is also gradually enhanced. These induce the change of the amount and the flow of the credit funds, and result in the difference between the real effect and the traditional analysis of monetary policy. These problems present a challenge of the stabilization of the law between the operation of monetary policy operations and the economic objectives. The aftermath of the subprime mortgage crisis in 2007 and subsequent global economic turmoil still save, and bank capital regulation has become the constraint which banks have to face, so all the risk behaviors of banks and monetary policy transmission in this environment will definitely different from that without capital constraints. Understandably, due to the tax and the information asymmetry, the cost of equity is higher than the cost of debt financing. Under the risk-based capital regulation, commercial banks would choose to reduce the relatively higher risk-weighted loans (credit crunch) or to increase the lower-risk-weighted assets (securitization and other off-balance-sheet high-leveraged business). On one hand, because of the capital constraints, some funds flowed to the real economy are insufficient. On the other hand, because of the less constraints to the off-balance-sheet business under Basel Accord (1988), the liquidity of society increasingly chases the high leverage business and subsequently the price of assets become increasing higher. As a result, the stagnation and the high price of assets coexist, so the generation of this crisis in USA is inevitable. The interaction between the expansionary monetary policy and the capital regulation is one of the particularities of this crisis. So, it needs to be tested that whether the introduction of capital regulation which

based on the Basel Accord, will affect the effectiveness of China's monetary policy implementation.

This paper is established in the transmission channels and effects of monetary policy. It is aimed at clarifying the effects of capital regulation on monetary policy implementation, and providing reference for monetary policy operations. The structure of this paper is as follows: The second section reviews the existing researches which study the capital regulation's impact on monetary policy; the third section considered the IS-LM framework with bank capital, and makes the extended analysis of this model to study the effect of monetary policy given the business cycle. The fourth section employs Stochastic Frontiers Analysis to test the joint effectiveness of monetary policy and Bank capital regulation in china from 2000-2009, and indicates that the effectiveness of the monetary policy on realizing economic objective would be weakened by bank capital regulation in China. The fifth part studies the prospect of the reasonable configuration between the macro monetary policy operations and the prudent bank capital regulation. The contribution of this paper is to expend the IS-LM model under bank capital regulation. It finds that capital constraints will result in asymmetric effects on monetary policy through bank credit channel, and verifies this conclusion on the basis of a stochastic frontier approach with Chinese data.

1. THEORETICAL AND EMPIRICAL BACKGROUND

Accompanied by the implementation of Basel Accord (1988) and the new Basel Accord (2004) on a global scale, the adjusted behavior of banks under the capital requirement constraints and its impacts on credit, monetary policy and the real economy are the focus of attention in the field of theory and practice. The research can be divided into two main lines: one is the analysis for bank capital constraints' impact on macro-economic, the other is the analysis for the mechanisms and channels through which bank capital constraints impact macro-economic. Studies of both rely on each other and influence each other. The former is the focus of attention in the field of academic in early times, while the latter is still at the stage of exploration. There is a large number of studies about the analysis for the capital constraints' impact on macro-economic (Aggarwal & Jacques, 2001; Barcel, 2004; Chiuri, 2002; Eurfine, 2000; Honda, 2002; HUANG, 2005; HUANG, 2009; LIU, 2005a, b; Rime, 2001; Santomero & Atson, 1977; Yudistira, 2003).

The study for the mechanisms and channels through which bank capital constraints impact macro-economic increases gradually as the importance of capital regulation is increasingly improved. The study of Bernanke and Lown (1991), as well as Kashyap and Stein (1994) showed that for most banks, credit channel is not obvious when banks' capital level is just at or below the regulatory minimum levels. This is because banks can not expand credit in absence of adequate capitals under the efficient and risk-based capital adequacy requirements. Chami and Cosimano (2001) assume that credit markets are oligopolistic markets, and banks use marginal revenue and marginal cost to determine the amounts and price of loans. The tightening of monetary policy will make the deposit interest rate rise, and due to the stickiness of lending rates, deposit interest rate increase would bring down the Bank's net interest income, which will bring about the decline in gross profit. The asymmetry change of the interest rate of deposits and loans induce the decrease of capital. As a result, in the next period, banks choose to contract the credit because of the decreased capital adequacy ratio, and this dynamic process is called "bank capital Accelerator". Tanaka's (2002) static equilibrium model shows that capital level and capital adequacy constraints affect the elasticity of the interest rate of the supply of loans, change the slope of the IS curve, and change effects that traditional channels of interest rates on bank loans. The decline of bank capital or the increase of capital adequacy requirements will make the optimal supply of loans be not sensitive to changes in interest rates. If bank capital is not adequate or the supervision is tough, these will diminish the effects of monetary policy shocks on output. Gontermann (2004) propose that, in addition to the reserves requirements of central Bank, banks also face capital adequacy constraints. So bank's net capital constraints should therefore be introduced in monetary policy analysis. From a dynamic perspective, changes in monetary policy (such as by changing the open market rate) affect bank profits, as time goes by the effect will accumulate in the changes of bank capital. From the state which capital requirements constraints become effective, any changes in the capital will have a tremendous impact on credit. As the capital regulation becomes increasingly strict, the role which bank capitals play in the monetary policy transmission is independent of the other traditional channels, and it forms a new transmission mechanism. Van den Heuvel (2002a) raised the concept for the first time, tight monetary policy will increase the short-term and long-term interest rate at the same time, but short-term interest rates increase more than long-term interest rates. Because the term of bank's assets is long, while the term of liabilities is short, this situation reduces the net interest income of banks, so does the total amount of capital. Under the constraint that it is not easy to obtain external financing in the short term, the pressure of banks' capital constraints will increase. Banks will choose to reduce the loan supply, and consequently this will amplify the effect of austerity policy.

Based on the study of Chami and Cosimano (2001), Nier and Zicchino (2006) introduced two variables-the probability of default and credit risk weight, and found

that tight monetary policy will make the probability of default loans increase and banks' capital levels decline. The risk-weights of loans become higher than the usual market conditions. The interaction between these two effects will increase pressure on Bank's capital which bring about and bring down the level of investment. Aguiar and Drumond (2007) introduced the concept of liquidity premium and amplified the effect of monetary policy. After tightening monetary policy, Bank's profits and capital adequacy levels fall, and bank need to achieve external financing. As the providers of deposits and external sources of financing, households prefer to saving, which is more liquid and has lower risk, other than bank's stock which has higher risk. Therefore, to ease the pressure of capital, banks must provide higher returns on capital to attract external investment, which increase Bank's "liquidity premium". This induced the increase of the external financing premium of loans, and thereby reduced the demand for corporate loans and finally the total output. Meh and Moran (2010) found that tightening monetary policy would bring down the profit level of bank loans. External investors would think that the possibility of moral hazard of banks will increase, and request banks to increase the ratio that own funds in credit lines. In the short term, banks can't achieve external financing, so banks can only choose to reduce the supply of loans. Therefore this will amplify the effect of tightening monetary policy.

We all noticed the macroeconomic effects of capital constraint. But for the effect on monetary policy implementation, there is no uniform conclusion, the monetary policy transmission mechanism under capital constraint considered the economic cycles.

2. THE MODELING FRAMEWORK

The analysis on the influence of bank capital regulation to monetary policy have two types: one is the dynamic general equilibrium models which based on BGG model, such as MarKovic (2006), Van den Heuvel (2002),Chami and Cosimano (2001).The other is the static, or comparative static partial equilibrium models which base on IS-LM model, such as Tanaka (2003), Gontermann (2004). In a dynamic general equilibrium model, the capital constraints' impact on monetary policy is achieved through numerical simulation, and its direction and size depend on the setting of the steady-state value, and the initial value of economic variables. In contrast, IS-LM framework is more intuitive in the theoretical analysis. The existing IS-LM framework which considered bank capital demonstrates the impacts that bank capital and regulation on the effects and equilibriums of monetary policy. But they do consider the economic cycle. This article develops the existing framework on the basis of Gontermann (2004), and proves that there would be different conclusions when consider the economic cycle.

2.1 IS-LM Model Considered Bank Capital

Consider the four main economies: household (h), firm (f), Bank (b), and government (g). There are three types of assets in the economy: deposit (d), bonds (b) and bank loans (l). Because of information asymmetry between borrowers and lenders, bonds and loans are not perfect substitutes for both firms and banks, and they have sticky prices.

Behavior function of family is:

$S(Y, i) = D^h(Y, i) + B^h(Y, i)$

Family savings exist in the form of deposit D^h and bonds B^h, Y represents real income, i represents the interest rate of bonds.

The equilibrium of Enterprise behavior:

$I(i, r) = B^f(i, r) + L^f(i, r)$

In order to finance for the invest I, firms issue bonds B^for borrow from banks L^f. R represents interest rates of loans. When interest rates of bonds and loans are higher, there are less investment.

Government budget constraint is:

$G = R + B^g$

Representative bank's balance sheet is:

$R + B^b + L^b = D^b + E$

Bank's assets are composed of require reserves in the central bank R, Bonds B^b and loans L^b. Liabilities are the deposits D^b, and E represents the equity. Obvious, sources of capital in the bank's balance sheet are divided into two parts D^b and E. Compared with Bernanke and Blinder (1988)'s analysis of the credit channel of monetary policy, bank's equity is separated. As the minimum capital adequacy requirements significantly increased the importance of bank capital, this set seems more reasonable. Therefore, banks not only face the constraints of require reserves, but also the constraints of capital requirements. Suppose α is the require reserve ratio, β is the capital amount that banks must hold for one unit of risky asset, the capital adequacy ratio. Bank's risk assets are bonds B^b and loans L^b. Banks faced two constraints:

$$\alpha D^b \le R \quad (1)$$

$$\beta(B^b + L^b) \le E \quad (2)$$

(1) is the constraint of loanable funds, (2) is the constraint of capital requirement. When the agent variable of monetary policy r changes, bank's asset operation must face one of these constraints.

Assumption: equity capital in the bank sector is E, and does not change in this part of the analysis. And the banks do not hold excess reserves.

Scenario 1: when the constraint of loanable funds is valid:

$$\alpha D^b = R \quad (3)$$

$$\beta(B^b + L^b) \le E \quad (4)$$

R equals to the minimum reserve requirements, and the money supply in the economy depends on the $\frac{R}{\alpha}$.

Therefore the money supply is $D^b = \frac{R}{\alpha}$. In addition to the reserves, bank assets meet $B^b + L^b = D^b + E - R$, now formula (4) does not constitute a substantive constraints.

$$B^b + L^b = \frac{R(1-\alpha)}{\alpha} + E$$

Set $M(R) \equiv \frac{R(1-\alpha)}{\alpha} + E$, Therefore,

$$B^b + L^b = M(R),\ \frac{dM(R)}{dR} = \frac{1-\alpha}{\alpha} > 0 .$$

Set $\bar{v}$ for shares of bonds, $\bar{u} = 1 - \bar{v}$ for shares of loans, $B^b = \bar{v}(i,r)M(R)$, $L^b = \bar{u}(i,r)M(R)$. Then the condition of loan market clearing is:

$$L^f(i,r) = \bar{u}(i,r)M(R)$$

The equilibrium interest rate of loans is:

$$r = \bar{\phi}(i, M(R))$$

The expression of LM curve is:

$$\frac{R}{\alpha} = D^h(Y,i)$$

The expression of IS curve is:

$$I(i, \Phi(i, \varphi(R))) + G = S(Y,i)$$

When the constraint of the loanable funds is effective, the change of monetary policy R will not only cause LM Curves to move, but also will cause IS Curve to move in the same direction. This process emphasizes the role of reserves in the banking system for credit and monetary policy. Compared to the effect that interest rate channel on monetary policy transmission in the traditional IS-LM model, bank credit magnifies the effect of monetary policy, as in Figure 1.

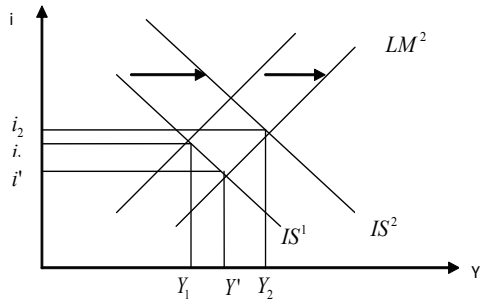

Figure 1
The Effect that Credit Channel on Monetary Policy

Scenario II: when the constraint of capital requirement is valid:

$$\alpha D^b \le R \quad (5)$$

$$\beta(B^b + L^b) = E \quad (6)$$

Bank holds reserves which exceed the reserve requirements, and this excess reserves will not generate interest income, nor need to retain capital. Therefore LM curve is:

$$R + \frac{E(1-\beta)}{\beta} = D^h(Y,i)$$

And IS Curve is:

$$I(i, \Phi(i,E)) + G = S(Y,i)$$

In such cases, as long as banks' equity capital E do not change, the IS curve will not move. In the same strength of monetary policy ΔR, when the constraint of loan funds is effective, the money supply will change $\frac{\Delta R}{\alpha}$. When the constraint of capital requirement is valid, the money supply will change ΔR, and the multiplier effect disappeared.

Bring $D^b \le R/\alpha$ into the right side of the LM curve expression, then could have $R + \frac{E(1-\beta)}{\beta} \le R/\alpha$. And simplify it we could have $\frac{\beta(1-\alpha)R}{\alpha(1-\beta)} \ge E$. That is when the constraint of capital requirement is valid, $\frac{\beta(1-\alpha)R}{\alpha(1-\beta)} > E$, then the effectiveness of monetary policy may fall.

Based on the IS-LM Models which consider the bank capital, when the capital adequacy ratio is a valid constraint, assuming E is unchanged, IS Curve will not move like that demonstrated in Bernanke and Blinder (1988)'s study. The symmetry effect of monetary policy will weaken.

2.2 Extensions to the Basic Model

Analysis showed that while the capital adequacy constraint is valid, both expansionary and tight monetary policies will weaken in symmetry. When considered the variable dynamic effect of bank capital, the effects of policies may be very different.

Based on the experience, monetary policy operations are essentially counter-cyclical. Expansionary policies are corresponded to the economic downturn, tight policies are corresponded to economic prosperity. When the expansionary monetary policy is implemented in economic recession, the changes of speed and amount of additional capital are much slower than that of the additional reserves, and the constraint of capital requirement is valid at this time. When the tight monetary policy is implemented in economic prosperity, because the money is plentiful in the previous period, the speed of decrease of the capital value is much slower than that of reserves. And at this time the constraints of loanable funds is effective.

Set the change of the proxy variable of monetary policy as ΔR. When the expansionary monetary policy

is implemented, according to the assumption, bank will add capital ΔE_{up} next step. By LM expression, changes in the money supply is $\Delta R + \frac{\Delta E_{up}(1-\beta)}{\beta}$. And the distance that IS curve move to the right is $I(\Delta E_{up}, i)$. When the tight monetary policy is implemented, the values of bank capitals decrease ΔE_{down}. But the constraint of loanable funds is valid at this time. The LM curve will move to the left, the changes in the money supply is $\frac{\Delta R}{\alpha}$, and the distance that IS curve move to the left is $I(\Delta R, i)$. Because when the expansionary policy is implemented, the speed to replenish the capital is slower than the growth of reserves, and when the tight monetary policy is implemented, the speed of the loss of the capital is faster than the decrease of reserves, and these assumption can be expressed as, $\Delta E_{down} > \Delta R > \Delta E_{up}$ and there is $I(\Delta R, i) > I(\Delta E_{up}, i)$.

Scenario 1: if $\alpha < \beta$, it must have $\frac{\Delta R(1-\alpha)}{\alpha} > \frac{\Delta E_{up}(1-\beta)}{\beta}$.

The distance that the LM and IS curves move to the left in the tight monetary policy is clearly larger than the distance that the curves move to the right in the expansionary monetary policy. Therefore in the same intensity, the effect of tight monetary policy is greater than the expansionary monetary policy.

Scenario 2: if $\alpha > \beta$, and $\frac{\Delta R(1-\alpha)}{\alpha} > \frac{\Delta E_{up}(1-\beta)}{\beta}$, the conclusion is the same with scenario 1.

Scenario 3: if $\alpha > \beta$, and $\frac{\Delta R(1-\alpha)}{\alpha} < \frac{\Delta E_{up}(1-\beta)}{\beta}$, the effects of expansionary and tight monetary policy are uncertain.

There is a hint in these various situations. The multiplier effect of the capital requirement is the same with the reserve requirement, that is $\frac{1-\beta}{\beta}$. When the Central Bank's statutory reserve requirements is lower than the capital-adequacy ratio, the asymmetry of monetary policy is most obvious. When the Central Bank's deposit reserve ratio is high, and the multiplier effect of currency is lower than that of capital-adequacy ratio, the asymmetric effects of monetary policy is weakened. If the distance that LM curve moves $\Delta R + \frac{\Delta E_{up}(1-\beta)}{\beta}$ is less than $\frac{\Delta R}{\alpha}$, that is, $\frac{\Delta R(1-\alpha)}{\alpha} > \frac{\Delta E_{up}(1-\beta)}{\beta}$. The effect of tight monetary policy $Y_1 - Y_0$ is greater than the effect of expansionary monetary policy $Y_2 - Y_0$.

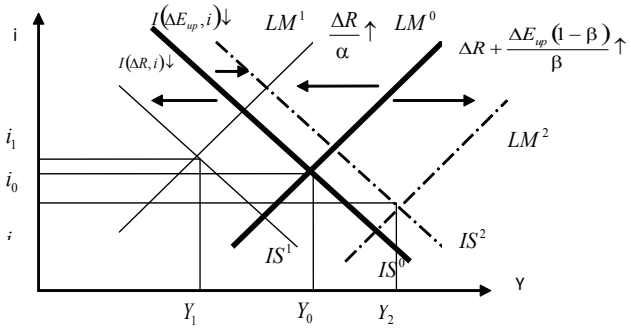

Figure 2
The Asymmetric Effects that Bank Capital on Monetary Policy

Conclusions can be drawn: under the background of the economic cycle adjustment, the adjustment of bank capital is non-symmetric. The effects of monetary policy depend on the deposit creation and the size of the multiplier effect of capital adequacy ratio. When the Central Bank's statutory reserve requirements is lower than the capital-adequacy ratio, the asymmetry of the tight and expansionary monetary policy is most obvious. The above conclusions rely on the asymmetric judgments on the strength and the speed of capital adjustment. The changes of the effects of monetary policy also depend on the specific status of capital regulation and other factors, such as the possibility and the scale of regulatory arbitrage. On the other side, the capital adequacy constraints influence monetary policy, and what is important is that the effect is non-symmetric.

In general, when the economy is in a period of inflation, price levels are higher at this time. To stabilize the prices level, the central bank is bound to adopt tight monetary policy. Then the effect of tight monetary policy is depended on the banks' balance sheets. When the economy is expanded, it is easier for the bank to add capital. The first thing that is affected by the tight monetary policy is loanable funds. Therefore, in the early time of tight monetary policy, the bank credit channel and traditional interest rate channel play the leading role. With the passage of time, because of the reduction of loans and the reduction of spreads, profits of banks are compressed. The value of bank capital decreases and it is more difficult with equity capital financing. The effect of bank capital channel becomes gradually obvious. The interaction of the reduction of excess reserves and the constraint of bank's capital increasingly strengthen the effect of tight monetary policy. Summing up the above, the exits of bank capital requirement will strengthen the effect of tight monetary policy.

3. JOINT EFFICIENCY TEST OF MONETARY POLICY AND CAPITAL REGULATION IN CHINA

From the above analysis we can see that the bank capital regulation has asymmetric effects on the effects of monetary policy. When the capital adequacy ratio is a valid constraint, it is more difficult to achieve the economic goals for expansionary monetary policy, while is easier to achieve goals for tight monetary policy. And this induce that it is hard to grasp the rule of monetary policy transmission. This section will examine the joint efficiency of bank capital regulation and monetary policy on achieving the overall objectives. Based on the preceding theoretical conclusions, we should be able to see the difference of the efficiency of macroeconomic objectives before and after 2004 year. The efficiency of expansionary monetary policy is much lower, while the efficiency of tight monetary policy is relatively high.

3.1 Methodology

This section attempts to employ the stochastic frontier analysis (SFA) to examine the joint efficiency of bank capital regulation and monetary policy in China, and shows capital regulatory effects on the efficiency of monetary policy to achieve the ultimate goal from the perspective of policy inputs and outputs. Take the Supply and demand analysis for example, the OLS approach can combined the observed price and quantity to estimates the average trend that is the average demand curve. In any quantity Q_0, the model can predict an average P_0, but the actual price charged by the firms may be higher or lower than P_0. This means that the forecast of OLS estimation which represents of the average level may be higher or lower than the actual price, and it is impossible to set upper and lower limits. The frontier estimate is to fix this effect. he application scope of Stochastic frontier analysis (SFA) includes: production function, cost function, demand model, joint efficiency test, agency costs, mergers and acquisitions, as well as shadow input (such as corruption) efficiency analysis. The errors in SFA are made up of two parts, u_i and v_i , $v_i \sim iidN(0, \sigma_v^2)$, $u_i \geq 0$ and $\text{cov}(v_i , u_i) = 0$, while v_i captures the random factors in joint errors, and u_i captures single-inefficient, u_i's distributions generally have the following hypothesis: the half-normal distribution (Half-Normal), the exponential distribution (Exponential), the truncated normal distribution (Truncated Normal), and Gamma Distribution. STATA software are able to handle these distributions. After the estimation of SFA, an important step is using likelihood ratio test (LR Test) to verify the technical inefficiency is ever existed, the zero hypothesis test is $\gamma = 0$, Which $\gamma = \frac{\sigma_u}{\sigma_v}$.

In the Joint efficiency SFA analysis, the inputs and outputs in this relationship must be set. The input is capital adequacy ratio of the banking system and monetary policy, and the outputs are the macroeconomic goals in the economy. The independent variables are monetary policies variables and capital adequacy ratio variables, and macroeconomic variables may need to be addressed. Macro-economic goals include economic growth, full employment, price stability and the balance of payments. The objectives of monetary policy in China is to combine the previous two, namely, economic growth and price stability, but these two objectives must be standardized to form a unified joint efficiency indicator for measuring policy. We make use of principal component analysis on the dimensional reduction, forming a policy target variables. Set the function of stochastic frontier analysis as follows:

$$macroobj_t = \beta_0 + \beta_1\left(\frac{\Delta M}{M}\right)_t + \beta_2\left(\frac{\Delta M}{M}\right)_t^2 +$$

$$+ \beta_3(\Delta CAR)_t + \beta_4(\Delta CAR)_t^2 + v_t - u_t \quad (7)$$

While $macrobj_t$ represents macroeconomic objective variables; t represents period; β_i, i = 0,1,2,3,4 represents the coefficient of maximum likelihood estimates; $\frac{\Delta M}{M}$ represents the change rate of money supply; ΔCAR represents the deviation of actual adequacy ratio from regulatory requirements, and measures the degree of regulatory constraints; v_t is the random disturbance term $v_t \sim iidN(0, \sigma_v^2)$, u_t represents inefficiency value, then the joint efficiency TE, $TE = 1 - u_t$.

3.2 The Description and Preliminary Processing of Data

We select the data of the first quarter of 2000 year to the fourth quarter of 2009 year for the analysis of joint efficiency. This period not only reflects the event that regulatory authorities introduced of statutory capital constraints on commercial banks in China, and covers the whole period of this economic cycle. Select the actual GDP quarter growth rates as indicators of economic growth (choose the price level of 2005 year as the benchmark), GDP deflator as the proxy variables of change of price, and the changes of M_1 as proxy variables for monetary policy. These three types of data are from BVD macro-economic database. The indicators of capital regulations should take into account the average capital adequacy of all financial institutes, but also take into account the deviation of the regulatory requirements. We select the ratio of paid-up capital to quarterly data of credit funds as the proxy variable of the average core capital adequacy ratios, and these data are from the statistics column on the people's Bank of China website.

Macro target variables are set as follows: If the economic growth rate is higher, and the inflation rate is lower, the overall achievements of the goals are better.

According to the realities of China, we set the target of economic growth rate as 8% and target of inflation rate as 2%. When the quarterly growth rate is over 8%, it means that the achievement of economic growth is good. When GDP deflator is below 2%, it means that the achievement of stability of price level is good. Therefore, we used the value which equals the economic growth rate minus 8% as the indicators of economic growth, and use the value which equals 2% minus GDP deflator as the indicators of inflation. First of all, standardize these two indicators and establish the characteristic values and contribution rates of coefficient matrix. The principal components analysis shows the contribution of comprehensive target factor value reaches 66.7%. This process is actually looking for the main components and reducing the dimension of existing sequence.

Table 1
Macroeconomic Objective Factor

Time	Macro target factor	Time	Macro target factor	Time	Macro target factor	Time	Macro target factor
2000:Q1	1.293511	2002:Q3	0.755279	2005:Q1	-0.09843	2007:Q3	-1.82303
2000:Q2	1.119253	2002:Q4	0.84576	2005:Q2	-0.13834	2007:Q4	-1.84376
2000:Q3	1.113451	2003:Q1	0.49899	2005:Q3	-0.23279	2008:Q1	-1.26374
2000:Q4	1.387051	2003:Q2	0.960778	2005:Q4	-0.53342	2008:Q2	-1.06757
2001:Q1	1.287369	2003:Q3	0.345958	2006:Q1	-0.68655	2008:Q3	-0.94005
2001:Q2	1.320074	2003:Q4	0.405404	2006:Q2	-1.03817	2008:Q4	-0.21209
2001:Q3	1.345405	2004:Q1	0.396645	2006:Q3	-0.8487	2009:Q1	0.398764
2001:Q4	0.906498	2004:Q2	-0.08192	2006:Q4	-1.0645	2009:Q2	-0.08049
2002:Q1	1.159561	2004:Q3	0.26871	2007:Q1	-1.54155	2009:Q3	-0.56899
2002:Q2	0.970001	2004:Q4	0.245293	2007:Q2	-1.75459	2009:Q4	-1.20507

3.3 Stochastic Frontier Analysis

After we get the variable which represents the economic growth and price stability, we use the target variables as dependent variables, monetary policy and capital regulation as independent variables, and use maximum likelihood estimation to estimate the stochastic frontier model. As there are different assumptions of the distribution of u_i, we test them respectively. Under Half-normal distribution assumptions, it convergences after 6 iteration. But except for the significance of the two coefficients of monetary policy under 10% Confidence, the coefficients of other variable are not significant. Under Truncated normal distribution assumptions, the coefficients are significant, but the likelihood ratio test cannot be refused $\gamma = 0$, the original hypothesis that technical efficiency does not exist. Under exponential distribution hypothesis, outcomes of model fitting are as follows:

$$macroobj_t = -2.04 + 15.91\left(\frac{\Delta M}{M}\right)_t - 46.82\left(\frac{\Delta M}{M}\right)_t^2 +$$

$$162.87(\Delta CAR)_t - 2637.49(\Delta CAR)_t^2 + v_t - u_t$$

All variables are significant in 10% levels, and all coefficients are significant in 1% Levels except for $(\Delta CAR)^2$. $\sigma_u = 0.8365$, Wald statistic *Wald chi*2(4) = 76.98 indicates that the model can pass the test. Likelihood ratio test chibar2 (01) =10.66, Prob>=chibar2=0.001, reject the Original assumptions $\sigma_u = 0$ and the inefficiency term does not have heteroscedasticity (see Table 1).

Table 2
Results of Stochastic Frontier Analysis

Stoc.frontier normal/exponential model Number of obs = 40 log likelihood=-40.68763 Wald chi2(4) = 76.98				Prob > chi2 = 0.0000
Variable	**Coefficient**	**Standard deviation**	**z**	**P>z**
	15.90764	5.9052	2.69***	0.007
	-46.8175	14.995	-3.12***	0.002
	162.8714	51.108	3.19***	0.001
	-2637.5	1599.37	-1.65*	0.099
C	-2.04	0.7256	-2.81***	0.005
	0.1863	0.0609		
	0.8366	0.1527		
	4.4902	0.1759		
Likelihood-ratio test of sigma_u=0:chibar2(01) = 10.66 Prob>=chibar2 = 0.001				

Note: *,*** Represents statistics 10%,1% Levels significantly.

3.4 Analysis of Results

The efficient of one-time term of monetary policy is positive, and the quadratic coefficient is negative. These demonstrate that expansionary monetary policy has a trend reversal effect on economic goals. It will promote the realization of economic targets within a range. But if the currency is beyond a certain limit, it will drag down the achievement of economic objectives. Explained from the perspective of economy, when monetary policy is appropriate, it will promote economic growth. But if the amount of currency is over, it will bring about inflation, and this will have adverse effect on the stability of price level. Specifically, $\frac{\partial mcroobj_t}{\partial(\Delta M/M)} = 15.91 - 93.64(\Delta M/M)$, the critical values of the reverse level of monetary policy is 17%. That is if money supply is over 17%, it will drag down the achievement of the overall objectives of macro-economy. Therefore the issue of money should be cautious.

The efficient of one-time term of capital regulation ΔCAR is positive, and the quadratic coefficient is negative. These demonstrate that increasing the bank capital adequacy ratio moderately can promote the achievement of economic objectives, but capital adequacy ratio which is too high will have adverse impact on economic objectives. Explained from the perspective of economy, increasing the bank capital moderately, can improve the robustness of the banking system, and promote the achievement of economic objectives. But the high or inappropriate capital adequacy requirements, will contract the credit in the banking system and damage the macro-stability, which have adverse impact on economic goals. Among them, $\frac{\partial mcroobj_t}{\partial(\Delta CAR)} = 162.87 - 5274.98(\Delta CAR)$, the critical value of reverse level of capital regulation is 3.1%.When the capital adequacy ratio that we choose (here is the core capital ratio) is larger than 7.1%, it will have adverse impact on macro-economic effects. Of course, this studies only analysis the average capital adequacy ratio of all banks in the economy, without taking into account capital distribution between different banks, which in fact will affect the macroeconomic targets. After estimation of stochastic frontier analysis, we get the joint efficiency of monetary policies and the regulatory capital.

From the time series of joint efficiency of monetary policy and bank capital adequacy regulation, Joint efficiency before the first quarter of 2004 year is above 0.7, and the fluctuations is small. We can say that they are relatively effective. In 2007, the efficiency values fall to the minimum. The impact that capital regulation policy on joint efficiency fits the reality well, and which is significant. Combined with our previous logical analysis, it can be inferred that after the capital adequacy regulation, the joint efficiency is weakened in China.

CONCLUSION AND REMARKS

Our empirical study shows that, beyond a certain range, monetary policy will affect the economic goals. The statutory capital adequacy requirement should be reasonable and appropriate, and their operation needs to be cautious. In particular, the Basel 3 core capital ratio increased to 6%, the impact of the measures on China's macro-economic targets is noteworthy. What's more, monetary policy reaction function should take into account the capital adequacy and regulatory environment variables, to fix the micro-prudential supervision effect on monetary policy. In China, economy is dominated by banks, distinct characteristics of the banking system are obvious, and the characteristics of distribution of bank capital should also be taken into account, such as the response of commercial banks which have different types of capital quality would also affect the ultimate effect of monetary policy. How to corporate the capital trait status and regulatory strength into monetary policy reaction function needs the support of research in the future.

After this crisis, under the framework of G20, financial stability committees, Bank for international settlements, Basel committees and other bodies all treat the macro-prudential supervision as the core content of the reform of the international financial system after the crisis. The major international recognitions of the framework of macro-prudential supervision are: macro-prudential regulation should be focused on the stability of the financial system as a whole, and may use certain tools of micro-prudential supervision, such as the requirement of bank capital and the provision. Its essence is that it is medium and it is from the angle of reverse-cycle. The intention of this framework is very intuitive, but not complete, nor comprehensive. On one hand, the dynamic adjustments of counter-cyclical regulation always lag the actual state of banks, on the other hand, when to implement the dynamic adjustment of reverse cycle and where the inflection point is are very uncertain. In conclusion, we believe that, to achieve macroeconomic goals, banks' capital regulatory policy and monetary policy should not be fragmented. We should use monetary policy as the main line, establishing monetary policy-related indicators of macro-and medium-warning systems. We should also pay attention to the measurement and management of real risk, to avoid the regulation to be static and rigid.

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