Effect of Capital Constraints on Risk Preference Behavior of Commercial Banks [*]

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Abstract: This study aims to analyze how the financial supervision authority utilize the strong restrictions of capital constraints imposing on the commercial banks to lead the macro economy develop in a stable and harmonious way. This paper first uses multilateral game to deduce that big banks have a loan preference for big enterprises and small banks have a preference for establishing a bank syndicate to pursue large projects, and find the conditions which should be satisfied when the heterology banks carry out loans across the border. Second, it discusses the effect of capital constraint on the credit structure of the commercial banks. By introducing vector and void coordinate, this paper proves that changes of capital adequacy requirements will force the credit structure of the commercial banks adjust along efficient frontier broken line or efficient frontier plane under the condition of interest rate regulation and interest rate marketization respectively. Then, it constructs a credit behavioral preference index to describe the risk preference of the commercial banks, and introduces the implementation and softening of capital constraints into the econometric model. And it uses 522 data points of 29 commercial banks from 2002 to 2006 to do the empirical tests, and finally gives some policy implications to the problem that how Chinese financial supervision authority can regulate effectively. It is the first time to find the conditions of banks beyond the loan border, and to analyze the behaviour adjustment of banks using the vector and void coordinate.

Key words: commercial banks, loan preference, capital constraints, behavioral selection

JEL Classification: G21, G28, G43

Manuscript Classification: Research Paper

I Introduction

As some economic phenomenon suggests, commercial banks have certain behavioral preference when grant loans to enterprises, but the capital constraints can force the banks to adjust it, which means that the financial supervision authority could make full use of the strong constraints of the capital adequacy regulations imposing on commercial banks, adjust the fluctuation of macro economy and lead the economy back to the set direction through financial intermediates, such as the commercial banks. Thus, it has theoretical and practical significance to study the lending preference of commercial banks, analyze the impact imposed by capital constraints, and discuss the corresponding behavioral changes of enterprises and

the development of the whole economic situation.

With regard to the lending preference of commercial banks, difficulty in getting loans for small and medium enterprises (SMEs) is widely discussed in previous literature. In the analysis of this phenomenon, economists mostly take the information asymmetry as a starting point. Leland and Pyle (1977) introduced the views of Aklorf (1970) and Spence (1973) into the financial intermediation theory and the field of operation management research of the commercial banks, pointing out that commercial banks have an advantage dealing with the information asymmetry. Baltensperger(1978) constructed the theoretical framework of credit rationing. Stigliz and Weiss(1981) demonstrated that information asymmetry is the critical reason creating credit rationing through a classical model. Thereafter, with continuous completion of the assumptions, Wette(1983) and some other people demonstrated that it was the banks' preference for credit rationing causes the borrowing difficulty of SMEs whereas Peek and Rosengren(1996)、Strahan and Weston(1998)、Jayaratne and Wolken(1999) provided many empirical tests about these. Besides, many other scholars addressed this problem from the perspective of management, among which the theory of small enterprises circle and the small enterprises relation loan theory are comparatively influential. Domestic scholars have also done lots of research on the bank-firm relation especially the relation between banks and loans for SMEs. For example, Lin and Li(2001) pointed out that the planned economy based on the catching up and surpassing strategy resulted in the borrowing difficulty for SMEs, and developing and perfecting small and medium financial institutions was the fundamental way to solve the financing difficulty problem of SMEs. Li (2002) proved that there was a positive relation between the information advantage and quantity of small and medium financial institutions and the total financing amount of SMEs. Hao et al.(2002) and Li et al. (2003) improved the previous models by introducing different elements and Chinese features. Wang and Zhang(2003) introduced the signal screening mechanism of collaterals to analyze the credit rationing of the banks and SME loans with the extended model. Feng and Yuan(2005) introduced the signal mechanism into the financing structure, addressing suggestions for the reform of China's financial system on a more general level.

The academic contributions of the previous research conclusions from the scholars are beyond dispute, However, their research mostly assumed the borrowing difficulty for SMEs from the very beginning, then analyzed the reasons. However, the borrowing difficulty of SMEs is relative in the practice. For example, it is easier for SMEs receiving fund support from small and medium banks than large banks. During the period from 2002 to 2006, for example, the proportion of the loans to small enterprises from China's four state-owned commercial banks was 37.44%, whereas the proportion of the loans to small-sized enterprises from city commercial banks was up to 52.44%. So, in the analysis, the research premise of the borrowing difficulty for SMEs can't be absolute. This enlightens us to change the research thoughts, such as classify the banks and the enterprises by scales. In a multilateral game, research results and the policy suggestions may be more realistic and constructive.

With respect to the impact of capital adequacy constraints on the commercial bank credit structure behavioral preferences，economists have presented many studies, but the conclusions are not consistent. Koehn and Santomero(1980), Kim and Santomero(1988) addressed that the requirements for capital adequacy would force commercial banks to choose portfolios with higher risk. Furlong and Keely(1989), Rochet(1992) argued that the constraints of bank's capital adequacy would result in the diversification effects of the portfolio, thus reduced the risk preference of banks. However, Dietrich and James(1983) stated that the constraints of bank's capital adequacy have nothing to do with the credit change of commercial banks. Santomero and Watson(1977), Peek and Rosengren(1995) suggested that excessively strict capital regulations will lead banks to reducing the supply of credit and productive investment. Chiuri,

Ferri and Majnoin(2001) addressed that the constraints of capital adequacy hinder the bank's credit supply which has a huge negative effects. The research of Sheldon(1996), Masaru Konishi and Yukihiro Yasuda(2004) suggested that, with the strengthening of the constraints of capital adequacy, the risk undertaken by the banks would be reduced. Keely and Furlong(1990)、Hovakimian and Kane(2000) believed that capital constraints will not change the credit scale and risk preference of banks, which is consistent with the empirical research of UBS data from Rime(2001). At present, there are many theoretical researches on the problem of how capital constraints change the credit behavioral of the commercial banks in China. For example, Xi and Tan (2004) studied the regulation of capital adequacy and the effectiveness of the central bank's open market operation. Liu(2005a,b) explored the effects of capital adequacy rate's on credit、economy and monetary policy transmission, then conducts empirical research according to China's situation. Guo and Mo(2006), Wu and Zhou(2006) also presented some empirical research based on China's data and provide some beneficial results. Due to different research perspectives, the scholars have got different conclusions of the effects from capital constraints. Moreover, these studies were mostly good at reasoning, but weak in operating, and almost not involved in how to improve the drawbacks brought by capital constraints. So what we are considering is whether we can construct a unidimensional measuring index about the credit structure behavioral preference on the basis of the capital constraints' influence mechanism imposed on the behavioral change of commercial banks, then set a corresponding function between capital constraints and the index, so as to strictly test their relationship using data series, thus provide the proper way to take the strong constraints of the capital adequacy regulation into effect.

Based on above goals, this paper studies these problems, which are mainly reflected on the following aspects: firstly, classify the banks and enterprises by their scales and construct a multilateral game, pointing out that big banks have a preference for lending to big enterprises whereas small banks have a preference for forming syndicated banks to pursue larger projects revenue, finding the conditions that should be satisfied when banks with different scales operate cross-border loans; secondly, introduce vector and void coordinate in the analysis, then discuss the effects of capital constraints's on the credit structure behavioral preference under the situation of interest rate regulation and interest rate liberalization respectively, pointing out that varying capital adequacy ratio will make the credit structure of the commercial banks adjust along efficient broken line or efficient plane; thirdly, construct a credit behavioral preferential index to describe the behavioral preference and risk preference of commercial banks, introduce the softening effects of capital constraints as a variable into the econometric model, then use the quarterly data classified by loaning objects from 29 commercial banks in the period from 2002 to 2006 to do empirical tests, get a relatively reasonable conclusion in terms of fitting degree, and address policy suggestions for financial supervusion authority on how to implement capital constraints effectively.

The logical structure of this paper is as follows: the first part is the literature review, and introduction of research significance and innovation; the second part analyzes the lending behavioral preference in commercial bank's operation process; the third part studies the impact on the behavioral preference and risk preference of the commercial banks imposed by the capital constraints; the fourth part provides empirical tests based on China's data; the fifth part concludes and gives some policy suggestions.

II The Selection Preference of Bank's Credit Structure

When choosing loan borrowers with different scales, commercial banks with different scales may have certain preferences.

Suppose a big bank is playing with a small bank, and they both have two choices: lend to a big

enterprise or a small enterprise. If one bank can only lend to one enterprise, then the equilibrium is unique and stable. The big bank will choose to lend to the big enterprise for more profit and less resource, comparing with a small enterprise; the small bank will choose to lend to the small enterprise, since it cannot match the demand of a big enterprise. The game profile is shown in Table 1, and the Nash Equilibrium solution can be expressed as (big bank lend to big enterprise, small bank lend to small enterprise).

Table 1：The Game between Banks and Enterprise with Different Scales[①]

		Small Bank	
		Lend to Big Enterprise	Lend to Small Enterprise
Big Bank	Lend to Big Enterprise	More return, cannot match the demand	More return, rational resource allocation
	Lend to Small Enterprise	Less return, cannot match the demand	Less return, rational resource allocation

The above equilibrium is clear, and the conclusion is intuitive. However, its assumptions are not correspondent with the reality. In real economy, a bank can lend to many enterprises, and a company may borrow from more than one banks. So the discussion here may be more complicated.

Suppose the big bank has two choices: lend to a big enterprise, or to n small enterprises. The two choices must be compared with the profits from risk-free assets. Assume that the loan of the big enterprise L_b is equal to the total loan nL_s of n small enterprises, the interest rate for the big enterprise is r_b, and the interest rate for small enterprises is r_s, the average return of market portfolio is r_f. Assume the risk of the big bank is D_k, return of the investment is a stochastic variable $\tilde{\xi}$. The risk of every small enterprise is δ, and be independent with each other，implying that $\sum_{i=1}^{n}\delta_i = n\delta$. Turn back to the above game, the structure is the same, but the selection has changed.

When the big bank lend to a big enterprise, the maximum expected return is

$$E_{toBig}^*(\tilde{\xi}) = \max\left(L_b r_b - \delta - D_k, \; r_f L_b\right) \tag{1}$$

When the big bank lend to n small enterprise，the maximum expected return is

$$E_{toSmall}^*(\tilde{\xi}) = \max\left[n(L_s r_s - \delta) - D_k, \; r_f nL_s\right] = \max\left[nL_s r_s - n\delta - D_k, \; r_f L_b\right] \tag{2}$$

Given interest rate regulation，the loan interest rate for big or small enterprises are equal or very close, i.e., $r_b \approx r_s$. Since $L_b = nL_s$, so we have $E_{toBig}^*(\tilde{\xi}) > E_{toSmall}^*(\tilde{\xi})$. Therefore, big banks will choose to lend to big enterprises and will not have interest for the demand of small enterprises.[②]

If interest rate can be determined by the market, a big enterprise may get a interest rate much lower

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[①] Bank is the positive chooser in the game. This is just an ansumption to simplify the problem. Actually enterprises can also choose banks, but the results are the same with table 1.
[②] In a strict interest rate regilation situation, when the benefit is less than the market given government set interest rate, banks will give up all loans and investment all to risk-free assets.

than a small enterprise, i.e., $r_b << r_s$. The expected return from loans to big or small enterprises can be considered as the following:

If $r_s - r_b > \dfrac{(n-1)\delta}{L_b}$, this implies that, for big banks, loan benefits from big enterprises are too low, and the benefit reduction is greater than the gain from the risk advantage of big enterprises. So big banks will give up their loan to big enterprises and turn to SMEs. On the contrary, if $r_s - r_b < \dfrac{(n-1)\delta}{L_b}$, big banks will give up their loan to small enterprises and choose big enterprises. The critical value is the interest rate margin between the lending rate to big and small enterprises, $\dfrac{(n-1)\delta}{L_b}$. At this time, big banks have no preference between different loan objectives. Thus, we have[①]:

Proposition 1: Big banks have the preference to lend to big enterprises; if the interest rate is determined by the market, and the loan interest rate margin between small and big enterprises is greater than the certain critical value, big banks may choose SMEs.

For small banks, let stochastic variable $\tilde{\eta}$ be the investment return of small banks. Limited by the size, small banks cannot lend uniquely to big enterprises. So their choice is: either lend to a small enterprise and get the loan benefit, or form a syndicate with n small banks and lend to a big enterprise, then allocate the benefit within the syndicate[②]. Similarly, these two selections must be compared with risk-free return. So the maximum expected return for a small bank lending to a small enterprise is:

$$E_{toSmall}^{*}(\tilde{\eta}) = \max\left(L_s r_s - \delta - D_k, \ r_f L_s\right) \tag{3}$$

the maximum expected return for a small bank lending to a big enterprise is:

$$E_{toBig}^{*}(\tilde{\eta}) = \max\left[\frac{L_b r_b - \delta - D(\sum_{i=1}^{n} k_i)}{n}, \ r_f L_s\right]$$

$$= \max\left[(\frac{L_b}{n})r_b - \delta - D_k + (n-1)(\frac{\delta}{n} - D_k), \ r_f L_s\right] \tag{4}$$

Under interest rate regulation, since $L_s = \dfrac{L_b}{n}$ and $r_b \approx r_s$, the comparison between these two expected returns is determined by the sign of the term $(n-1)(\dfrac{\delta}{n} - D_k)$, where δ and D_k are fixed value, and n must greater than 1. So we definitely can find a $n^* = \dfrac{\delta}{D_k}$, when n is large enough, i.e.,

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① Given interest rate liberalization, since return of loans is always greater than that of market portfolio, banks will not give up loans and invest all money to risk-free assets according to the principle of market selection.

② For simplicity, we assume bank syndicate is formed by n small banks with the same size, so they will distribute benefits accordingly.

$n > n^* = \dfrac{\delta}{D_k}$, $\dfrac{\delta}{n} - D_k < 0$, and $E_{toBig} < E_{toSmall}$. In this case, syndicate loan to a big enterprise cannot maximize benefit.

Under interest rate liberalization, r_b will not equal to r_s . If $r_s - r_b < \dfrac{(\dfrac{n-1}{n})\delta - (n-1)D_k}{L_s}$, small

banks will form syndicates and lend to big enterprises, then distribute the benefit；if

$r_s - r_b > \dfrac{(\dfrac{n-1}{n})\delta - (n-1)D_k}{L_s}$, small banks will choose to lend to small enterprises. The critical value

is $\dfrac{(\dfrac{n-1}{n})\delta - (n-1)D_k}{L_s}$, where small banks is indifference on preference.[1]

The above discussion implies that when choosing loan objectives, small banks have the incentive to form a bank syndicate and obtain big projects. The incentive is determined by the size of the project. If the size is greater than a critical value, the bank syndicate will face a dilemma: the bank syndicate should be large enough to fulfill the project, however, too large project may lower the benefit of small banks comparing with lending to small enterprises. Thus, small banks may prefer to medium enterprises as loan objectives.[2]. So, we have：

Proposition 2：Limited by the size, single small bank can only lend to small enterprise, but small banks have the preference to form bank syndicates and pursue larger projects.

The above conclusion comes from the analysis that views the bank as the positive chooser. If we divide all enterprises into big, medium, and small enterprises according to their scales, then big enterprises can only get loan from big banks, small enterprises can only be financed by small banks, medium enterprises are competing objectives of different banks, since they are benefit to both small and big banks.[3]

So, when selecting specific loan objectives, commercial banks may exhibit particular preference according to their scales. What we want to know is whether the credit structure of banks will be affected by strict capital constraints, which are the main approaches of international bank regulation? If yes, what's the mechanism?

III The impact of the capital constraints on commercial bank's lending behavioral preferences

Basel Accord, the core of which is to exert strict capital constrains on the commercial bank with the purpose of the healthy and sound development of the commercial bank, is the main principal document on

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[1] Here ignore the costs of benefit distribution. In reality, the costs will increase sharply along with the number of the banks. The critical point will be left-skewed.

[2] Different banks all exist the possibility of cross-border loan. So strictly dominant equilibrium does not exist. However, dominant equilibrium will induce banks to get right choice.

[3] This implies the dilemma for the loans of small enterprises：big banks only pay attention to bug projects, small banks also prefer to form bank syndicates to pursue big projects. So it is difficult for small enterprises to borrow from banks in general.

banking supervision in today's world banking system. But since being published and practiced, it has been constantly in dispute. For example, it is a common problem for SMEs especially for small to get loaned, will capital constraints exacerbate the trend and what changes it will bring to the credit structure of the commercial bank? This part will explain the questions above with the help of models and the description of behavioral changes of commercial banks.

For capital constraints couldn't change the revenue and risk condition of the production enterprises directly, but could firstly alter the credit structure of the commercial bank, we deduce on the basis of our early research[①]. In the early research, we have classified the commercial banks into three types due to the attribute of capital: low-capital adequacy banks with soft capital attribute、low-capital adequacy banks with rigid capital attribute and high-capital adequacy banks with multiple selectivity capital attribute, and discussed the changes of the credit scale with different attribute under capital constrains. However, the process during which the state changes from beginning period to the end of the period is still a "black box". To interpret the change, we try to introduce vector and void coordinate to analyze.

Under the assumption of interest rates liberalization, the banks take the loans L_b for big enterprises and the loans L_s for small enterprises as the loan portfolio of the beginning period [②], the loan interest rates of which are r_b and r_s respectively, and we get $r_s >> r_b$. Take the expectation revenue of the bank $\tilde{\tau}$, so

$$E(\tilde{\tau}) = L_b r_b + L_s r_s \ .$$ Take (L_b, L_s, E) as a three-dimensional coordinate, so we get

$E(\tilde{\tau}) = L_b r_b + L_s r_s$ equivalent to a plane which is through the origin and whose slope is r_b in L_b's direction、r_s in L_s's direction.[③] We name this plane as bank's "loan structure and revenue plane".

Point A in the plane represents some credit structure and revenue pattern of the bank's beginning period, so $\vec{oA} = \vec{i} L_s + \vec{j} L_b + \vec{k} E$. The distance from point A to plane $L_s E$ is the total amount of loan for small enterprises from the bank. The distance from point A to plane $L_b E$ is the total amount of loan for big enterprises from the bank; and the distance from point A to plane $L_s L_b$ represents the bank's revenue in the beginning period.

Now we are going to discuss that under the premise that capital constrains bring changes to the credit scale of the bank how the credit structure of the bank will respond. This is equivalent to the following problem：

$$\begin{cases} \max E(\tilde{\tau}) = \left\| \vec{oA} \right\| \sin \theta \\ s.t. \{\Delta L_1 | \Delta L_1 \geq 0\} \bigcup \{\Delta L_2 | \Delta L_2 \geq 0\} \end{cases} \text{ or } \begin{cases} \max E(\tilde{\tau}) = \left\| \vec{oA} \right\| \sin \theta \\ s.t. \{\Delta L_1 | \Delta L_1 \leq 0\} \bigcup \{\Delta L_2 | \Delta L_2 \leq 0\} \end{cases} \quad [④] \quad （5）$$

where $\left\| \vec{oA} \right\|$ is the norm of vextor $\vec{oA}$, and θ is the angle of $\vec{oA}$ and plane $L_b L_s$. The change of credit scale from commercial bank which results from capital constrains is a plane that is

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[①] Dai Junxun and Ma Li：Capital constraints and capital features determine the lending behavior and scales of banks——modelling and empirical studies based on utility functions，Working Paper，2007

[②] Due to cross-border loan, banks can use big and small enterprise loans to form their own portfolio.

[③] Due to interest rate liberalization， we have $r_s > r_b$. Then, the loan structure and revenue plane is downward to the ledtand upward to the right.

[④] The first and second maximization expresses the expansion and depression of credit due to capital constraints

perpendicular to L_sL_b and intersects the bank's loan structure and revenue plane at line EF.[①]
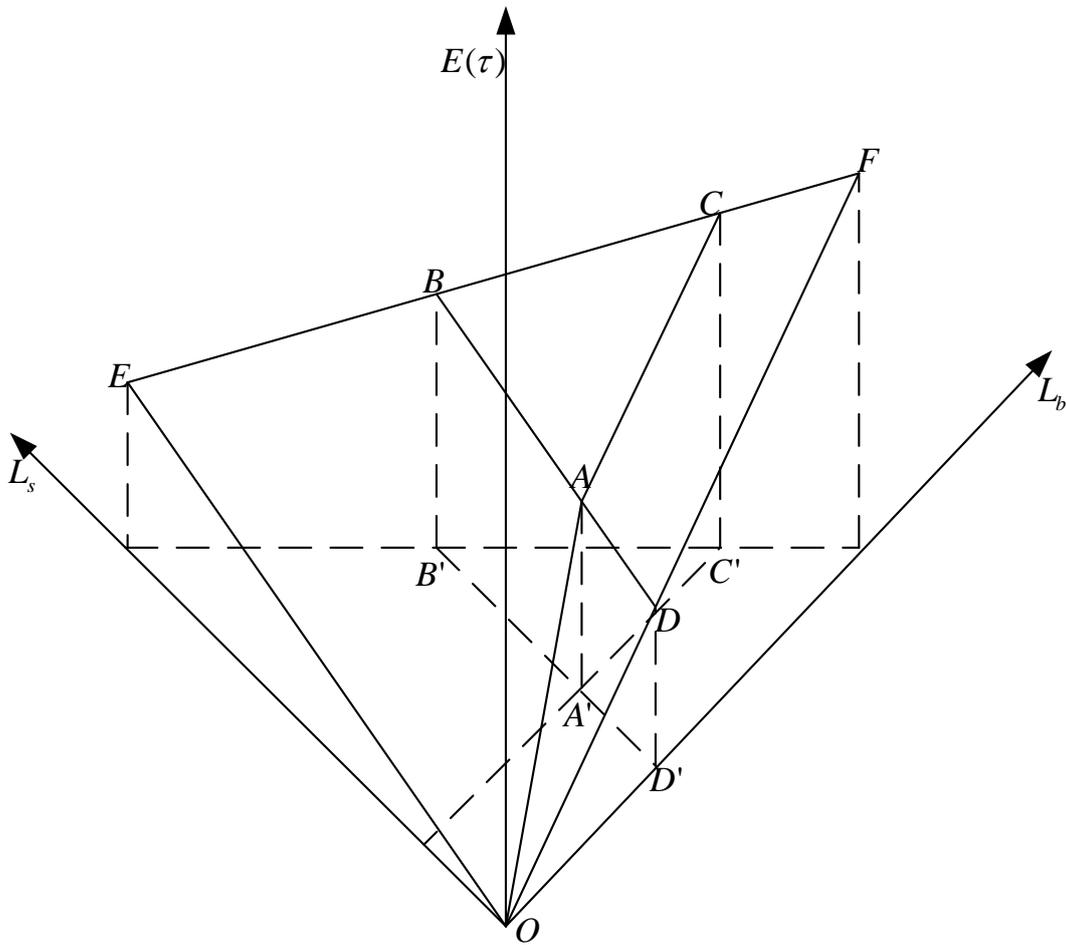
First we examine the situation that capital constrains bring about the credit expansion of the commercial bank. Point A's projection A' extends the credit structure in the beginning period, getting a plane $A'B'C'$ which is the projection of ABC that is a subfield of the bank's loan structure and revenue plane. The area of ABC is crucial to the banks for banks will not search for development beyond that[②]. And in the area of ABC, there still exists optimality that is the boundary of $\overrightarrow{AC}$. For A is a moving point and $\left\| \overrightarrow{oA} \right\| = \dfrac{L_b}{\cos \alpha}$[③]. Considering the area of ABC, only the points on $\overrightarrow{AC}$ guarantee the maximum of L_b、the minimum of $\cos a$ and the maximum of θ during the changing process, so with the expansion of credit,

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[①]Assume a fixed increase of loan ΔL, then $\Delta L_s + \Delta L_b = \Delta L$. Move the origin from o to A, obviously $\Delta L_s = -\Delta L_b + \Delta L$ represents a plane be perpendicular to L_bL_s in void coordinates system.

[②] If banks develop the credit structure beyond ABC, there are two disadvantages：either $\left\| \overrightarrow{oA} \right\| \downarrow , E \downarrow$, and maximization is not satisfied；or reduce L_s or L_b, these are not beneficial to the operation of banks, and may cause unnecessary costs.

[③] α is the cos of axis $\overrightarrow{oA}$ and $\overrightarrow{oL_s}$.

vector $\overrightarrow{oA}$ moves along $\overrightarrow{AC}$ making $E = \left\|\overrightarrow{oA}\right\| \sin\theta$ always maximizes.

Figure1：Impact of capital constraunts on bank credit structure（interest rate liberalization）

Then we turn to the situation that capital constrains bring about the credit crunch of the commercial bank. Find point D representing the credit structure in the beginning period，connect point A and D, getting the broken line $\overrightarrow{AD}$ and $\overrightarrow{Do}$, in the same way $\left\|\overrightarrow{oA}\right\| = \dfrac{L_b}{\cos\alpha}$. When the scale of the credit crunch $|\Delta L| < \left\|\overrightarrow{AD}\right\|$, that point A moves along $\overrightarrow{AD}$ shouldn't have to reduce the value of L_b, so that the decrease of $\left\|\overrightarrow{oA}\right\| \downarrow$. However, when $|\Delta L| > \left\|\overrightarrow{AD}\right\|$, we must reduce the value of L_b. If making point A moves along $\overrightarrow{AD}$ first, then turn to $\overrightarrow{Do}$ when necessary, for the direction cosine formed by $\overrightarrow{Do}$ and axis oL_s is the minimum among all the vectors in the plane ADO, so the process of point A moving along $\overrightarrow{Do}$ makes the reduction of $E = \left\|\overrightarrow{oA}\right\| \sin\theta$ slower.

Figure 2： Impact of capital constraints on bank credit structure（interest rate regulation）

Combined with the above two situations, we take the broken line $\overrightarrow{CA} + \overrightarrow{AD} + \overrightarrow{DO}$ as a efficient broken line which derived from the credit structure change of the commercial bank that made by capital constraints under the supposition of the liberalization of interest rates, thus getting the conclusion:

Proposition 3: under the supposition of the liberalization of interest rates, capital constraints forces the credit behavior of the commercial bank adjusting along the efficient broken line.

If the commercial bank is under the regulation of rate, it has to charge equal or approximately equal interest rate on the production enterprises with different types. As $r_b \approx r_s$, the bank's "loan structure and revenue plane" is even from the right to the left.

When capital constraints bring about the credit expansion of the commercial bank, as taking the same approach, we get an area of ABC whose projection on plane $L_s L_b$ is plane $A'B'C'$. Different from the situation of the liberalization of interest rates, the side of the triangular prism under interest rates regulation is rectangle $BCB'C'$ [①], which means that when the credit structure point of the commercial bank moves along $B'C'$, its corresponding revenue shifts along BC indifferently. Adding all these indifferent revenue curves together, we get a plane ABC. In the same way, when capital constraints bring about the credit crunch of the commercial bank, the indifferent revenue curves constitute a plane ADO. We call $ABC + ADO$ an efficient plane which derived from the credit structure change that made by capital constraints under the supposition of the interest rates regulation, thereby getting a conclusion:

Proposition 4: under the premise of the interest rate regulation, capital constraints will lead to the adjustment of the credit behavioral of the commercial banks on the efficient plane.

Proposition 3 and 4 explain the changing route of the behavioral preferential features revealed by the credit structure of the commercial banks with the limitation of the capital constraints.

IV Empirical tests based on China's data

In China, strict implementation of Basel Accord was started from 2004. Therefore, the empirical part of this paper firstly aims at quarterly data processing for commercial banks loans classified by objectives before 2004 in China, to observe whether there is a preference for the characteristics of credit structure.

The data collected was began from 2002, the borrowers were divided into five categories: group enterprise loans, large enterprise loans, medium-sized enterprise loans, small enterprise loans, and other enterprise loans; the banks involved are Industrial and Commercial Bank of China、Agricultural Bank of China、Bank of China 、China Construction Bank 、Bank of Communications、CITIC Bank、Huaxia Bank 、China Everbright Bank、China Merchants Bank、Pudong Development Bank、Minsheng Bank、Guangdong Development Bank、Industrial Bank and a number of city commercial banks which add up to 29, and 522 data sample points.

From the view of loan balance, the four major state-owned commercial banks (large banks) focused their business on group enterprises and large enterprises. The loan advantage of shareholding commercial banks (medium-sized banks) is medium-sized enterprises. As for the city commercial banks (small banks), they take the largest share of loans in the small business loan market. Taking into account the weak capital size of the city commercial banks compared with large banks and medium-sized banks, its large share in the small business loan market is obviously very amazing(Table 3).

[①] Under interest rates liberalization, the side of the trianglar prism is left lower and right higher.
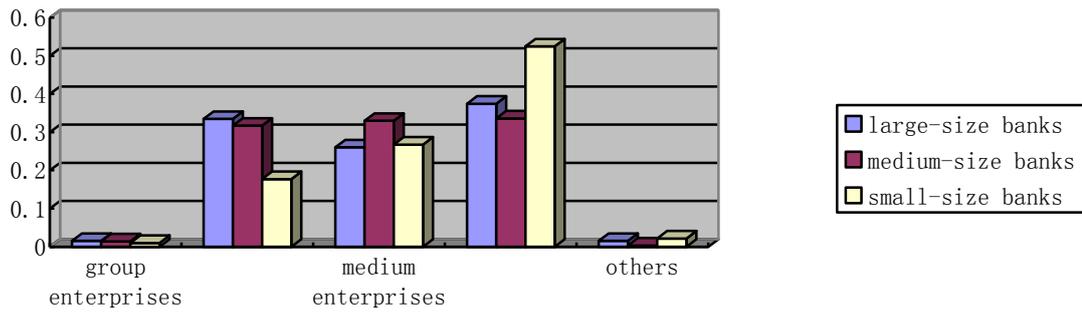
Figure 3：Proprotion of loan objectives for different commercial banks[①]

If the group enterprise loans and large enterprise loans merge of the definition as "big business loans" while the medium-sized enterprise loans, small enterprise loans and other enterprise loans merge of the definition as "small business loans," the trend is more obvious(Figure 4).
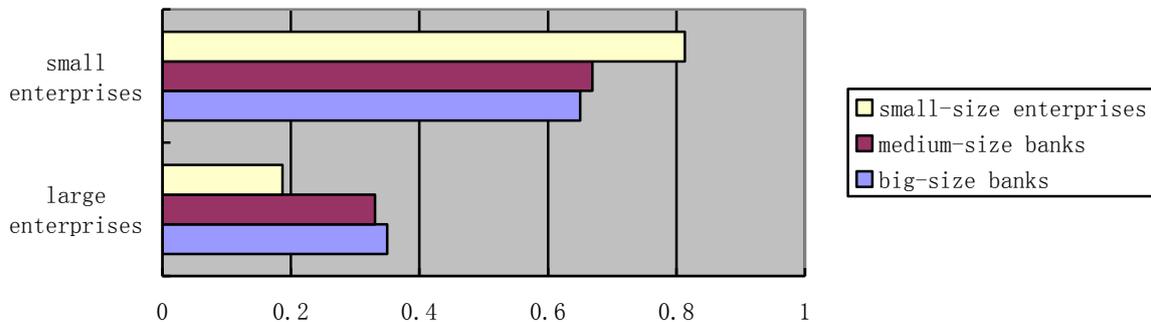

Figure 4：Proprotion of kwo kinds of objectives for different commercial banks

Data show that the commercial banks of different sizes indeed have certain preferences when they have the choice of loans to businesses of different sizes as objects; but the boundaries which large banks to large enterprise loans and small banks to small enterprise loans are not absolutely distinguished. Under real conditions in China, when we consider the "cross-border loans" from commercial banks, there can be attributed to two factors: First, the gradual liberalization of interest rate change the revenue patterns of commercial banks; Second, the government guarantees and protection reduce the enterprises' risk level, especially small and medium enterprises. This is consistent with Proposition 1 and Proposition 2 which are derived in the previous section.

[①] Data sources：Bankscope、Banker、CCER、China Financial Yearbook、China Statistical Yearbook.
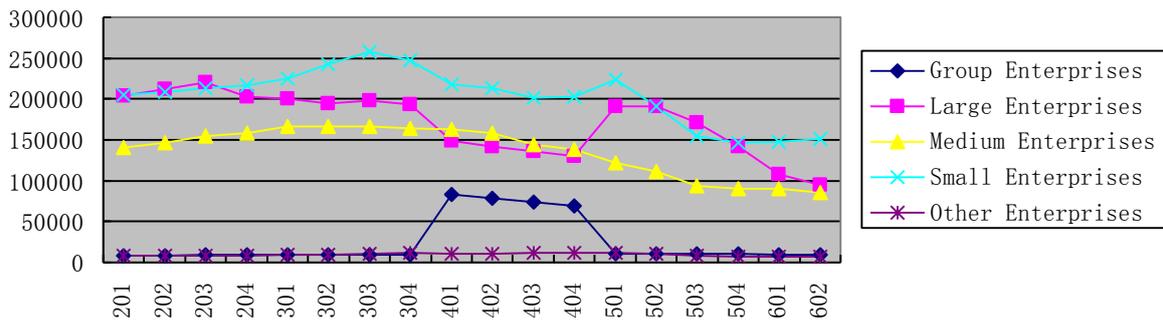
Figure 5 Major State-owned Banks Loans (large-size banks, 2002-2006)[①]
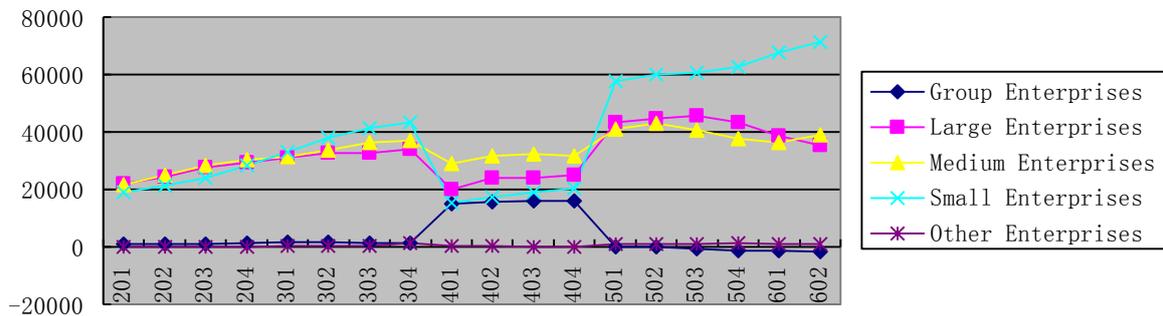
Figure 6 Joint-equity Banks Loans (medium-size banks, 2002-2006)
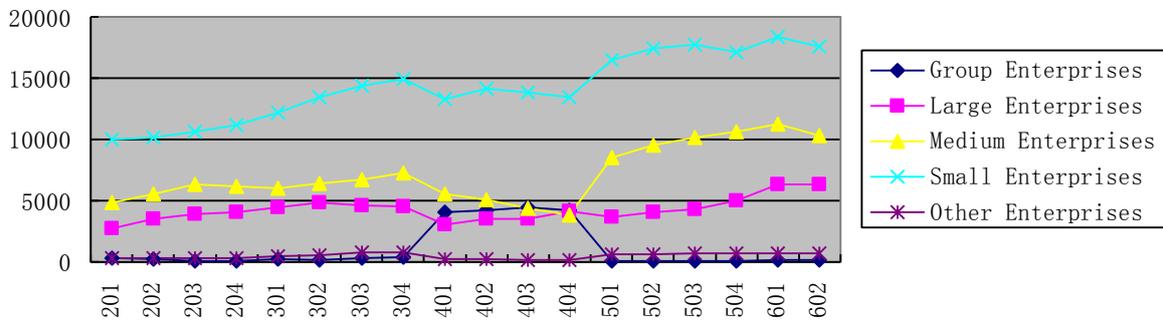
Figure 7 Urban Commercial Banks Loans (small-size banks, 2002-2006)

Since "big" banks and "small" banks have a certain preference when they have the choice of different borrowers, then whether the capital constraint will change this preference pattern? We tried to analyze this issue by using the regression test model. The purpose of the study is to understand if there is a strong correlation between the capital constraints and commercial bank credit structure.

From Figure 5 to Figure 7, the commercial banks were classified into three categories: state-owned commercial banks, joint-stock commercial banks and city commercial banks. We subdivide the loan balance of the commercial bank by objects before and after the new Basel Accord were put into practice. Observed from the graph, loan balances have a very obvious pulse fluctuation in 2004. All kinds of

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[①] For typesetting purpose, the abscissa tick mark, for example 404, refers to the fourth quarter of 2004. The rest can be done in the same manner.

commercial bank loans to the business group have a positive fluctuation, while loans to small businesses a reverse fluctuation, which shows there are external factors that led to the changing in the behavior choices of commercial banks .Under the influence of the external factors, more commercial banks choose the healthy way of expansion, and at the meanwhile compress the credit behavior of high risk.

As shown in Figure 7, before and after the formal implementation of the new Basel Accord in 2004, the choice of credit behavior of China's commercial banks appeared obvious variations. Then whether this behavior preference is caused by the capital adequacy ratio? Or how important the restriction of the Capital adequacy ratio might be in this process? Regression tests are given as the following.

Available comprehensive data was started from 2002, so we defined the first quarter of 2002 as the base period and constructed the "credit structure preference index" of commercial bank as:

$$Index = \frac{\Delta L_b}{L_{b0}} - \frac{\Delta L_s}{L_{s0}} \qquad (6)$$

where L_{b0} is the large enterprise loans in the base period, ΔL_b is the increment of the large enterprise loans compared with the base period, L_{s0} is the small enterprise loans in the base period and ΔL_s is the increment of the small enterprise loans compared with the base period[①].

The format of the credit structure preference index of the commercial bank constructed here is quite simple, but still has six changes involved:

Case 1: If $\Delta L_b > 0, \Delta L_s < 0$, $risk > 0$, it means banks adjust to low-risk credit structure.

Case 2: If $\Delta L_b < 0, \Delta L_s > 0$, $risk < 0$, it means banks adjust to high-risk credit structure.

Case 3: If $\Delta L_b > 0, \Delta L_s > 0, \frac{\Delta L_b}{L_{b0}} > \frac{\Delta L_s}{L_{s0}}$, $risk > 0$, it means banks adjust to low-risk credit structure.

Case 4: If $\Delta L_b > 0, \Delta L_s > 0, \frac{\Delta L_b}{L_{b0}} < \frac{\Delta L_s}{L_{s0}}$, $risk < 0$, it means banks adjust to high-risk credit structure.

Case 5: If $\Delta L_b < 0, \Delta L_s < 0, \frac{\Delta L_b}{L_{b0}} > \frac{\Delta L_s}{L_{s0}}$, $risk > 0$, it means banks adjust to low-risk credit structure.

Case 6: If $\Delta L_b < 0, \Delta L_s < 0, \frac{\Delta L_b}{L_{b0}} < \frac{\Delta L_s}{L_{s0}}$, $risk < 0$, it means banks adjust to high-risk credit structure.

Credit preference index can be positive, negative or zero, and the larger the value of commercial bank credit preference index is the more robust structural features and less risk it has. The smaller the value is , the more active structural characteristics and greater risk it has. Therefore, Index is a good indicator for the change in the credit structure of the commercial bank and the risk preferences. These are shown from

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[①] This is a simple way, in reality, we can set different weights for different loan objectives. The general expression for credit structure preference index is: $Index = \sum_{i=1}^{K} \alpha_i \frac{\Delta L_i}{\Delta_{i0}}$, where α_i is the weight, K is the classification standard of bank size differences. In real calculation, we also made some simplification.

Figure 8 to Figure 13. The credit preference index calculated is shown in Table 2, column 2.
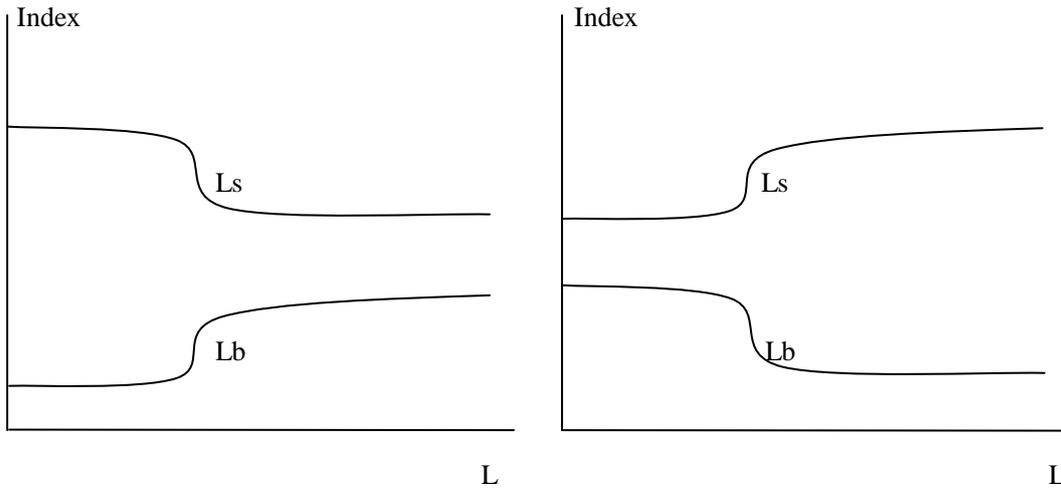
Figure8：preference index and credit structure（1）　Figure9：preference index and credit structure（2）
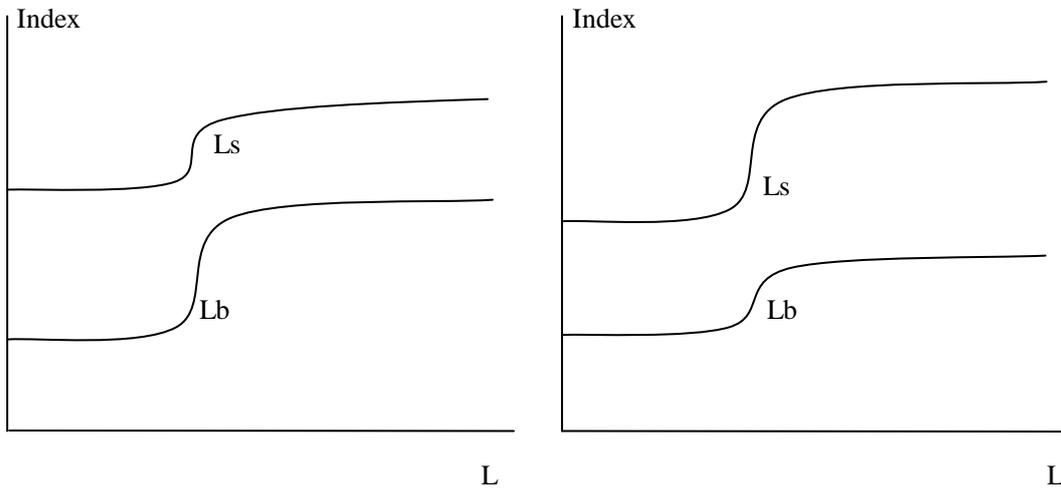
Figure10：preference index and credit structure（3）Figure11：preference index and credit structure（4）
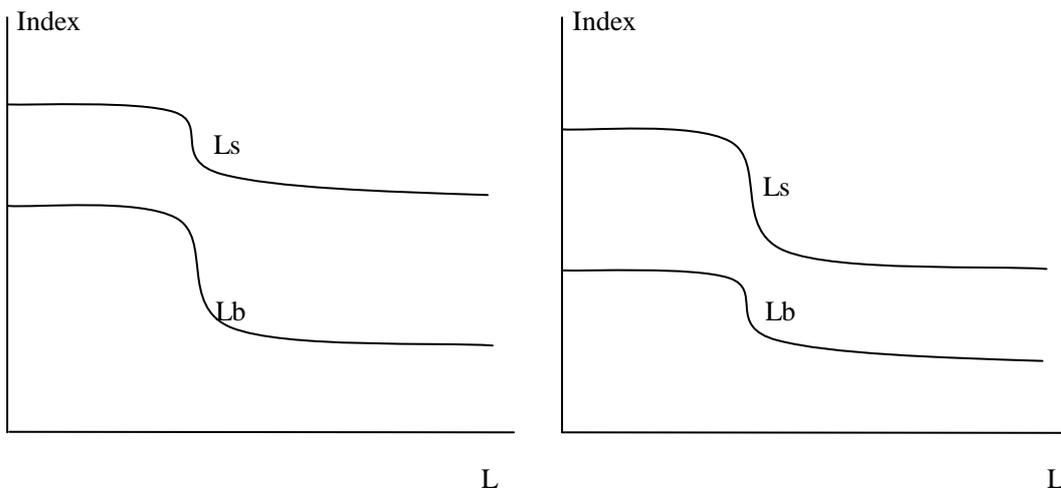
Figure12：preference index and credit structure（5）　Figure13：preference index and credit structure（6）

Take the first quarter GDP in 2002 as a base, we get the GDP growth rate from the first quarter in 2002

to the second quarter in2006 using interpolation，constructing series so as to get the first 4 rows in Figure 2[①]:

Table 2：Results of regression

Time	Index	Institute1	GDP	Institute2
200201	—	—	—	—
200202	-0.01706	0	0.024343	0
200203	-0.0075	0	0.048687	0
200204	0.044036	0	0.07303	0
200301	0.057833	0	0.097373	0
200302	-0.08789	0	0.132689	0
200303	-0.15653	0	0.168004	0
200304	-0.12218	0	0.20332	0
200401	9.60334	1	0.238635	0
200402	9.296527	1	0.293479	0
200403	8.878072	1	0.348322	0
200404	8.386994	1	0.403166	0
200501	-0.13862	1	0.458009	1
200502	-0.02853	1	0.510917	1
200503	0.047737	1	0.563825	1
200504	-0.05207	1	0.616733	1
200601	-0.14976	1	0.669641	1
200602	-0.20489	1	0.722549	1

Set a dummy variable:

$$Institute1 = \begin{cases} 0, \text{without capital requriements (before Jan., 2004)} \\ 1, \text{with capital requirements (after Jan., 2004)} \end{cases}$$

Take the first quarter *GDP* in 2002 as a base, we get the *GDP* growth rate from the first quarter in 2002 to the second quarter in2006 using interpolation，constructing series so as to get the first 4 rows in Figure 2[②].

The regression model is:

$$Index = C_1 + C_2 Institute1 + C_3 GDP + \varepsilon \qquad （7）$$

The regression results of the above model based on the data from the first quarter in 2002 to the fourth quarter in 2004 are as follows:

Table 3：Empirical results only under the condition of capital constraints

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.318476	0.149738	2.126885	0.0661
C(2)	9.804082	0.283933	34.52951	0.0000
C(3)	-3.369654	1.143702	-2.946271	0.0185

[①] In empirical tests, we use data from group enterprises to substitute big enterprises, and use data from small enterprises to subsitute small enterprises. Thus, we can ensure the properties of cresit structure preference index, and highlight the index and the results.

[②] The first quarter of 2002 is the base point, so there is no data.

It seems that the regression results of the model is reasonable from a technical point of view, but the end of the sample interval endpoints for the 4th quarter of 2004, so the model can't give a sufficient explanation for transaction situation of commercial banks' credit structure after the fourth quarter of 2004. According to our initial vision, capital constraints should result in the change of commercial bank's credit structure, which should have been appearing and maintained if capital constraints still exist, as Figure 8 to Figure 13, but there seems not the same trend of China's actual data. In 2004, under the capital constraints, the credit structure of commercial banks does change, but which reverted to the state of no capital constraint from the first quarter of 2005, under the capital constraints still exist. As Figure 5 to Figure 7[①]。

Why is it? We suspect that the appearance of this phenomenon may be caused by the negative effects of a new element which partially offset the impact of capital constraints. This may be the result of soft constraints brought by the Basel Accord II under the current reality in China. Two-stage game is showed as followed: the first stage, the regulatory authorities came up with a strict requirement in the capital constraints, which commercial banks made an active reaction based on earnings expectation; the second stage, the commercial banks found that the Basel Accord is not so horrible[②]，that they all seek to maximize return, gave up the pursuit of sound credit structure, so all went back to the old situation when there is no capital constraints.

Based on this, we set a new dummy variable:：

$$Institute\,2 = \begin{cases} 0, \text{expected effectiveness of capital requirements (before Jan., 2005)} \\ 1, \text{ actual loosening of capital requirements (after Jan., 2005)} \end{cases}$$

Therefore , Figure 2 is the complete data list including 18 lines 5 rows 90 data points in sum. So the regression model is:

$$Index = C_1 + C_2\,Institute1 + C_3\,GDP + C_4\,Institute\,2 + \varepsilon \qquad （8）$$

The regression results of the above model based on the data from the first quarter in 2002 to the second quarter in 2006 are as follows：

Table4：Regression results given implementation and softening of capital constraints

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.145978	0.115947	1.259010	0.2302
C(2)	9.458172	0.212231	44.56539	0.0000
C(3)	-1.754177	0.746272	-2.350588	0.0352
C(4)	-8.656386	0.247191	-35.01903	0.0000

Judging from the technical indicators, the regression model has a good effect of fit in the whole of the available data sample interval. Goodness of fit is 0.9975, the adjusted goodness of fit is 0.9969; AIC and SC detection is very low; the coefficients of the explanatory variable have passed the t test; DW test also show a low correlation. Therefore it is a regression process that matches with the reality very well.

Judging from the economic significance, this regression model also matches with the economic reality. First, the results show that capital constraints have such a great impact on the credit structure of commercial banks that one percentage point change in capital adequacy ratio will lead to 9.46 percentage

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[①] This is particularly obvious for the extreme situation: group enterprise loans and small enterprise loans.
[②] There is a premise for capital adequacy regulation in the Basel Accord, i.e., capital is relatively expensive. If banks cannot raise capital when capital adequacy is raised, they have to adjust total asset or asset structure. However, capital costs is not high in China, banks have some low-cost ways to increase capital. So capital structure adjustment is not necessary.

point change in the same direction in credit structure index of commercial banks. So the more stringent capital constraints are，the larger credit structural adjustment the commercial banks have, and the more stable they operate, and lower risk they have; Second, the regression results also show that the softening of capital constraints would bring a very negative effect on the adjustment of commercial bank credit structure, the relative ratio reached -8.66, a negative effect almost devour most of the beneficial effect which the capital constraints have brought, it means that the more softening of capital constraints are , the more active the capital structure of commercial banks are, and the greater risks the operation has , so regulators must guard against the capital constraint softening. As for the GDP, growth rate are in proportion to operating risk of commercial banks, which is also very consistent with reality.

V. Conclusions

In this paper, according to theoretical modeling and empirical tests, we present conclusions and recommendations as the following:

1.The commercial banks of different sizes indeed have certain special behavior preferences when they are choosing specific borrowers. Specifically, large banks prefer lending to large enterprises, but under the conditions of the gradual liberalization of interest rates and bank lending spreads on the size of the enterprise are greater than a critical value, the large banks will choose the medium-sized enterprise loans and small enterprise loans as borrowers. Only a single small bank loans to small businesses within its capacity, but small banks have preference in building up more large projects. We also discuss the critical condition of different sizes of commercial banks as "cross-border loans" points both cases of interest rate controls and liberalization of interest rates.

2.Capital constraint will have an impact on the credit structure and risk preference of commercial banks. The process of change is shown as follows: In the premise of the interest rate liberalization, the capital constraint will force the commercial banks to adjust credit structure along the line of efficiency; in the premise of interest rate controls, capital constraints will lead to the credit structure of commercial bank to move in the efficient plane.

3.Through the introduction of China's data and rigorous regression analysis, we find that commercial banks show some preferences of credit structure in the course of business, and capital constraints have a large impact on the credit structure of commercial bank, the more stringent capital constraints are，the larger credit structural adjustment the commercial banks have, and the more stable they operate, and lower risk they have. However, the softening of capital constraints would bring a very negative effect on the adjustment of commercial bank credit structure, t the more softening of capital constraints are , the more active the capital structure of commercial banks are, and the greater risks the operation has, so regulators must guard against the capital constraint softening.

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