The Capital Adequacy Requirement and Risk Taking by Banks : A literature survey and some sugguestions for future studies

Dai, Jianzhong
Graduate School of Economics, Kyushu University

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The Capital Adequacy Requirement and Risk Taking by Banks

—A literature survey and some sugguestions for future studies

Jianzhong Dai†

Introduction

Since the publication of Basel Accord in 1988, risk weighted capital adequacy ratio (CAR) requirement has been adopted by more and more countries as an important tool of bank regulation. At the end of last century, there are more than 100 countries which have adopted the CAR regulation (BIS, 1999.) By the year of 2006, the Accord was elevated to a new version called Basel II and a further version (Basel III) will begin in effect in many countries in 2013. The aim of the CAR regulation is to control the risk taking of banks so that the safety of the bank system can be improved.

However, even before the publication of the Basel Accord, there is an intensive debate about the effects of the CAR requirement on the risk taking behaviors of banks. Various theoretical and empirical papers in this area have been published[1]. The debate not only is useful for the evaluation of the efficiency of CAR implementation; it also has important implications for macroeconomic policies. If the implementation of CAR requirement causes banks to significantly decrease their credit supply, triggering a so called "credit crunch" phenomenon, it will have negative effects on the economy. If CAR requirement implementations are carried out in an inflationary environment, then nothing needs to be worried. Unfortunately, most bank restructurings since 1990s occurred at a time when a recession is prevailing. If a stricter CAR requirement causes a "credit crunch," then the bank restructuring will worsen the already severe economic condition, and this in turn will further deteriorate the bank conditions. A vicious cycle may be formed. At best situation these negative feedback effects will increase the cost and time of bank restructuring. If this negative feedback is too strong it even may ruin the efforts of bank restructuring.

Evidences of the conflicts between economic growth and bank restructuring since 1990s are not rare: The United States has experienced a "Credit Crunch" in the period from 1990-1992. In the

† Graduate school of Economics, Kyushu University, Japan. E-mail: jianzhongdai@yahoo.com

1) A survey about the results of CAR regulation by a BIS group lead by Patricia Jackson (1999) includes 130 about papers!

mean time, the same thing happened in some Scandinavian countries (Norway, Sweden and Finland). Japan since 1995 and Southeast Asia after 1997 also have been in this dilemma. The sub-prime debt crisis broken out in 2007 and the following European government debt crisis also caused the concern for "Credit Crunch" in the related countries, re-igniting researcher's interest in the role of capital requirement in the economy.

This paper will survey the literature of the theoretical and empirical analysis about the effects of CAR regulation on the risk taking behaviors of the banks. The paper is divided into three parts: part 1 deals with the theoretical development in the analysis of the relationship between the risk taking behaviors of banks and CAR regulation; part 2 scrutinizes the different empirical methods of testing the theories mentioned in part 1 and their results; part 3 concludes and makes some suggestion for further studies.

1 . Theories about the risk taking behaviors of banks under CAR regulation

1.1 The bank capitals and the risk level of the banks

When a CAR requirement is imposed on the banks, different banks will have different reactions. First of all, this depends on the capital conditions of each individual bank at the time of the introduction of the requirement. Obviously the behaviors of the banks whose level of capital are above the minimum requirement will not be affected by the CAR regulation. Only those that can not meet the minimum requirement (under-capitalized banks) will have to take some action to cope with the requirement.

The banks whose CAR requirement is binding can use four different methods or some mix of them to solve the problem: 1) Enlarge their capitals by issuing new stocks or other debts that are recognized as tier 1 or tier 2 capitals; 2) Decrease the supply of new assets; 3) Credit arbitrage or short selling, such as securitization to get rid some of the accumulated credits; 4) Re-arrange their structure of assets so that the risk adjusted value of the total assets is decreased while the unadjusted value remains the same. These can be achieved by shift their assets from those with higher weights according to the Accord to the assets with lower weights. The first method will increase the nominator of the CAR, while the remaining three methods can reduce the denominator of the ratio. Different methods will have different effects on the risk levels of the under-capitalized banks. Different theories also have different assumptions about the actions that under-capitalized banks may take. These differences in assumption will influence their results.

According to the conclusions of the models, theories about the effects of CAR regulation on the

risk taking behaviors of the banks can generally be divided into two categories: "the capital crunch" school, the "risk shifting" school (Anthony Saunders, 2002).

The "capital crunch" hypothesis was first mentioned by Syron (1992). Researchers advocating this school believe that CAR regulation will have negative effects on the loan (and other risky assets) supply of the banks. The total level of risks of the banks will be reduced, but may cause a so-called "credit crunch" phenomenon, which was first caught the attention of economists in the early 1990s in the United States and stimulated a very hot discussion. The "capital crunch" school predicted that with the tightening of the requirement of CAR, a bank's ability of loan (and other risky assets) supply will decrease. The reasoning behind this hypothesis is very simple. With the introduction of CAR requirement, in order to fulfill the requirement of the bank supervisors, those banks with weak capital positions will be forced either to raise new capitals in the capital market or reduce their total risk assets. Since at most situations it is costly or even impossible for under capitalized banks to issue new stocks they would be forced to reduce the total volume of risky assets, or shift their assets to those with lower weights (most likely the government securities). If a large proportion of the banks take this action, a "credit crunch" phenomenon may prevail.

However, there is also another school called "the risk shifting" school. This school argued that, although it is very possible that the under-capitalized banks will reduce the total volume of their risky assets after the implementation of CAR requirement, at same time they also may "shift" their assets to more risky assets with a same weight, causing the rise of their risks. The reason why "risk shifting " can be possible is because the risk weight rules of the Basel Accord are not perfect and thorough, leaving enough rooms for the operation of "risky shifting." Thus the net effects of the introduction of CAR regulation are ambiguous. In some case risk shifting effects may overwhelm the risk reducing effects so that the total volume of risk of the banks will increase.

Different methods have been used by economists in the analysis of risk shifting effects. They can be grouped into three categories: the complete market approach, portfolio selection approach and game theory approach.

1) The complete market approach

Rochet (1992) has used a complete market model to analyze the effects of CAR requirement on the risk taking of the banks. In a complete market setting, the CAR regulation has no influences on the risk taking attitude of the banks, regardless whether there is any kind of explicit or

implicit (in the form of government rescue of the default banks, for example) deposit insurance. For if there is no deposit guarantee, market discipline will let banks to take a cautious attitude towards risk, even if there is no CAR requirement. In this case CAR regulation is not necessary. On the other hand, with deposit insurance, depositors will not pay attention to the risk level a bank takes, thus on condition that the deposit insurance is not contingent on the risk a bank taken the bank payoff function become convex. In this case all the investment of the banks will be flow to a specific risky asset which has the highest risk among the same expected returns (Rochet, 1992, proposition 1). Imposing a CAR requirement will not affects the risk taking behaviors of the banks: they will still choose the assets with highest risk, although the total volume of risk may be reduced if the CAR requirement is binding. In other words no risk shifting will occur (Rochet, 1992, proposition 3, Mayer 1992.)

Therefore the complete market approach is not very useful in analyzing the risk shifting behaviors of the banks. Besides, as Repullo (1992) has appointed out, any complete market assumption will immediately raise the question why there is any reason for the existence of the banks.

2) The portfolio selection approach

Some analysts treat banks as a portfolio manager and use the portfolio selection theories (mainly the mean-variances analysis) to study the effects of CAR regulation on the risk taking behaviors of the banks. The models are developed from the portfolio model of Pyle (1971), Hart and Jaffe (1974) and was first used by Kahane (1977). Kohen and Santemero (1980), Kim and Santemero (1988) , Rochet (1992) further developed the model. Among them Rochet's model synthesized the other models. Below we will mainly use the model developed by Rochet to discuss the major conclusions of portfolio selection school.

Assume that:

a) The bank behave like a portfolio manager;

b) Equity capital C cannot be increased ($\Delta C=0$); which means it is not allowed in the model for banks to increase their CAR by adding new capitals. This is because it is hard to model the behavior of the prices of the bank stocks[2].

c) No credit arbitrage or short-selling is allowed; otherwise the CAR cannot be binding.

d) The value of capital at the end of period ($\tilde{K}_1$) is normally distributed with mean μ and variance

[2] In the models of Kohen and Santemero (1980), Kim and Santemero (1988), Banks are allowed to issue new stocks, at a fixed exogenous price. The volume of C will be decided endogenously along other variables in their models. If C can be increased, unless its cost is higher than the unrisky assets, CAR condition cannot be binding.

σ^2

Then we can apply the Mean-variances analysis to solve the problem of portfolio selection.

Case 1: A portfolio model without bankruptcy (unlimited liabilities)

In this setting, we need to solve:

$$\underset{(\mu,\sigma)}{Max}\ U(\mu,\ \sigma)$$

$$St.\ (\mu,\ \sigma) \in A_0^+(K)$$

Where $A_0^+(K)$ is the efficient set:

$$A_0^+(K)=\{(\mu,\ \sigma) \in A_0(K),\ \forall \mu' > \mu \notin A_0(K)\}.$$

$A_0^+(K)$ is the upper bound of the feasible set $A_0(K)$ in terms of μ, σ. It can be obtained by solving the problem:

$$\underset{\sigma}{Min}\ \sigma^2,$$

$$St.\ E(\tilde{K}_1)=\mu$$

Where: $\sigma^2=<x,\ Vx>$, x is the vector of values of assets, V is the covariance matrix of the value of the assets.

According to CAPM theory, in the case of non CAR regulation, $A_0^+(K)$ is a straight line called market line: $\mu-K=\lambda\sigma$.

Since the choice of portfolio is along the market line, in this case Rochet proved that the default probability of a bank is a decrease function of its capital adequacy ratio (Proposition 6).

When a CAR requirement is added, the efficient set $A_1^+(K)$ now is:

$$\underset{\sigma}{Min}\ \sigma^2,$$

$$St.\ E(\tilde{K}_1)=\mu$$

$$\left(\frac{\tilde{K}_1}{<a,\ x>} \geq C\bar{A}R\right.$$

Where: $C\bar{A}R$ is the required minimum level of CAR.

$A_1^+(K)$ now is a set of combination of a portion of the "market line" and a part of the non-decreasing upper bound of the set $\frac{\tilde{K}_1}{<a,\ x>} \geq CAR$. The later's slope is less steep then the market line (Rochet, proposition 8). Thus the effects of CAR requirement is a kink of market

line at some point towards the riskless assets.

If the risk weight α is proportional to the famous β in the CAPM theory, then the hyperbole reduced to a horizontal line of $\mu=\bar{\mu}$. In this case the capital constraint banks will have a corner solution at the intersection of the two lines, which means a less risky portfolio. Those who choose a portfolio alone the market line are not constrained by the CAR requirement. Their risk taking decisions will not be affected.

However, If α is not chosen according to β, for those banks which are capital constrained, the total value of risk weighted assets will be reduced on the condition additional capitals can not be placed; on the other hand, these banks will be "shift" their assets to the more risky assets in order to maintain their profit rate as that before the imposition of CAR requirement. Thus a "risk shifting" phenomenon will occur. The net result will be ambiguous. In some case it is possible that the banks become more risky. The same result is also obtained by Kim and Santomero.

Case 2: a portfolio model with bankruptcy (limited liabilities)

If we further add an assumption that the liability of the banks is limited, The value function that banks need to maximize become:

$$W(\mu,\ \sigma)=U(\mu,\ \sigma)-CN\left(-\frac{\mu}{\sigma}\right),$$

Where $C\geq 0$ is the fixed cost of bankruptcy, $N\left(-\frac{\mu}{\sigma}\right)$ is the normally distributed possibility of bankruptcy.

The new objective function W is now neither uniformly convex nor concave with respect to σ. Rochet (1993) showed that for the reasons similar to the complete market setting, some severely under capitalized banks may even tend to be risk loving. Thus a moral hazard problem may appear. Whether a bank will become risk loving will depends on the time substitution of his preferences. In fact, for some $-\frac{u''(x)}{u'(x)}\leq\alpha$, if $K<1/\alpha$ W is increasing in σ (Rochet 1992, proposition 11.) Similar results are obtained by Kahane (1977), Kohen and Santemero (1980)

Portfolio Selection approach has produced some interesting results; however, it has a major weakness. The CAR suggested by Basel Accord Ⅰ is based on the "credit risk", which is mainly deals with possibility of default, not the "market risk," which comes from the fluctuation of the bank assets. So as Repullo (1992) has pointed out, portfolio selection approach may better suit

the analysis of non-bank financial institutions. However, with the implementation of Basel II and Basel III, this approach may become more suitable for the analysis of the risk taking behaviors of the banks.

3) Game theory approach

Some economists use game theories, especially the "moral hazard" concept to analyze the risk taking behaviors of the banks and try to predict what will happen when a CAR restriction is imposed upon the banks.

To understand the "moral hazard" problem, we first should understand the importance of franchise value in the risk taking behaviors of the banks (Caprio and Summers, 1996.) The franchise value can be treated as the capitalization of profit earning ability. The franchise value of banks is a special case since in most countries there is no free-entry into the banking industry. Setting up a bank needs special authorization by the government.

Since the franchise value is the capitalization of monopoly profit earning ability. It is positively related to its profit rate. The lower is the profit rate of a bank the lower of its franchise value. When a bank is closed, the franchise value will disappear. Thus when the franchise value is low, for the same reasoning of the low capital value, bank will follow a more risky strategy since in this situation the firm has less to lose and much more to gain. In the extreme case, when the value of capital $\tilde{k} \leq 0$, banks will become extremely risk loving. This is a typical case of "moral hazard" phenomenon.

Franchise value can shed some new light on the relationship between risk taking behaviors of banks and their CARs. If a bank's capital is increased relative to its assets, on the one hand it will let the bank be more prudent, since it has now more own capital to be lost if the investment failed; on the other hand, it will lower down the profit rate per share, thus the bank will be tempted to take more risk.

Hellman et al.(1999) used a infinite repeated game model to analyze the risk taking behaviors of the banks. In each period, at first stage, bank can freely choose his level of capital K, but at a cost higher than the returns of its prudent investment. This assumption guaranteed that a CAR requirement could be binding in some case. Banks then offer an interest rate to attract deposit in a competitive market. After the raising the deposit, at the second stage banks allocate his fund into two projects: one prudent project with a constant return α and another gamble project which yield a expected return $\theta\gamma+(1-\theta)\beta<\alpha$ (θ is the possibility that the gamble yield a return

$\gamma > \alpha$). If the bank chooses the prudent project, the game will be continued; if it chooses the gamble project and the gamble is successful it will get a higher return $\gamma > \alpha$ and also continue the game. However, if the gamble failed, the bank will be closed and its franchise value will disappear (No forbearance of the failed banks in the model).

From the point of social efficiency, banks should choose the prudent project, since $\theta\gamma+(1-\theta)\beta < \alpha$. However, due to the severe competition in deposit market, banks may have to pay inefficient high deposit interest rate. If in this the case there is no capital requirement, Hellman et al. showed that the only sub-game equilibrium is that banks pay a high deposit interest rate and invest it in the risky project. Adding a CAR requirement can solve the problem, however, the CAR would have to be set at relatively high level due to the controversial effects of capital mentioned above.

Deposit interest rate ceiling is another policy choice, however, as the regulation Q of the United States in the early 1970s had shown, the ceiling may become binding and cause a disintermediation problems or force the banks to find ways inefficiently to shirk the regulation. Hellman, et al. suggest a policy combining the two regulations. In this way the ceiling can set at a high level so that it will be not binding easily and the CAR requirement can be set at a much lower level than the case with only CAR regulation. Hellman et al. proved that there always exists a combination that dominates the policies which only use CAR regulations in the sense of Pareto optimum (proposition 4).

In model of Hellmans, et al, there is no "bail out" by the government if the risky project is failed, but in real world, this is an important factor in the risk taking decisions of the banks, as in Japan before 1995 and in former socialist countries. Berglof, et al. (1995) build a "gamble for bail out" model to describe the risk taking behaviors under the "soft budget" environment. In this model, government has an interest to let the failed investment to be continued. When an investment failed they will come to rescue it. The rescue will only take the form of recapitalization of the banks and it is beneficial to them. Thus if the banks believed that government will rescue a loan project when it go bad, they will provide loan to the project even if they knew ex ante the project will fail. Berglof, et al. argued that recapitalization under soft budget constraint can not itself let the undercapitalized banks to be prudent in their investment decision; therefore it can not solve the lack of capital problems. Only a combination of recapitalization and hard budget constraint will be successful.

Agénor and Silva (2010) built a model to analyze the role of bank capital in an imperfect

market. Under the assumption of imperfect market, bank capitals can be used as a signal of the safety of the banks to the depositors. Well capitalized banks can attract deposits with lower interests than the poorly capitalized banks. Thus in their model except direct influence on the loan supply, bank capital can also indirectly influence the bank loan supplies through loan cost. This effect exists even for those banks whose capital requirement is not binding. Thus they found that bank capital are procyclical no matter the capital is constraint or not.

1.2 The dynamics of the reaction by banks to the tightening of CAR requirement

Some economists try to analyze the dynamics of the reaction by banks to the tightening of CAR requirement. Calem and Rob (1999) analyze and quantify the dynamic portfolio choice by using empirical data from US banking industry over period 1984-1993. They point out banks with different capital positions react differently to capital-based regulation. They find a U-shaped relationship between capital position and risk-taking: under-capitalized banks take maximum risk and as the bank's capital rises they take less risk. However, as their capitals continue to rise, banks will take on more risk again. Severely under-capitalized banks take higher risks because costs of bankruptcy are shifted to the deposit insurance fund in the United States. Well-capitalized banks take higher risks because of their higher profitability and low probability of bankruptcy. In addition, the paper also examines the comparative effects of a flat vs. a risk-based capital regulation.

Hyun and Rhee (2011) set a simple dynamic model to analyze the choice of the banks when they face capital constraints. Except the high cost of issuing new shares, Hyun and Rhee (2011) offered another explanation why banks would rather reduced the loans in stead of issuing new capitals. They proved that reducing loans rather than issuing new capitals is preferred by the incumbent shareholders of the banks, because issuing new capital will dilute the earnings of the incumbent shareholders.

Meh and Moran (2010) build a dynamic stochastic general equilibrium (DSGE) model to analyze the role of bank capital in the economic activities. The model includes a sector of final goods, a sector of intermediary goods and householders. Bankers and investors are involved in the production of capital goods. The role of bank capital is to solve the moral hazard problems in the banks. The existence of capital can let depositors believe that banks will use the funds they obtained properly. Thus sudden decrease of bank capitals will affect banker's ability to attract funds from investors due to the decline of credibility and cause a significant decline in loan supply. This will lead bank capital to be procyclical.

1.3 Comparison of the effects of Basel Ⅰ and Basel Ⅱ

Ever since the publication of Basel accord in 1988 (Basel Ⅰ) various problems have been revealed during its implementation, thus a revised version (Basel Ⅱ) has been proposed in 2006. It is planned to be implemented in the developed G20 countries by the end of 2011. Ever since the publication of the Basel II it has drew the attentions of many analyzers. The focus is on whether the new Accord is more procyclical than the old ones. Unlike the Basel I which bases the risk weight on a simple classification of the debtors (firms, government of the developed countries, government of the developing countries, private lending, mortgage lending etc.,) the Basel II used a much more complex and flexible method to determine the risk weight assigned to an asset. Because the credit classification is much more differentiated than the old Accord, it make more rooms for "risk shift." The method mainly depends on the credit rating of the asset by external credit rating institutions or internal judgment of the banks. Because these ratings usually have a procyclical tendency (an asset will get a higher rating in boom and a lower rating in bang,) it is highly likely that under Basel Ⅱ bank loan supply is more procyclical than the Basel Ⅰ.

Jaques (2008) established a simple one period model to analyze the effects of Basel II on the loan supply. In the model bank assets are divided into three categories: loans with low risk (L^L), loans with high risk (L^H) and a security with further lower risk (S). Different kind of assets have different requirement of capitals (γ^L, γ^H and γ^S). They proved that, under the condition of Basel Ⅱ, capital constrained banks will reduce more high risk loans than in the case of Basel Ⅰ ($\gamma^L = \gamma^H = \gamma^{88}$). Meanwhile the low risk loans will reduce less or may actually increase. Thus Basle Ⅱ will reduce the total level of bank risks, but its effects on the total loan supply are ambiguous. Its result will depend on the risk weights assigned to different assets, the degree of competition in bank market and the buffers of capital (surplus capitals above the requirement hold by the banks.)

Agénor and Silva (2010) also analyzed the difference of effects between Basel Ⅰ and Basel Ⅱ. In their model under the assumption of Basel Ⅱ, risk weights are correlated with the risk premium banks charge upon the interest rates on the borrowers with different level of credibility. Under Basel Ⅱ loans to the borrowers with high risk will have a higher risk weights compared to those to the low risk customers, but their interest rate also will be higher so that the demand for them will be lower. The later will counteract the procyclical effects of bank capitals. Thus they concluded that under Basel Ⅱ bank capital is less procyclical than under the assumption of Basel I.

2 . Evidences about the effects of CAR regulation on the risk taking of the banks—The Empirical research

Analyzing the causality between the adoption of CAR regulation and the risk activities is a very tough work, if not a mission impossible; because it is hard to disentangle the effects of CARs from those of the other factors, such as economic environment, market discipline, other government regulation policies, etc. For example, it is hard to tell during a recession period whether a decline of a risky asset (such as some kind of loans) is caused by weak demand for the asset or the reduction of its supply by the banks. Even it is due to the shrink of supply, it can either explained by the self-willing of the banks or the restriction of the CAR regulation. It also may forced by other regulation changes. Market discipline can also play some role in this situation. In the determination of the trend of a risky asset, capital regulation and market discipline are likely to be closely interrelated. Just a clear regulatory capital standard that is actively enforced may make it easier for the market to exert pressure.

2.1 Effects of CAR regulation on the level of risky assets of the banks

During and after the "credit crunch" in the United States in 1989-1992, there was a lot of empirical research about the effects of the CAR regulation on the credit growth (a major category of risky assets of the banks) in U.S.A. Up till now these studies are still one of the major empirical works in this area.

Some analysts used an indirect way to explore the role played by banks in the "Credit Crunch" of the United States by analyzing the demand factors (the economic fundamentals) in loan market. The reasoning is that if the demand factors cannot fully explain the slowdown of bank loans, then the supply factors must have something to do with it. One of this kind of research is done by Mossier and Steindel (1993). They build demand models for four forms of credits. They found all of the four models significantly over-predict the real values of loans ($Y-Y^*<0$) in the period of "credit crunch". That means in this period the growth rate of credit is exceptionally low. There must have been some supply factors behind it.

Agenor, et al. (2004) used an indirect approach to test the credit crunch hypothesis for the East Asia financial crisis in 1998, which is a little similar to the loan demand approach we mentioned above. They built a demand model for excess liquid reserves by banks, and then they used the model to see whether there are "involuntary" accumulation of liquid reserves (reserves which are much larger than that the demand model will predict), If this is the case, then we can say there is indeed a credit crunch. By using this method they found that the Thailand was indeed in a

situation of credit crunch during that time.

Unlike the other papers, Jokipiin and Milne (2008) estimate a model for the demand of capital buffers (surplus capitals above the requirement by the government) for a sample of banks in 25 European countries during the period of 1997-2004. For the total sample they found a significant negative relationship between the capital buffer and real GDP growth. That is : the capital buffers rise in the period of recession, fall in the period of boom. Therefore the bank supplies are procyclical. However, when the sample is decomposed they found that for small banks and cooperative banks, capital buffers have a positive relationship with the real GDP, indicating that for these banks bank loan supplies are counter-cyclical.

Stolza and Wedow (2011) used a similar dynamic model to analyze the effects of business cycle on capital buffer for a sample of west Germany banks over the period of 1993-2004. They found that for the whole sample the bank capital buffer are counter cyclical. However, low capitalized banks reduce capital and raise the risk asset simultaneous in boom as well as in bangs. On the other hand, well capitalized banks maintain their capital and risk assets in booms, but will increase capitals and reduce the risk assets in bangs.

However, there is a major restriction in the demand side approach. That is: It implicitly assumed that there is no structural change in the loan demand model. Otherwise it is not appropriate to use historical data to predict the loan demand. If the demand effects cannot be correctly predicted, then the supply effects also cannot be correctly estimated. For example some analysts pointed out that new inventory management technology has greatly decreased the needed volume of inventories in many industries and were partly responsible for the decline of firm's demands for liquidity credit in the United States. It is also not suitable for the analysis on the trend of loan growth in a transforming economy, since in these economies there are usually also enterprise reforms operating in the same time with the bank restructuring.

Other economists directly analyze the factors which influence the loan supply. For example, Bernanke and Lown (1991) used a reduced form model for loan supply to estimate the effects of CAR regulation on loan supply during the period of "credit crunch" in the United States in 1989-1992. They assume that the impact of changes in capital regulation can be inferred from the coefficient on capital in a regression of bank loan growth on measures of bank capital and various other control variables for loan demand. They estimate the effect of falling bank capital on lending are statistically significant but small, suggesting that in most regions the capital shortage has only a modest effect on the availability of loans. In addition, they examine the other types

of credit extension, not just bank lending, which have declined since the onset of the recession, and show that falling CAR is a major factor in the slowdown of these assets.

Lown and Wenninger (1993) used a cross-sectional regression model to analyze the role of banking system in the United States in 1989-1992. The regressions proved that the link between bank capital adequacy ratio (CAR) and loan growth is stronger in the period of 1989-1991 than 1988 (the coefficient, its t-value and R^2 ratio is much higher), especially when only CAR is included in the model.

Building on previous researches, Jacques and Nigro (1997) used a three-stage least square model to analyze the relationship between bank capital and the adoption of risk-based capital standards. The paper covers 2570 FDIC-insured commercial banks with assets greater than $100 million, using call report data from the end of year 1990 to the end of year 1991. The results suggest that the risk-based capital standards brought about significant increases in capital ratios and decrease in portfolio risk of banks which already met the new risk-based standards.

Woo (1999) use a similar method as Lown and Wenninger (1993) to analyze the effects of bank restructuring on loan growth during the Japanese financial crisis. Woo use a panel data and run a series of cross-sectional regression (loan growth regressed against CAR) for each year from 1991-1997. He find that from 1991-1994, there is a negative relationship (significant) between bank loan growth and the CAR, indicating that the Japanese banks did not pay attentions on their capital positions; however, after 1995 the coefficient of CAR turned to be positive and the R^2 ratio is increased significantly, showing banks become increasingly aware of their capital positions. On the other hand, Horiuchi and Shimizu find that before 1995 the growth rate of loan is negatively related to the capital/asset ratio of the Japanese Banks.

Bertrand (2000) focus on the banking industry in Swiss by using a simultaneous equations model. The results indicate that regulatory pressure induces banks to increase their capital, but does not affect the level of risk. It implies that for Swiss banks, an increase in available capital through retained earnings or equity issues is less costly than a downward adjustment in the risk of the portfolio. The absence of a developed market for asset-backed securities in Switzerland offers a plausible explanation for the relative rigidity of Swiss banks' portfolio.

Otchere and Chan (2003) have done a case study of the privatization of the Common Wealth Bank of Australia (CWBA). They find that while privatization has significantly raised the CWBA's capital adequacy ratio, but it also stimulates the banks to follow a more aggressive

strategy, thus its NPLs have increased.

All the above empirical analysis is carried out with the example of one country. Chiuri, Ferri and Majnoni (2002) collected an international panel sample from 15 emerging economies with heterogeneous bank and economic conditions and used a model similar to that used by Peek and Rosengren (1995) to testify the hypothesis of "capital crunch". They found evidences that bank credit growth was negatively related to the tightening of capital requirement, particularly at less well-capitalized banks and bank-based emerging countries and the negative impact has been larger for countries enforcing CARs in the environments of currency/financial crises. Even in countries with relative sound bank systems, the result still holds.

Patrick Van Roy (2003) addresses the effect on G-10 banks of the enforcement of 1988 Basel Accord. The paper uses a modified model developed by Shrieves and Dahl (1992) to analyze adjustments in capital and portfolio risk in banks from G-10 countries over the period 1988-95. The result suggests that banks close to the Basel standards have generally increased their capital adequacy ratio without any offsetting increases in portfolio risk. In addition, the outcome finds that banks close to the Basel minimum requirements increased their capital ratios (except in France and Italy), whereas there is only weak evidence for a rise in their credit risk-taking. The evidence proved the U-shape relationship hypothesis proposed by Calem and Rob (1999) and indicates that the Basel Accord did not lead banks to engage in riskier activities, while providing them with a higher capital buffer against insolvency.

Watanabe (2010) built a bank loan supply model to analyze the choice of customers by the Japanese banks during the period of "credit crunch" (from financial year (fy) 1995 to fy 2001). He found that when faced a capital constraint, banks will cut loans to those customer which is relative safe, but will continue to offer loans to those which have difficulty in paying the outstanding loans to prevent these loan gone bad. This will increase the risk of the banks assets.

2.2 The relation between capital requirement and economic growth

The above empirical researches mentioned above received wide attentions among economists and greatly extended the literature about the cause and effects of bank loan growth. However, these studies also suffered some weakness and received wide criticism. One of the major shortfalls of these researches is that they still failed to persuasively distinguish the demand side and supply side causes of the change of loan growth. Even if they have, they failed to show that the slowdown of bank lending has caused or exaggerate the economic recession, since borrowers may find other channel of finances and the efficiency of the loan projects may be improved.

Peek and Rosengren (2000) have done an interesting empirical study about the effects of the Japanese bank crisis on the U.S real estate market to cover these shortfalls. Peek and Rosengren use a panel data model which is distinguished by different markets. Because the loan supply of Japanese branch is external for the U.S market this case study offered a good chance to isolate the supply and demand factors which affects the loan growth. Furthermore, because Japanese bank activities are concentrated in a few markets, they are able to calculate the effects of shrink of loan by Japanese branches on the U.S real estate growth. The research finds that the Japanese banks largely reduced their loan activities in the U.S. after 1995 due to their problems in Japan. Because the Japanese banks had deeply involved in the U.S. real estate loan market, the withdrawal of Japanese banks had significant effects on the growth of construction sector of the United States.

Similarly Sophie and Lahet (2009) analyzed the effects of capital requirement of the Japanese banks on the 1997 Asian crisis. They found that during the early 1990s heavily under-capitalized Japanese banks (due to the burst of bubble) have to shrink loans from the Asian countries. This has significant effects on the outbreak of 1997 Asian crisis.

2.3 Comparison of the capital requirement between the Basel Ⅰ and Basel Ⅱ

Ever since the announcement of Basel Ⅱ, in order to analyze the effects of the new Accord on the bank loan supply, some analysts tries to compared the effects of capital requirements between the Basel Ⅰ and Basel Ⅱ.

Antão and Lacerda (2011) compared the capital requirements for credit to non-financial firms under Basel I and Basel II using a sample of Portuguese banks. They found that under any reasonable assumption about the coefficients used in the calculation function of risk weights defined by Basel Ⅱ in general the capital requirements for the credit to non-financial firms are lower under the Basel Ⅱ than under the Basel Ⅰ, especially for the credits to the large corporations and the small and medium firms classified in the category of retails.

'Using a sample of ten Norwegian banks, Andersen (2011) simulated the effects of Basel Ⅱ on the capital positions for a wider scope of risk assets than the paper of Antão and Lacerda. The simulation was based on a system of simultaneous equations. He found that the risk weights of the bank assets increased in the scenario of recession. This will have negative effects on the bank asset growth. Consequently it will have negative effects on the economic growth. They also found that bank capitals decreased during the recession period due to heavy loan losses. This further deteriorated the problems and a vicious cycle has formed.

The 2007 sub-prime debt crisis in the United States and the following European sovereign debt crisis re-ignite the interests among analysts about the relationship between bank capital, loan supply and economic cycles. Already several papers have been published about the role of capital regulation of the Basel II in the crisis. For example, Heilpern, etc. (2009) analyzed the role of bank capital regulation played in the "credit crunch" happened after the 2007 sub-prime debt crisis in the U.S.A. As mentioned above, one of the techniques of get rid of the constraint of capital requirement is the securitization. Securitization can reduce the value of risk assets and increase the capitals for more loans while still let the banks earn considerable profits from the sales. The risks are shifted to the financial markets. This change of operation strategy encouraged the increase of mortgage in the United States and pushed the prices of the houses into unsustainable high level.

In the mean time, In the Basel II framework, bank assets are valued at the market prices and their risk weights are determined by their possibility of default (PD). Both are high in the formation of asset bubbles but may drastically fall down when the bubbles burst out. Therefore when the prices of houses drastically went down, it cause huge loss for the banks. This weakened the capital positions of the banks and bank loan supply decreased.

2.4 Bank capital requirement and the degree of risk of the banks

Some economists try to directly evaluate the effects of CAR regulation on the degree of risk of the banks. Furlong (1988) used a sample of 98 large bank holding companies of U.S. during the pre Basel period of 1975 to 1986. His approach is to use the famous Black-Scholes formula to estimate the variance of the bank assets. He found that the variances of the assets of the sample banks actually doubled during the period in which some capital requirement is added (1981-1986). However, there are no much differences in the growth rate of risks between under capitalized banks and well capitalized banks.

Sheldon (1996) used a similar method to estimate the variances of equity and assets of 219 banks from some G-10 countries over the period of 1987-1994. he found that the variances for the banks who have increased their CAR and those who have not after the adoption of Basel Accord have both increased; on the contrary in Japan the volatility of asset decreased although most banks increased their CAR.

Thus the result of variance analysis cannot prove the "risk shifting" theory. One reason is that there is still no widely accepted method to calculate the degree of risk and using Black Scholes formula is doubtful. Besides, both papers did not control for other factors that may influence the

risk of the bank capitals and assets.

Conclusion and suggestions for future research

The overall messages from the theoretical and empirical literatures convey us that capital regulations do have some effect on the risk taking behaviors of the banks; but there still have no consensus on the direction that banks will react to the capital regulations. I believe that this ambiguity is due to the strength of the enforcement of the CAR regulation. CAR regulation will reduce the total level of risk of severely under-capitalized banks if it is seriously carried out and a sound accounting system is in place. Net "risk shift" phenomenon could only happen in the situation that bank restructuring is not thoroughly carried out and the supervisors take a lenient attitude to the severely under-capitalized banks.

Beside the toughing of the implementation, to prevent risk shifting the classification of bank assets and the corresponding risk weights also need to be further improved to fully reflect the actual risk of banks' portfolio.

There are still a lot of works that needs to be done in this field. Among them the most important is to further explore the endogenous relationship between bank conditions, bank loan supply and economic growth. Especially how the reactions of banks to the tightening of capital regulation will affect the economic growth and how this effect will in return further affects the bank conditions and loan supply. As we mentioned at the beginning of the paper, the negative effects of the loan supply reduction on the economic growth may further increase the risk level of the banks, since former "safe" assets may now become risky as economic situation further deteriorated. This interaction between the bank conditions and economic growth has important meaning for macroeconomic policy and is also a major factor for the success of the bank restructuring, especially for those economies in which banking system plays a central role in financing and for bank restructuring carried out in severe recession.

Another topic is also worth noticing. From 2013 a new version of Basel Accord (Basel III) will begin to be implemented in many countries. What the effects of this new Accord will have on the loan supply? Answering this question also has both theoretical and policy importance.

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