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The Relationship between Bank Capital, Risk-Taking, and Capital Regulation: A Review of the Literature

by

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Abstract

Bank capital regulation seems to be today's most accepted regulatory instrument. The reasoning is that limited liability and deposit insurance appear to give banks incentives for excessive risk-taking. Capital requirements can alleviate this problem as banks are obliged to hold more capital which forces them to have more of their own funds at risk. But the theoretical literature has much more to say on how banks determine their capital structure and portfolio risk and how capital regulation influences this decision. This paper attempts to give an overview of the literature in order to see what theory suggests, what empirics seem to tell us, and what there is still to do for future research.

Keywords: Banking regulation, deposit insurance, capital structure
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1 Introduction

The 1970s were marked by continuous deregulation of the banking sector. In its course, asset regulation, entry controls, and deposit rate ceilings were abandoned. Since then, banking crises seem to have increased in number and severity. Therefore, regulators were looking for instruments compatible with free banking, and capital requirements have gained popularity. At first, capital requirements were implemented in the form of maximum leverage ratios. The rationale for it was that capital acts as a buffer. As shareholders' claims are subordinate to depositors' claims, banks are solvent if the asset value is at least as high as depositors' claims. Thus, apart from the riskiness of the loan portfolio, the capital ratio determines the probability of failure.

Capital regulation was justified by the perception that banks chose an excessive probability of default. Several reasons are given for this behavior, among which moral hazard due to limited liability of banks and deposit insurance are the most prominent. The idea that higher capital leads to higher capital buffers, thereby reducing the probability of insolvency, is, however, too simple. The reason is that banks might increase their asset risk in response to higher capital requirements, thereby possibly overcompensating the positive effect of the higher capital buffer.

To prevent banks from excessive risk-taking, regulators soon tried to link the required capital to the risk of the loan portfolio. By 1988, the time of the first international initiative (Basel Accord), most countries had already introduced one or another form of risk-sensitive capital regulation. The Basel Accord was signed by the G10 countries and was intended to apply only to internationally active banks. The accord assigns assets to different risk buckets.[1] The assets in a bucket have to be backed by a bucket-specific capital requirement and the total minimum requirement is set at 8% of capital to risk-weighted assets.[2]

The 1988 Basel Accord seems to have been successful in reaching its two principle aims: ensuring an adequate level of capital in the international banking system and creating a more level playing field in competitive terms. This led to its role as an accepted world standard with

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[1] All assets are assigned to one of four buckets. These buckets classify the riskiness of the respective contract, e.g. loans to OECD governments, loans to OECD banks and other OECD public sector entities, residential mortgage loans, loans to the private sector.

[2] At least half of the 8% minimum capital to risk-weighted asset ratio has to be met by tier 1 capital (equity capital and disclosed reserves). Tier 2 capital could include, among other instruments, hybrid debt capital instruments.

well over 100 countries applying the Basel framework to their banking system. But the accord also exhibited some major shortcomings. The bucket approach linked capital requirements to economic risk only insufficiently, opening up the opportunity for regulatory capital arbitrage.[3] This tended to reduce the average quality of bank loan portfolios.

The shortcomings of the 1988 Accord led the Basel Committee on Banking Supervision to release a first consultative package on a new, more risk-sensitive accord in June 1999 and a second revised version in January 2001. Whereas the old accord focussed on capital regulation, the new proposal consists of three mutually reinforcing pillars: minimum capital requirement, supervisory review process, and market discipline. Nevertheless, the calculation of minimum capital requirements is still the focus.

Under Basel II, banks can choose among a standardised approach and an internal rating based (IRB) approach. The former is conceptually the same as under the present accord. The innovation here is that the risk weights are to be refined by reference to a rating provided by an external credit assessment institution.[4] Alternatively under the IRB approach, a bank can opt for using its internal estimates of borrower creditworthiness to assess credit risk in their portfolio, subject to strict methodological and disclosure standards.

As the consultation period for Basel II is still running, this paper summarizes how the theoretical and empirical literature assess the efficiency of capital regulation. The focus of this survey is whether capital regulation can effectively reduce the probability of failure.[5] To allow for an analytical treatment, this question is divided up into subquestions such as why banks may prefer excessive risk-taking and low capital levels and what effect capital regulation may have on the bank's decision. The first part reviews theoretical papers. This strand of the literature is vast and comes to contradicting results. The assumptions of the models differ widely e.g. in the assumed interactions between banks, market imperfections such as information asymmetries, risk

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[3] Banks could increase their risk without increasing required capital by keeping the allocation between buckets constant and substituting low risk for high risk assets within a bucket.

[4] For example, for corporate lending, the existing Accord provides only one risk weight category of 100%, but the new Accord will provide four categories (20%, 50%, 100%, and 150%). For instance, a corporate loan which is rated between AAA and AA- is proposed to receive a risk weight of 20%. As the new framework maintains the minimum requirement of 8% of capital to risk-weighted assets, such a loan would have to be backed up by 1,6%.

[5] The interest of this paper is different from other surveys. Santos (2000), for instance, focuses on theoretical papers. He is less technical, but additionally reviews the literature on the existence of banks and the justification of regulation. The study by the Basel Committee (1999) reviews empirical papers on the impact of the Basel Accord on a broad number of micro as well as macro variables. Bhattacharya, Boot and Thakor (1998) concentrate on deposit-insurance related moral hazard and various regulatory instruments to fight excessive risk-taking. Freixas and Rochet (1997) provide an excellent overview on a wide scope of questions arising from regulation.

preferences, the time span (static and dynamic models), the rationale for regulation, and the regulatory instrument (flat capital requirements vs. risk-sensitive capital requirements). The aim of the first part of this paper is to systematize the theoretical models according to the question they try to answer and link their results to model-specific assumptions. The second part reviews the empirical literature. The objective is to see which of the theoretical implications are confirmed by the real behavior of banks. The conclusion tries to give impulses for future research.

2 Theoretical literature[6]

2.1   The Modigliani-Miller theorem as a starting point

If financial markets are assumed to be complete and depositors are perfectly informed about the failure risk of banks, the **_Modigliani and Miller (1958)_** indeterminacy principle applies. This, however, requires that shareholders do not have a possibility to exploit depositors. To illustrate this problem in a banking context, let us assume that managers act in the shareholders' interest, who seek to maximize the share value. As banks are corporations, the owners' liability is limited to their investment. This means that the shareholders' loss is limited, but a gain greater than the fixed amount owed to depositors fully falls to them. Due to the shareholders' convex pay-off function, banks prefer risky to save investments. This can also be seen very nicely within the option pricing framework. The pay-off of equity can be interpreted as the pay-off of a call option on the bank value with a strike price of the same value as the obligation towards depositors. However, if depositors are perfectly informed about the bank's investment strategies, they will demand deposit rates which fully reflect the bank's risk. Hence, shareholders cannot exploit their controlling position, and maximizing the share value is equivalent to the maximization of the bank's total value. Thus, the value maximizing portfolio is always chosen, and the market value of a bank is independent of its capital structure. In this framework, banks would always choose socially optimal risk levels and, hence, there would be no need for regulation.

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[6]   This survey sees banks as normal firms with some specificities. Thus, relevant parts of the corporate finance literature which do not explicitly refer to banks are also shortly reviewed. The focus of the paper is, however, the banking literature. As regulation mostly has a microprudential view, this study is restricted to the microeconomic literature and does not review papers on macro questions such as procyclicality. The justification of capital regulation is also not subject of this paper (refer to other papers such as Santos (2000)). For our purpose, it is simply assumed that regulation tries to lower default risk.

2.2 Moral hazard due to limited liability and deposit insurance

Some authors state that the Modigliani-Miller theorem is not applicable to banks (among them Sealey (1985) and Baltensperger and Milde (1987)). In a world with complete markets and in the absence of any fricitions, there would not be a need for financial intermediaries. Information theories suggest that a primary rationale for the existence of banks is that they have an information advantage in monitoring firms. Hence, depositors lack information in order to fully assess the riskiness of bank portfolios. Thus, they are not able to efficiently monitor and sanction banks. This information advantage of banks gives rise to moral hazard.

Jensen and Meckling (1976) show that, if information is not equally distributed (or alternatively, if debt holders cannot later interfere into the firm's actions and/or they cannot sign perfect contracts with the firm managers), equity holders have an incentive to pretend to invest in a low-risk asset, but after having sold bonds at a high price, to increase the portfolio risk or to issue additional debt. In a banking context, this means that if depositors cannot interfere into the bank's activity and/or cannot observe the bank's actions, interest rates fail to fully reflect the risk of bankruptcy. Moral hazard arises, i.e., banks will have an incentive to increase leverage and risk (see also Galai and Masulis (1976) and Green (1984) who describes the hidden action phenomenon for firms which are financed both with equity and debt).

The situation is similar under deposit insurance[7] with full cover where depositors do not incur any risk by depositing their funds with a bank. Thus, their pay-off is deterministic and independent of the riskiness of the banks' assets and they lose any incentive to monitor banks' behavior. As the deposit-rates demanded by the fully insured investors do not reflect the asset risk, banks will again have an incentive to increase the riskiness of their portfolios. This is of cause only true if deposit insurance premia do not take the asset risk into account. Properly priced risk-sensitive premia can eliminate the excessive risk-taking by banks since they will then internalize the externality associated with returns in states of bankruptcy (see on this issue for example Rochet (1992)). An extensive literature (for verbal discussions see also Benston et al. (1986) and Kane (1985)) has analyzed the way in which a fixed-rate insurance scheme rewards risk-taking by banks and insulates them from the market discipline required to ensure proper risk evaluation. One strand (for example Sharpe (1978), Kareken and Wallace (1978), Dothan and Williams (1980)) has analyzed this question within a state-preference framework.

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[7] As Diamond and Dybvig (1986) have remarked deposit insurance is the only known effective measure to prevent bank runs without preventing banks from creating liquidity. This was also acknowledged by regulators. Thus, despite the moral hazard problem of mispriced deposit insurance, most countries have set up deposit insurance facilities in one or the other form.

Beginning with Merton (1977), other authors such as Pyle (1984) have studied the adverse incentive effects of deposit insurance with the help of option pricing. They model the claim on the deposit insurer as a put option on the firm's value with the promised payment to the depositors being the strike price. The option is then priced using the Black and Scholes formula. This strand of the literature has shown that when deposit insurance underprices risk as done by flat insurance premia, banks seeking to maximize the value of their stockholders' equity will attempt to maximize the option value of deposit insurance. The associated beneficial wealth effect to bank stockholders is often referred to as "deposit insurance subsidy". Banks can exploit this subsidy by increasing leverage and/or asset risk thereby increasing the probability of failure.

Kane (1989) pointed at an extreme case of moral hazard due to deposit insurance in which **zombie banks** bet for their resurrection. Insured depositors have lost the incentive to force actually insolvent banks into bankruptcy which can, thus, keep in business. Depositors will even be willing to provide further funding as they do not incur any risk. The bank will in turn invest these new funds in risky assets hoping to become profitable if the gamble succeeds and leaving the losses with the deposit insurance if the gamble fails.

Concerns are often expressed with regard to moral hazard and large banks. According to this **too-big-to-fail** argument, large banks knowing that they are systemically important might count on a public bailout in case of financial distress. Thus, they have an incentive to take higher risks and, thereby, to exploit this implicit public guarantee.

While the literature widely agrees that the probability of failure may be excessively high due to the adverse incentive effects of mispriced deposit insurance, or the public safety net in general, it disagrees on the effectiveness of capital regulation to reduce this moral hazard problem.[8] Within both the state-preference models and the option pricing framework, capital requirements itself do not have an effect on risk-taking because increasing capital does not alter bank behaviour. It is still optimal for the bank to choose the highest risk portfolio. To limit the probability of failure in the presence of fixed-rate deposit insurance, capital requirements have to be combined with asset portfolio regulation.[9] *Sharpe (1978)* shows that risk-related capital

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[8] The interests of the deposit insurance system parallel those of a private bond holder because the deposit insurance system, not the insured depositors, stands to lose in the event of a bank failure. In this vein, regulatory capital requirements and other portfolio restrictions could be viewed as similar to private bond covenants (see Black, Miller, and Posner (1978) for a discussion of why bank regulation is analogous to the contractual enforcement of private lending agreements by private debt holders).

[9] In the context of asset regulation, a prominent proposal is to limit deposit insurance to "**narrow banks**" (see for example Tobin (1985), Kareken (1986), Litan (1987), Pierce (1991), and Merton and Bodie (1993)). That is, only those banks that invest in safe securities like government bonds would be able to offer insured deposit accounts. In this case, there is no need for additional capital regulation as narrow banks could not incur excessive default risk. Another suggestion which is often referred to in the

requirements can eliminate the adverse incentive effect to the same degree as risk-based deposit insurance premia. The question is then why capital regulation should be implemented at all if correct pricing of deposit insurance could eliminate moral hazard. ***Flannery (1991)*** points out that when the insurer is unable to exactly observe bank risks, these alternative pricing mechanisms are no longer equivalent and a combination of both instruments would minimize the errors on private-sector allocation. While Flannery abstracts from a moral hazard problem, ***Giammarino, Lewis, and Sappington (1993)*** explicitly treat this problem in the light of information asymmetries between banks and supervisors. They develop a model where bank managers know more about the innate quality of the bank's investment opportunities than the insurer-regulator does. Similar to Flannery (1991)), the insurer-regulator is assumed to manage the tradeoff between the social losses from default and the social costs of avoiding default. For regulators to achieve an optimum, risk-based capital requirements and insurance premia have to be additionally accompanied by restrictions on lending.

Furlong and Keeley (1989) contradict the view that flat minimum capital requirements do not have a moderating effect on bank risk-taking. They point out that under deposit insurance and within both state-preference models and option models, the magnitude of the incentive to increase leverage and risk depends on the level of leverage and risk.[10] Increasing the required capital level thus reduces the value of the deposit insurance put option, thereby reducing the incentive for banks to increase portfolio risk levels. Therefore, more stringent capital regulation will reduce moral hazard and thus, the probability of bank failure.

The result, however, is not undisputed. ***Gennotte and Pyle (1991)*** show within the same option pricing framework that capital regulation may even increase both portfolio risk and the probability of bank failure. This result is primarily due to their assumption of decreasing returns to investment in risky bank assets. Decreasing returns can be justified by the information-intensive, non-marketable nature of the loans in which banks typically specialize. In the Gennotte-and-Pyle model, an increase in the capital requirement may then induce a bank to simultaneously decrease the size of its portfolio and increase its portfolio risk. The probability of

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context of moral hazard is the ***subordinated debt*** proposal (see for instance Benston et al. (1986), Evanoff and Wall (2000), or Board of Governors of the Federal Reserve System (1999) for a detailed survey of past proposals). The benefits are seen among others in the discipline imposed by sub-debt-holders as they, unlike depositors, are forced to wait until the debt matures to walk away from the bank rather than run.

[10] Technically speaking, the marginal value of the deposit insurance option with respect to increasing asset risk is increasing in the level of leverage. Likewise, the marginal benefit from increasing leverage is increasing in the level of risk incurred by the bank.

failure may then be even higher than without regulation.[11] The possibility that flat capital regulation may have an adverse incentive effect on banks is actually a result for which another part of the literature is known, the so called portfolio models.

2.3   Portfolio models

Portfolio models assume that the bank's objective function is to maximize the expectation of a von Neumann-Morgenstern utility function that describes the preferences of the risk-averse owner-manager. To break it down to a mean-variance framework, one has to either assume a quadratic utility function or a probability distribution which can be described by its first two moments. Most work done in this field assumes a single period framework. Equity and deposits are modeled as securities with fixed returns. Banks thus face the well known Markowitz portfolio selection problem with additional restrictions on the sign of the shares invested in equity (negative), deposits (negative), and assets (positive).

Building on earlier work such as Hart and Jaffee (1974) and Kahane (1977), ***Koehn and Santomero (1980)*** analyze the effect of flat capital regulation. As higher required capital levels mean a loss in the expected return, banks will try to make up for this loss by investing in higher risk assets. The strength of this increase in risk-taking and, thus, the change in the probability of failure depends on the degree of risk aversion. For sufficiently risk-averse banks, the probability of default will drop as the relatively low increase in asset risk is outweighed by the higher capital level. For banks with low risk aversion, insolvency will become more probable if stricter capital regulation is imposed. Thus, the result of higher capital-asset ratios in terms of the average probability of failure is ambiguous, while the intra-industry dispersion of the probability of failure unambiguously increases. Koehn and Santomero find that capital regulation alone fails to reduce the probability of failure. To be effective, capital requirements have to be combined with asset regulation.

However, ***Kim and Santomero (1988)*** show that risk-sensitive capital requirements might be an effective means of reducing the probability of default of fully insured banks. This requires optimally chosen risk-weights which then give an upper bound on the probability of insolvency.

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[11] However, the expected costs imposed on the insurer generally is lower even when the failure probability is higher as in the Gennotte and Pyle model, since the value of the deposit insurance put option actually decreases. Higher expected insurer costs result only if an increase in expected deadweight liquidation costs from the higher failure probability outweighs the decrease in the put option value. However, it may be noted that if some extreme assumptions on the distribution of asset returns are made, examples may be found in which increased capital requirements result in higher put option values and insolvency risk without deadweight liquidation costs.

These theoretically correct risk-weights depend on the expected returns, their variance-covariance structure, and the upper bound on the allowable insolvency risk the regulator aims at. They are thus independent of individual risk aversion.

Keeley and Furlong (1990) note that the Koehn and Santomero (1980) and the Kim and Santomero (1988) type of portfolio models are inappropriate to analyze the effects of bank capital regulation on bankruptcy because of the assumption that borrowing rates are constant and costs are independent of portfolio risk. The ability to borrow unlimitedly at the risk-free rate rules out bankruptcy from the start. Rather in a world without deposit insurance and of non-zero probability of default, the deposit rate demanded by uninsured depositors will depend on the risk of the bank's portfolio, which in turn depends on leverage and asset risk. But even in the case of deposit insurance when depositors demand a constant risk-free rate, the assumption of constant borrowing costs is not applicable to banks. The reason is that the expected net marginal cost of deposits is decreasing in the quantity of deposits because the option value of the deposit guarantee increases as leverage increases.

Taking this last effect into account, Keeley and Furlong's model suggests that increased capital standards will not cause banks to increase portfolio risk.[12] This occurs because an increase in capital reduces the value of the deposit insurance put option, thereby reducing the incentive for banks to increase portfolio risk levels.

Rochet (1992) also shows that risk-sensitive capital regulation can reduce the probability of default if the risk-weights are chosen proportional to the systematic risks of the assets (market-based risk-weights). According to his model, all banks will continue to choose a portfolio on the efficient line with capital-restricted banks choosing a less risky portfolio. As a consequence, their default risk decreases.

Rochet also considers limited liability of banks. With bankruptcy, the relationship between utility of shareholders and asset returns is no longer uniformly convex or concave. For low values of capital requirements, banks will tend to choose risky investments for the same reasons as described in the complete market setup. For higher values of capital requirements, this strategy will, however, be deterred due to risk aversion. To avoid risk-loving behavior, capital requirements should thus be set at sufficiently high levels.[13]

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[12] Keeton (1988) also develops a model which is simpler, but also includes the put option value of deposit insurance. In contrast to Keeley and Furlong (1990), he shows that an increase in portfolio risk is quite possible as a result of increased capital standards.

[13] However, as Stiglitz and Weiss (1981) have noted in the context of credit rationing, in the presence of diminishing risk aversion, high capital requirements may lead to the selection of agents with lower levels of risk aversion and thus preferences for higher risk investments.

2.4 Charter value, reputation, and the role of competition

The literature reviewed so far studies a competitive bank in a static setting. In the framework of state-preference or option-pricing models, it was shown that shareholders have an incentive to increase leverage and risk. One strand of the literature, however, points out that intertemporal considerations may have a moderating effect on risk-taking. These researchers assume rent-generation possibilities. Such rents could result from differing monitoring costs or imperfect competition. In a dynamic setting, the present value of such expected future rents represents the bank's charter value. This charter value would be lost in case of bankruptcy. The higher the bank's charter value, the higher is the bank's private cost of portfolio risk and leverage (see Suarez (1994) who formalizes this intuition in a somewhat different setting).

Hellmann, Murdock, and Stiglitz (2000) study the effect of competition in this framework. They show that if competition erodes the bank's charter value (they call it franchise value), then the bank will increase leverage and risk. When analyzing the role of flat capital requirements as a means of reducing moral hazard, they show that apart from setting more of the own funds at risk, minimum capital requirements also have an adverse incentive effect: Increased financing through expensive capital lowers the profits in every period, thus banks will lose less franchise value when going bankrupt. For shortsighted banks, i.e. banks which give less weight to periods more distant in the future, this loss in charter-value is relatively small and can be outweighed by the positive capital-at-risk effect. Flat capital requirements can, thus, eliminate moral hazard for shortsighted banks. The minimum capital requirement, however, will be inefficiently high. The authors, therefore, argue in favor of a combination of capital regulation and deposit-rate ceilings.

In this dynamic setting, *Boot and Greenbaum (1993)* study a so far neglected aspect of deposit insurance, which they claim responsible for excessive risk-taking. They argue that reputational considerations have become increasingly important with the erosion of monopoly rents due to increasing competition in the banking sector. In this setting, banks have an incentive to avoid risk through greater effort on monitoring. Better monitoring improves banks' reputation, thereby, lowering their funding costs. These funding-related reputational benefits have the same positive incentive effects as monopolistic rents in the Hellmann, Murdock, and Stiglitz model. This funding benefit is, however, only available to uninsured institutions whose depositors care for the risks incurred. Deposit insurance, thus, has the effect of destroying the funding-related benefits of reputation. Boot and Greenbaum, therefore, argue that risk-insensitive deposit insurance might only be viable when low competition alone may encourage optimal monitoring. Monopoly rents will then limit moral hazard due to deposit insurance. However, when competition increases, banks reduce their monitoring efforts and incur higher risks. Capital

controls will not have an alleviating effect on this excessive risk-taking. In contrast, they may even aggravate it.

2.5   Managers' incentives

So far, it has been assumed that shareholders control the bank or, alternatively, that managers fully act in the owners' interest. Hence, shareholders' interests have determined the bank's actions. However, managers may have preferences diverging from shareholders' interests. ***Saunders, Strock, and Travlos (1990)*** study this idea within the banking context. They argue that managers might prefer a lower level of default risk than shareholders. Managers are assumed to be compensated with risky fixed claims on the bank and to have firm and industry specific human capital. Thus, they have a lot to lose in case of bankruptcy. Their disutility is therefore increasing in asset risk and leverage. As managers will try to balance risk and leverage, portfolio risk and capital are positively related. Managerial risk-aversion might, therefore, at least act as an alleviation to shareholders' adverse incentive effects.

Dewatripont and Tirole (1994) follow a different approach. Their theory starts with the standard managerial moral hazard within a firm. Thus, managers' effort choice is not observable so that they lose the incentive to monitor the bank's lending activities. It is assumed that formal incentive schemes are limited by imperfect verifiability of firm performance. Consequently, additional incentives are provided by the possibility of external involvement in management by outsiders such as equityholders or debtholders. As managers dislike interference, discipline is best provided by promising a low level of interference in case of good performance and a high level of interference in case of a mediocre one. Since equityholders have a convex and debtholders have a concave return structure and interference per assumption leads to a decrease in risk, debtholders are more prone to interfere than equityholders. Thus, control should shift from equityholders to debtholders in case of mediocre performance. As depositors lack the knowledge to take over control, another institution, for instance the regulator, should take over this task (This is the so called "representation hypothesis".).

Dewatripont and Tirole argue that capital regulation is a rough substitute for the optimal banking governance structure as it shifts control to the regulator when the bank's solvency falls under some threshold. Managers will thus balance their disutility of interference and their costs of monitoring the assets. As the probability of falling below the minimum capital requirement is increasing in the solvency requirement, managers will better monitor the assets thus lowering the portfolio risk. They will also increase capital if shareholders are willing to recapitalize. Therefore, capital requirements are able to lower default risk.

2.6   Recapitalization

Up to now, we have analyzed the effects of capital regulation on bank capital and risk-taking. Special focus has been given to shareholder incentives as they mostly determine capital and risk levels. Besides, recapitalization of capital-constraint banks may also have a negative effect on the share price.

Besanko and Kanatas (1996) derive this drop in share prices within a model which provides an application to banking of the ***Jensen and Meckling (1976)*** agency problem between inside (i.e. owner-managers who only hold part of the equity) and outside investors (shareholders). Jensen and Meckling present the idea that the owner-manager has an incentive to exploit shareholders by taking actions to increase their personal well being at the bank's expense. Under information asymmetries, outside investors do not have full control over the manager's action so that they cannot prevent the manager from exploiting them.

In the ***Besanko and Kanatas (1996)*** model, lending opportunities with positive net present value (assumption comparable to Gennotte and Pyle (1990)) and funding through deposits at the risk-free rate due to deposit-insurance adds to a stochastic surplus for shareholders. Insiders supply effort that increases the likelihood of the successful loan repayment. Solvent, but capital constrained banks are forced by the regulator to substitute equity for deposit financing, thus reducing the expected surplus available to bank stockholders. As a result of the reduction in the insiders' portion of the surplus, they will provide less effort, hence increasing asset risk. The new stockholders will anticipate this behavior and only pay lower prices for their shares. Thus, while recapitalization initially increases the amount of capital, it decreases its value via negative incentive effects. The model suggests that the decline in stock price is the greater the smaller the initial equity ownership of insiders. Thus, situations may exist in which the bank's issue of stock may reduce the market value of equity. Therefore, Besanko and Kanatas conclude that forced recapitalization may raise the probability of failure.[14]

2.7   Other aspects

So far, we have assumed shareholders to maximize asset risk and leverage due to moral hazard. However, taking other aspects into consideration may lead to a less extreme strategy.

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[14] This conclusion is similar to that of Gennotte and Pyle (1991) but while their result applies only to accounting-based capital controls, Besanko and Kanatas's conclusion applies to both accounting and market-value-based standards.

Before the corporate finance literature has studied agency costs, it viewed corporate taxes and bankruptcy costs as the primary determinants of optimal capital structure. As interest payments are tax deductible and dividend payments are not, debt financing was considered as having a tax advantage over equity. Without bankruptcy costs, firms would, therefore, finance themselves through debt. With bankruptcy costs, increased use of debt entails an increased risk of costly bankruptcy. The optimal capital structure is then reached where the marginal tax advantage is equal to the marginal disadvantage due to bankruptcy costs (see Kraus and Litzenberger (1973) for corporate taxation, DeAngelo and Masulis (1980) who additionally introduce personal income taxation and Miller (1977) who analyses capital structure in market equilibrium). In a banking context, this means that optimal capital levels may result from tradeoffs between the tax advantage of deposit financing and leverage related costs identified as the disadvantages due to reserve requirements, diseconomies of scale in the production of deposit services, and bankruptcy costs. As the value of expected bankruptcy costs is an increasing function of the probability of bankruptcy, banks tend to increase capital levels when they increase asset portfolio risk and conversely.

While this literature gives interesting implications for the banking sector, *Orgler and Taggart (1983)* want to see it being applied with caution as banks and non-financial firms exhibit fundamental differences which contribute to a large disparity in their degree of leverage. The first major distinction between banks and other industries is the nature of bank liabilities. Banks raise most of their funds in the form of deposits that offer different combinations of interest and services such as liquidity, safety, and bookkeeping. Both the tax treatment of services and economies of scale in the production of these services will tend to increase the aggregate amount of deposits in equilibrium. The second major difference between banks and non-financial firms is the regulatory environment. Banks are more closely regulated and supervised than any other industry. This specificity will reduce the agency costs borne by depositors and, thus, also lead to greater bank leverage in equilibrium.

Buser, Chen, and Kane (1981) explicitly refer to banks and additionally take deposit insurance into consideration. The optimal capital level results from the value-maximization of banks which optimize over the tax advantage of deposits, bankruptcy costs and (implicit and explicit) deposit insurance premia. As a result, banks operate at leverage levels slightly above the regulatory minimum. In this model, regulatory authorities adjust implicit costs associated with asset risk and bank capital levels in order to elicit desired changes. As a result, changes in regulation allow a bank whose capital level has increased to pursue riskier investments, and a higher risk level in effect forces a bank (through regulatory pressure) to increase its capital level. Thus, regulatory action would result in de facto risk-based capital standards, and a positive

association between changes in risk and capital levels among those banks for which regulatory mandates represent binding constraints.

Apart from this traditional corporate finance literature, another strand also rationalizes optimal (intermediate) capital structure in the presence of information asymmetries. Several authors have shown that firms may use their capital structure as a signal of variables which are not directly observable by outsiders. ***Ross (1977)***, for instance, assumes that managers have inside information about the value of the firm. Then managers could use the capital structure as a valid signal to convey information to investors. Accordingly, firms issue equity when they have poor prospects, and they issue debt when prospects are good. Stated simply, a firm with poor prospects will want to share its downside risk with new claimants, and thus prefers the issuance of stock, while a firm with good prospects will not want to share its upside "risk" with new claimants, and thus prefers the issuance of debt.

Ross' paper and similar analyses by Leland and Pyle (1977) and Myers and Majluf (1984) suggest that capital regulation may impose a real cost on banks as they lose the possibility to signal their true value to the market. A banks incurs the higher a cost, the more its future prospects are above the average as the market is unable to distinguish good from bad banks. This strand of the corporate finance literature does not directly refer to banks. But it could provide an explanation why banks might be reluctant to increase their capital ratios.

2.8   Simulations

Finally, we very shortly refer to simulation approaches. This kind of models tries to assess how banks may react to changes in the regulatory environment. For instance, ***Calem and Rob (1996)*** develop a dynamic model of a banking firm. The bank is subject to moral hazard due to deposit insurance and maximize the discounted value of its profits. Every period, it faces a random capital position as profits depend on the realizations of returns on their loans and makes a new portfolio choice. Calem and Rob calibrate the model using empirical data from the U.S. banking industry for 1984-1993. Then, they analyze the impacts on bank risk-taking of increased fixed and risk-based capital requirements.

Calem and Rob find a U-shaped relationship between the amount of risk a bank undertakes and the bank's current capital position. A severely undercapitalized (with respect to the regulatory minimum) bank typically takes on maximal risk in an effort to improve its capital position, even if the asset is inefficient. This result suggests that moral hazard is a serious problem among banks near to insolvency. Less undercapitalized banks pursue a more

conservative investment strategy. Well-capitalized banks will take on more risk as they are more remote from bankruptcy and riskier assets yield a higher expected return.

In the case of an increase of the flat capital requirement, well-capitalized as well as severely undercapitalized banks will take on additional portfolio risk. Less undercapitalized banks, on the other hand, will react little to the increase in capital requirements. The model suggests that an increased risk-based capital standard is analogous to a higher flat standard, if the risk-based rule is not too stringent. If the risk-based rule is sufficiently stringent, however, raising the standard will have a moderating impact on risk-taking.

In *Furfine (2000)*, banks also maximize the present discounted value of future profits less costs. Costs are incurred in the form of adjustment costs (costs if the bank adjusts the growth of its loan portfolio over time at a rate different from what is dictated by its loan demand), costs of issuing equity, and costs incurred through their capital position (i.e. real costs due to regulatory sanctions if the bank fails to meet the capital requirements). Nonlinear relationships between bank capital levels and lending are derived from the model. Furfine also estimates his model using panel data on large U.S. commercial banks from 1989 to 1997. Using simulations, he predicts that an increase in the flat capital requirement leads to a decrease in the level of both loans and securities by approximately the same percentage. An increase in the risk-based capital requirement, in contrast, leads to a decrease in the level of loans and a shift towards a less risky portfolio.

2.9   Summary of the theoretical literature

Theories related to banks' choice of risk and capital levels suggest that risk and capital decisions are simultaneously determined and interrelated. Taxes, bankruptcy costs, agency costs, and signaling considerations may be determinants of the optimal capital structure. Besides, banks may have an incentive to increase portfolio risk and/or leverage due to moral hazard resulting from incomplete contracting and/or hidden action together with limited liability and deposit insurance. Countervailing effects may come from managerial risk aversion, and dynamic considerations such as the loss of the bank's charter value in case of bankruptcy. Competition also plays a role via its impact on bank rents.

Capital regulation influences the bank's decision by acting as a constraint to their optimization. But capital requirements may even have an impact on banks in excess of the minimum capital level because banks may consider the probability of falling below the minimum

capital levels. This in turn would mean extra costs in the form of being closely monitored by regulatory authorities which may impose additional constraints on the bank.

The literature provides contradicting implications for the response to increasing capital requirements. Many models indicate that *flat capital regulation* could lower the probability of failure due to higher capital buffers. Some authors, on the other hand, suggest flat capital regulation may have an unintended effect such that banks will increase their portfolio risk. This may even overcompensate the positive effect of a higher capital buffer so that the probability of failure rises. Moreover, forced recapitalization of capital constraint banks may lead to falling share prices of these banks so that even the capital buffer decreases. In contrast, *risk-based capital regulation* could eliminate adverse incentive effects. However, this result crucially depends on the correct risk-weights. However, determining market based risk-weights may be difficult or even impossible. Information theories suggest that a primary rationale for the existence of banks is that they have an information advantage in monitoring firms. Hence, the market values of bank assets are not directly observable. Thus, market-based capital regulation cannot readily be imposed on banks. A related point is the fact that a large part of bank assets are non-marketable loans. In the light of increasing securitization, this argument may, however, lose relevance (see Rochet (1992)). But incorrect risk-weights may allow for asset substitution and, thus, provide new risk-increasing incentives.

In summary, the theoretical literature on bank risk-taking, capital structure and capital regulation is vast and comes to contradicting results. Furthermore, the modeling framework itself is often subject to criticism. In the case of portfolio models for instance, Keeley and Furlong (1990) note that variance alone is an inappropriate measure of risk for truncated, skewed distributions such as that for equity when bankruptcy is possible. These theoretical flaws lead to a mischaracterization both of the risk-return frontier absent capital regulation and the shift in the risk-return frontier due to capital regulation. To decide which of these theoretical models have any implications for real banks, they have to be tested empirically.

3 Empirical literature

In this chapter, we review the empirical bank literature which may give implications for the optimal capital structure, risk-taking, and interaction with regulation and supervision. We start with a presentation of the most extensive strand which studies the relationship between capital and risk under different regulatory regimes (flat and risk-based capital regulation). Then, we continue with more specific studies on questions concerning the impact of deposit insurance,

charter value, and ownership structure on bank risk-taking. We finish off with a review of stock market reactions to recaptialization.

3.1   Studies on the relationship between capital, risk, and regulatory pressure

Most authors try to explain changes in risk and capital in a partial adjustment model.[15] Changes in risk and capital are assumed to depend on two components, one discretionary and an exogenously determined random shock.[16] The endogenous components are proportional to the difference between a banks target level of risk (capital) and the risk (capital) level at the beginning of the period. The target levels of risk and capital depend on exogenous variables such as the market interest rate, the degree of tax advantage of deposit relative to equity finance, and the degree of regulatory pressure as well as, for simultaneous equations models, capital and risk respectively.

3.1.1. Studies on fixed capital requirements

Before the early 1980s, US regulation could be characterised by a peer group approach which means that supervisors orientated themselves at the average bank balance sheet. **Marcus (1983)**, who tries to explain the decline in capital to asset ratios in U.S. commercial banks between 1965 and 1977, confirms the peer group theory of regulatory pressure. This implies that when all banks suffer capital losses (for example, from a rise in the interest rate), the increase in regulatory costs for a particular bank is much smaller than it would be if that bank alone lowered its capital. Drops in capital common to all banks do not induce regulatory review of any particular bank and consequently do not require banks to readjust capital.

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[15] To understand the reason why changes in capital and risk are explained rather than absolute levels, let us assume a mean-variance framework such as in Kim and Santomero (1988). Banks with relatively low risk aversion will then choose relatively high leverage and relatively high asset risk. We would, thus, expect to observe a negative cross-sectional correlation between the level of asset risk and capital ratios due to cross-sectional variation in risk preferences. Hence, in order to test the theories discussed above which have different implications for how individual banks adjust capital to changes in risk (and vice versa), it is necessary to analyze the relationship between changes in risk and changes in capital.

[16] Hart and Jaffee (1974) and Marcus (1983) point out that changes of risk and capital are the result of exogenous shocks and discretionary behavior. This problem must be dealt with to empirically model the interrelation between bank capital and risk decisions. With respect to capital, "exogenous" changes can be the result of enforced increases in capital required by regulators, unanticipated changes in earnings caused by fluctuations in operating income or loan values which affect loan loss allowances. With respect to risk, exogenous changes could be the result of unanticipated shocks to the national or local economy, such as changing characteristics of loan demand in the bank's market area, or volatility in the value of loan collateral such as real property.

During the early 1980s, minimum capital-asset ratio requirements replaced the earlier peer group type of capital regulation. Using the same methodology, **Keeley (1988)** studies the effect on the capital positions of the 100 largest bank holding companies. He finds that the regulations succeeded in causing banks with low capital ratios to increase their book value capital ratios both absolutely and relative to banks with initially high capital ratios, and that banks did so primarily by slowing asset growth.

While Marcus and Keeley did not consider risk-taking, **Shrieves and Dahl (1992)** analyze the relationship between changes in bank capital and changes in portfolio risk for the US banking-sector in the mid-eighties. They refine the Marcus' methodology by using a two-stage simultaneous equation estimation, thereby taking into account that banks simultaneously determine capital and risk levels.[17]

Shrieves and Dahl find evidence for a positive relationship between bank capital and risk-taking. The fact that this held true even in banks which were in excess of the minimum regulatory capital requirement supports the conclusion that the positive association between risk and capital of such banks is not strictly the result of regulatory influence. It rather reflects the view that risk-taking behavior tends to be constrained by bank owners' and/or managers' private incentives. Target capital levels and rates of adjustment of capital were higher for banks presumed to be under regulatory pressure due to low capital levels. This indicates that capital regulation was at least partially effective for banks with low capital levels. The results suggest that banks will tend to offset regulatory induced capital increases with increases in asset risk unless constrained from doing so by the regulatory apparatus.

3.1.2. Studies on risk-sensitive capital requirements

Avery and Berger (1991) analyze the risk-based capital (RBC) standards using data on U.S. banks from 1982 to 1989. They assess the association between bank performance and the RBC relative risk-weights and compliance with the RBC standards. To do so, they regress several measures of bank performance, including bankruptcy, on the lagged proportions of bank portfolios in each of the risk categories defined by the RBC standard. They find that banks with higher ratios of risk-weighted assets to unweighted assets have poorer predicted performance. Comparing the RBC standard with the former flat capital requirements, both standards seem to

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[17] Shrieves and Dahl argue that major determinants of the risk of a bank's asset portfolio include the allocation of assets among risk categories and the quality of the assets in the loans component of the portfolio. Thus, they use two risk measures, the composite measure of asset risk adopted by regulators in risk-based capital guidelines and the ratio of non-performing loans to total loans. Support for these measures can be found in Chessen (1987) and Keeton (1989) for the composite measure and in Meeker and Gray (1987), Beaver et al. (1989), and Nejezchleb and Morgan (1990) for non-performing loans.

have independent information in predicting future bank performance problems, but that the new standards have more information. However, Avery and Berger find several instances in which the risk weights for specific categories appear to be out of line with the performance results. The degree to which banks fail the new standards is found to be a good predictor of future performance problems, lending support to prompt corrective action policies to take action against banks based on the degree to which the standards are violated. Surprisingly, the degree to which banks exceed the standards is not found to predict better future performance.

Between 1989 and 1993, banks shifted their portfolio towards low-risk assets. For instance, while in 1989 U.S. banks held only 15 percent of their total loans in government securities, by 1993, this share had risen to 22 percent. ***Haubrich and Wachtel (1993)*** apply an analysis of variance to study the question whether this dramatic shift in bank portfolios can be attributed to the new risk-based capital accord (Basel I) which were agreed upon in 1988 and gradually being phased in until 1993. Their findings suggest that the implementation of Basel I caused poorly-capitalized banks to reconfigure their portfolios away from high-risk assets and towards low-risk assets.

By using the same methodology as Shrieves and Dahl,[18] ***Jacques and Nigro (1997)*** examine whether their results are changed under risk-based capital standards. They study the relationship between bank capital portfolio risk, and the risk-based capital standards for US banks in the first year the Basel Accord was in effect (1991). Jacques and Nigro find that the risk-based capital ratios led to significant increases in capital ratios and decreases in risk exposure both for risk-based capital-constrained and unconstrained banks. Although the overall results suggest that the risk-based capital standards played a significant role, the banks' responses showed surprisingly little connection to the degree to which the banks fell short of the standards. This result of a negative relation of changes in capital ratios and risk is in contrast to the positive relation found by Shrieves and Dahl (1992).

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[18] While Jacques and Nigro measure capital in a similar way as Shrieves and Dahl, they, however, argue that both risk components (the allocation of assets across risk categories and the quality of its loans) are captured by the risk-weighted asset to total asset ratio. Avery and Berger (1991) and Berger (1995), however, argue that this ratio is only positively correlated with risk. Jacques and Nigro also refine the regulatory pressure variable. They assume that banks may respond differently depending on whether they are x% in excess of required capital or x% in shortage of required capital. Similar to McManus and Rosen (1990), Jacques and Nigro account for this nonlinear relationship by splitting regulatory pressure into two variables, one relating to banks in excess of capital and the other relating to capital-constrained banks

Using the same framework,[19] ***Aggarwal and Jacques (1998)*** investigate the impact of the prompt corrective action (PCA) provisions on bank capital ratios and portfolio risk levels. The Federal Deposit Insurance Corporation Improvement Act of December 1991 had defined a series of capital thresholds used to determine what supervisory actions would be taken by bank regulators. Aggarwal and Jacques find that both adequately capitalized and undercapitalized banks increased their capital ratios and lowered portfolio risk in response to PCA during both the announcement period 1992 and the first year the standards were in effect (1993). The speed with which banks adjusted these variables was higher for 1993 than for 1992. These results suggest that PCA has been effective in getting both undercapitalized and adequately capitalized banks to increase their capital ratios without an offsetting increase in portfolio risk.

Ediz, Michael, and Perraudin (1998) study the U.K. banking sector from 1989 to 1995. This paper is one of the rare studies of European banks. The authors analyze whether pressure by supervisors affect bank capital dynamics when capital ratios approach their regulatory minimum (trigger) and how banks adjust their capital ratios when subject to regulatory pressure. They study the change in capital ratios within a dynamic, multivariate panel regression model which is very similar to the model used by Shrieves and Dahl.[20] With respect to their first question, Ediz, Michael, and Perraudin (1998) find that capital requirements induce banks to increase their capital ratios even after one allows for internally generated capital targets. With respect to their second question, they conclude that banks do not significantly rely on asset substitution away from high-risk-weighted assets to meet their capital requirements as they approach the regulatory minimum. Instead, the regressions suggest that the adjustment comes through increases in narrow capital (Tier 1). The adjustment to higher capital requirements that occurs when banks are close to their triggers is more evenly spread across the two categories of capital.

By applying the Shrieves and Dahl methodology, ***Rime (2001a)*** analyzes adjustments in capital and risk of Swiss banks when they approach the minimum regulatory capital level. Switzerland is interesting insofar as Swiss capital requirements might be more risk-sensitive as the Basel Accord as they stipulate a larger number of risk classes. Furthermore, regulatory pressure might be stronger in Switzerland than in the US as a breach of the guidelines rapidly leads to the closure or to the take-over of the bank. Rime found the same empirical evidence for

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[19] The explanatory variables are very similar to those used by Shrieves and Dahl (1992) and Jacques and Nigro (1997), with the exception that regulatory pressure is measured using dummy variables to signify the bank's PCA zone.

[20] Regulatory pressure is captured by two measures. First, a dummy variable is introduced which equals one if the bank has experienced an upward adjustment in its trigger ratio in the previous three quarters. Second, another dummy is included that equals unity if the risk-asset ratio falls close to the regulatory minimum to allow for a regime shift. This study is therefore comparable to Jacques and Nigro (1997).

Switzerland as Ediz, Michael, and Perraudin for the U.K.. This is that regulatory pressure induced Swiss banks to increase their capital, but did not affect the level of risk. A plausible explanation for the relative rigidity of Swiss banks' portfolios is the lower liquidity of assets due to a less developed market for small banks stocks and the absence of a market for asset-backed securities.

3.1.3. Studies within the option pricing framework

This strand of the literature is reviewed in an own subsection because it applies a very different methodology compared to the studies just surveyed.

Furlong (1988) studies how the default risk of large U.S. bank holding companies changed in the pre-Basel period from 1975 to 1986. His approach builds on the insights of the option pricing theory that the equity market capitalization of a bank may be regarded as the value of a call option written on the bank's underlying asset value with deposits being interpreted as the option's strike price. Furlong then infers the volatility of the asset values by inverting the Black and Scholes call option pricing formula. He finds that asset risk measured in this way actually doubled in 1981-1986, the part of his sample in which banks faced capital requirements, compared to the earlier period. It appears that the large increase in asset risk more than offset the improved capital positions thereby increasing default risk. However, the increase in asset risk was not more pronounced for capital-deficient than for well-capitalized banks.

Sheldon (1996) performs a similar analysis for 219 G-10 banks over the period 1987 to 1994 in which the Basel regulations came into force. He studies the risk-seeking effects of the implementation of the new risk-based capital standard. His results suggest that asset volatility in US banks rose irrespective of whether the banks increased their capital. In Japan, asset volatility fell although most banks raised their capital ratios. Sheldon's results provide little evidence that the implementation of the Basel guidelines increased the probability of bank failure.

The problem with these two studies is that neither Furlong nor Sheldon controlled for the host of other influences which might have affected risk-taking in the sample periods. Besides, the assumptions of the Black and Scholes formula concerning the underlying probability distribution may be problematic as well.

3.2 Studies on moral hazard due to deposit insurance

There is an extensive empirical literature which confirms the adverse incentive effects of deposit insurance. For instance, **Thies and Gerlowski (1989)** and **Wheelock (1992)** find for the US

banking sector that risk-taking and probability of failure are increasing in deposit insurance. Similarly, **Demirgüç-Kunt and Detragiache (2000)** find in a sample of 61 countries that over a period from 1980-1997, deposit insurance significantly increased the probability of a banking crisis. The adverse impact of deposit insurance on bank stability was stronger where bank interest rates were deregulated (suggesting also that high bank charter values can alleviate moral hazard). The authors also find that in countries where bank regulation and supervision is of poor quality, moral hazard due to deposit insurance is higher. Unfortunately, they assess quality by some general measures of the institutional environment and do not take capital regulation explicitly into account.

The findings by **Gropp and Vesala (2001)** stand in contrast to these former empirical results. They study the relationship between deposit insurance, debt-holder monitoring, bank charter values, and risk-taking for European banks. They find that the introduction of explicit deposit insurance reduces the risk-taking of banks. Gropp and Vesala explain their counterintuitive result by the expectation that in the absence of deposit insurance, a public bailout would save banks in time of distress. The establishment of an explicit deposit insurance system then actually limits the scope of the safety net. This result implies that the belief of the depositors in a public bailout is sufficient for moral hazard of banks. They also find that banks with lower charter values reduce risk taking more after the introduction of explicit deposit insurance. This supports the mitigating effect of charter value on moral hazard. The authors also show that large banks do not change their risk-taking in response to the establishment of deposit insurance. This suggests that the introduction of explicit deposit insurance does not alleviate "too-big-to-fail" problems.

While empirical research provides evidence for moral hazard due to the public safety net, it does not seem to show that banks in general maximize the put option value. First, a study by **Keeley (1988)** provides evidence that many banks hold substantially more capital than the required amounts. And second, other researchers have found that for many banks, the value of the deposit insurance option is less than its price (see Marcus and Shaked (1984), Ronn and Verma (1986), and Pennacchi (1987)). Moreover, for most of its 50-year history, the insurance system has been characterized by low failure rates and low payouts, just the opposite of what might be expected if banks were maximizing the value of the put option successfully. However, during these 50 years, the banking sector was mostly highly regulated. The fact that the savings and loans crisis occurred just after a period of extensive deregulation suggests that high charter value may have effectively counterbalanced the negative incentive effects due to deposit insurance (see next paragraph).

3.3   Study on the impact of charter value

As moral hazard due to fixed-rate deposit insurance fails to explain the sudden increase in bank problems in the 1980s, *Keeley (1990)* tests the hypothesis that increases in competition caused bank charter values to decline. This in turn caused banks to increase default risk through increases in asset risk and reductions in capital. His empirical results are consistent with this hypothesis. Banks with more market power, as reflected in larger market-to-book asset ratios, hold more capital relative to assets (on a market-value basis) and they have a lower default risk as reflected in lower risk premiums on large, uninsured certificates of deposit. Thus, at least some of the increase in bank problems may be due to a general decline in the value of bank charters associated with increased competition within the banking industry.

3.4   Study on the impact of ownership structure

Saunders, Strock, and Travlos (1990) provide empirical evidence for the impact of ownership structure and deregulation on bank risk-taking for bankholding companies over the period 1978-1985. Using a cross-section time-series regression, they explain risk (using several different capital market risk measures) by the ownership structure, the regulatory environment, and other bank specific variables. Their results suggest an agency problem between managers who also hold capital of the bank (insiders) and outside investors, who only hold capital without being managers. Bank loan portfolios seem to be less risky when insiders own a sufficient fraction of the bank's equity and more risky when banks are controlled by their outside stockholders. Besides, the authors find that risk-taking differences between stockholder and managerially controlled banks become more transparent in periods of deregulation. This also suggests that high bank charter values can mitigate moral hazard by stockholders.

3.5   Studies on the stock market response to recapitalization

Keeley (1989) examines differences in stock price reactions following voluntary capital injections by commercial banks and involuntary recapitalizations required to meet regulatory capital requirements. His study covers U.S. bank holding companies in the period from 1975 to 1986. He finds a significant drop in the share price of capital-constrained banks after the recapitalization announcement while for well capitalized banks, the stock price did not show a similar behavior.

In a comparable analysis, ***Cornett and Tehranian (1994)*** study the U.S. banking sector from 1983 to 1989. While they also find that announcements of equity issues by banks that appear, by regulatory standards, to be undercapitalized result in stock return declines, stock return declines associated with voluntary common stock issues appear to be even significantly greater. Their findings also indicate that this drop in the stock return is the greater, the greater is the relative size of the recapitalization. This can be explained by the drop in the deposit insurance subsidy. In addition, Cornett and Tehranian find that insider ownership is also significant in explaining the size of the decline in return. The greater the insiders' holdings, the smaller the decline.

Despite the contradicting results for well capitalized banks, the drop in share prices which both studies have found may indicate that this fall can be an issue with respect to the regulator's aim of limiting the probability of failure.[21]

Laderman (1994) finds that between 1989 and 1992, U.S. bank holding companies faced a significant decrease in stock returns if they issued new common stock. This negative shareholder wealth effect discouraged new common stock issuances and, thus, forced bank holding companies deficient in Tier 1 capital to meet the risk-based standards by decreasing loans outstanding. This effect was less pronounced for bank holding companies deficient in other types of capital.

3.6   Summary of the empirical literature

The empirical literature suggests that banks have an incentive to increase leverage and/or portfolio risk due to tax advantages of deposit financing, the possibility to signal the bank's true value, and moral hazard induced by the public safety net. Managerial risk aversion, on the other hand, may keep this moral hazard under control. The same is true for charter value. This assigns a significant role for competition, interest rates, and the ownership structure.

Capital regulation seems to be able to influence bank behavior. The stricter the control, the greater is the impact. Supervision, thus, seems to play an important role. Under fixed capital requirements, banks raise capital levels and slow asset growth to comply with the regulatory

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[21] Cornett and Tehranian have a larger sample and cover a period in which required capital injections were subject to stated capital ratios and not to discretionary decisions by regulators. Thus, their result of a drop of the share prices even for well capitalized banks may be more reliable. They explain their findings by support of Ross' signaling theory. Only voluntary capital issuances carry information on the true value of the bank. Thus, the fall in stock returns is larger in the case of voluntary capital injections.

pressure. However, banks appear to have the adverse incentive effect to compensate for the rise in capital by increasing portfolio risk.

The picture, however, is more heterogenous under risk-based capital requirements. To comply with the new standard, banks seem to increase their capital levels. Banks now also have the possibility to decrease portfolio risk. For this decision, institutional differences seem to play a role. While U.S. banks decreased risk, the new regulatory framework did not have an effect on the Swiss banks' risk-taking. As there is no evidence that it is cheaper to recapitalize in Switzerland, an alternative explanation could be that portfolio adjustments are more expensive. This argumentation is supported by the lower liquidity of assets due to a less developed market for small banks stocks and the absence of a market for asset-backed securities in Switzerland. Another reason could lie in the fact that in the U.S., the share of capital which is held by insiders is higher. Finally, Hancock and Wilcox (1993) present evidence that U.S. banks' own internal capital targets explain the decline in private sector lending better than do the capital requirements imposed by regulators. This is in contrast to the reviewed papers (see also Hall (1993), Calem and Rob (1996), Lavin, Griswold, and Karels (1996)[22], and Thakor (1996)) which claim that capital requirements played a role in the decrease of portfolio risk.

These empirical results should, however, be treated with caution. Most of the studies use book instead of market values. Market values would be desirable as theory refers to market values. But especially for assets, they are often not available. Measuring risk is also problematic especially for banks which do not have frequently traded securities. Thus, the used risk measures are only a very simplification of reality.

4 Implications for future research

With many questions unanswered, there is still a lot to do for future research. The present survey shows that papers often study one particular aspect, but fail to show the interactions with other effects. More complex papers might be more successful in explaining the observed differences among countries. Furthermore, the corporate finance literature has failed to give quantitative implications for the capital structure. A principle obstacle to develop quantitative models has been the valuation of corporate debt. But recent progress in this field has been made. Combining this strand of the literature with corporate finance may prove valuable (see Leland (1998) for first

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[22] Lavin, Griswold, and Karels (1996) found, in a survey of 205 banks, that 37% of the sampled banks raised their capital-asset ratio over the period 1989-1994, and that 46% of that group attributed the increase to the risk-based capital standards.

attempts). Besides, the analysis in the literature of the implications of bank recapitalization for regulation has been only cursory. Approaches similar to that of Leland (1993) may be useful in future recapitalization analyzes.

Compared to the literature which studies the capital structure of a firm, the theory of a bank's capital structure is underdeveloped. ***Diamond and Rajan (2000)*** have just presented a model which simultaneously rationalizes the asset and the liability side of banks. In their model, greater capital reduces the probability of financial distress, but also reduces liquidity creation. The quantity of capital influences the amount the bank can induce borrowers to pay. Optimal bank capital, thus, trades off effects on liquidity creation, costs of bank distress, and the ability to force borrower repayment. Risk and capital will, therefore, be positively related. A rise in the binding capital requirement renders the bank safer, but also increases the bank rents, reduces the amount the bank can pledge to outsiders, and raise the bank's effective cost of capital. But in this framework, capital requirements also have more subtle effects such as changing the bank's horizons, distributional effects and the possibility of a bank run. Thus, capital requirements affect the flow of credit and can even make the bank riskier. Further research along these analytical lines may prove valuable.

The implications of the coexistence of the standard and the internal ratings based approach of Basel II for the distribution of risk-taking may also be worthwhile studying (see Rime (2001b)). Besides, the literature has mostly used the variance as the only risk measure. But it is impossible to capture risk in only one number. Besides, the normality assumption has been most prominent although the empirical evidence hints at fat tail distributions. The literature will thus have to consider more complex risk measures to give more realistic implications.

With regard to the empirical literature, studies of the EU banking sector have been very rare. The reason for this is mostly lacking data. This should, however, encourage researchers to set up new data bases. It could also turn out to be valuable to study why European banks respond to the Basel Accord so differently from U.S. banks. The last point I want to make within this listing is the role of capital regulation itself. Although the risk-based capital accord seems to solve some of the previous adverse incentive problems, risk-weights will not be able to measure the whole risk incurred by taking this asset into the portfolio. Thus, the role of banking supervision is crucial in limiting the moral hazard of banks especially in times of increasing competition. This role is even more important as capital regulation seems to be the most accepted regulatory instrument and additional asset regulation or deposit rate controls seem unlikely to be reintroduced. Thus, the theoretical and empirical literature should further analyze the interaction between capital regulation and supervision, especially aspects of asymmetric information between banks, regulators, and supervisors, the supervisor's monitoring ability, and his incentives.

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