Market Structure, Monitoring and Capital Adequacy Regulation

THOMAS GEHRIG*

1. INTRODUCTION

Are capital adequacy rules effective instruments to contain bank failure risk? In the light of intensifying (international) competition within the banking industry and between banks and capital markets this question receives increasing relevance.

The recent developments in the process of international harmonization of banking regulation, especially those that are related to capital adequacy regulation, seem to build on the conviction that capital rules will in fact contribute to the safety and soundness of the banking industry and financial markets more generally (COOKE, 1991, CROCKETT, 1995). This underlying conviction is supported by the widespread view that indeed capital regulation is an effective instrument in constraining banks' appetite for risk (MERTON, 1977, DEWATRIPONT, TIROLE, 1993). This view finds empirical support, e.g. in the US experience of the savings and loan institutions which on aggregate have taken massive risks after their balance sheets had turned unprofitable. Indeed, capital regulation may be an effective instrument in constraining *asset-substitution* moral hazard, or, in its extreme form, gambling for resurrection.

However, it has also been noted that capital regulation may have quite perverse effects on banks' monitoring incentives.[1] Capital rules may force insiders to dilute their ownership rights. To the extent that insiders have to incur private effort in screening and monitoring their loan portfolio, dilution of ownership rights may reduce the incentives of inside equity holders to (properly) monitor loans. Hence capital regulation may reduce the monitoring intensity of capital constrained banks and consequently result in riskier loan portfolios. Thus, paradoxically, capital regulation can increase bank failure risk even in the absence of any riskshifting activities.[2] This is a consequence of a version of *effort-aversion* moral hazard (JENSEN, MECKLING, 1976).

* Institut für Volkswirtschaft, Petersgraben 51, 4003 Basel, Switzerland Tel.: +41-61-267 3379. I would like to thank ARNOUD BOOT, the discussant, NIKLAUS BLATTNER, CHARLES GOODHART and EVA TERBERGER for their comments as well as seminar participants at the University of Munich. Financial support of the Schweizerischer Nationalfonds under grant 12-39248.93 is gratefully acknowledged.

1. See e.g. BOOT, GREENBAUM, 1993.
2. Also KAHANE (1977), KOEHN and SANTOMERO (1978), GENOTTE and PYLE (1991) and BESANKO, KANATAS (1993) emphasize the potentially destabilizing consequences of capital regulation.

Which effect is more relevant? Of course, pure armchair reasoning will not help to decide the issue and empirical work is called for. However, theory would help to predict that the relative importance of asset-substitution moral hazard relative to effort-aversion moral hazard should also be related to market structure, or more generally, to the intensity of competition. In oligopolistic markets asset substition seems much less problematic than in fairly competitive markets (GEHRIG, 1995). Accordingly, one would expect that an increase in capital requirements would affect banking behaviour particularly in competitive markets. On the other side, in competitive markets there is little scope for dilution, and capital requirements would seem to have little effect on monitoring intensity. Capital regulation, however, might seriously affect monitoring behaviour in oligopolistic markets with sizeable rents.

This discussion suggests that the effects of capital requirements should not be analyzed independently of market structure considerations. In different economic environments different forms of moral hazard may call for different forms of prudential concerns. For example, the recent difficulties of the banking industry in the US, the Scandinavian countries, and Switzerland may have to be attributed to quite different sources of market failure. Therefore, in this paper I analyze the interaction between market structure, monitoring incentives, and bank failure risk within a simple model of an imperfectly competitive banking market. Thus I can analyze the likely consequences of capital rules on equilibrium in the loan market and on banks' (individual) insolvency risk for a given market structure.

The model formulates monitoring in the specific form of screening, or ex-ante monitoring. In a first stage banks screen potential applicants. This screening activity is imperfect and requires personal effort. Perfect screening is prohibitively costly. Accordingly, banks will never choose a perfect screen and accept errors of two types. They will reject creditworthy borrowers and accept unworthy borrowers. However, they can reduce the probabilities of these two types of errors by investing in screening-effort. In a second stage banks advance loans to creditworthy borrowers. Competition at this stage is imperfect as borrowers incur transaction costs, which take the form of transportation costs in the chosen model.

It turns out that the rewards from monitoring decrease upon the imposition of capital requirements. Accordingly, banks' loan portfolios deteriorate and bank failure risk may rise when capital requirements are increased. Banks need to provide larger provisions for bad loans and raise lending rates accordingly. Furthermore, the provisions turn out to be proportional to the risk free rate and, therefore, behave procyclically. Consequently, capital requirements exhibit adverse business-cycle properties. The wedge between lending and risk free rate, and, therefore, also the volatility of lending rates increase as market conditions become more competitive in the loan market.

Furthermore, the model suggests a complementarity between prudential regulation and market structure regulation. A symmetric equilibrium has the feature that the monitoring intensity under free entry may be much lower than in an oligopolistic context. Therefore, in a competitive environment the costs of lending may actually be higher than

in an oligopolistic context. This occurs since lending rates reflect both, an oligopoly premium, and a premium for bad loans. In a competitive environment the premium for bad loans exceeds the oligopoly premium in an oligopolistic context. In addition, in a competitive environment one might expect a higher rate of bank failures because banks enjoy lower rents which may serve as buffers against adverse shocks.

Data on the Swiss banking industry (Figures 1 and 2) reveal that loan provision have increased significantly during the recent decades of intensifying competition. Since SHELDON (1996) finds little evidence of riskshifting in Switzerland the effort-aversion explanation should be taken serious for at least some European banking markets.

The paper unfolds as follows. Section 2 discusses the Swiss evidence on bad loan provisions. Section 3 provides the basic model and explains the monitoring technology. Sections 4 and 5 analyze the banks' monitoring and lending decisions respectively. The relation between aggregate risk and bank failures is discussed in section 6. Section 7 analyzes the effects of capital adequacy regulation and section 8 concludes.

2. BAD LOAN PROVISIONS OF THE SWISS BANKING INDUSTRY

Since the 1970's the Swiss banking industry at large experiences a continuous increase in provisions and losses. Figure 1 relates aggregate provisions and losses to interest revenues for the aggregate industry.[3] This statistic is taken as a crude measure for bad loan provisions and loan losses. Unfortunately, more informative data are not available. However, under the hypothesis that provisions and losses largely relate to credit activities the published data are of some use.[4] This hypothesis seems reasonable and applies to a subset of individual banks.

Figure 1 reveals that provisions and losses did continuously increase relative to interest margins.[5] This could be explained by an increase in the intensity of competition in the banking industry that exerts pressure on interest margins. However, also the ratio of provisions and losses relative to gross interest income, a measure of the volume of lending, results in a similar pattern (Figure 2).[6]

3. The data are own calculations based on Schweizerische Nationalbank, 1996, table 40. Figure 1 provides the ratio = col. 20 / (col.4 +col.5).
4. Otherwise one would have to explain the relative increase in provisions and losses from trading activities.
5. The reliance on accounting data that are liable to short-run smoothing activities does not materially affect the results since a long-run phenomenon is described.
6. Figure 2 is based on Schweizerische Nationalbank, 1996, table 40. It provides the ratio = col. 20 / col.2.

Figure 1: Relative Bank Losses – Swiss Banks

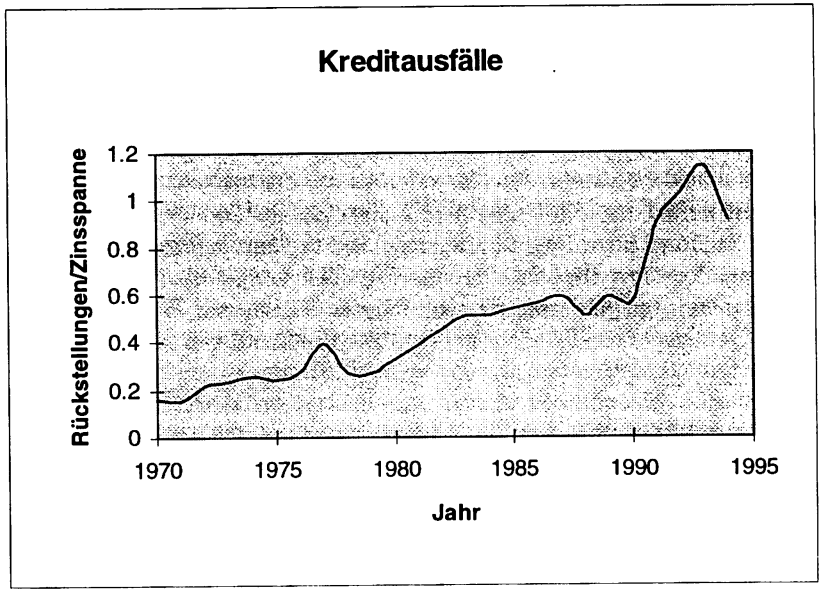
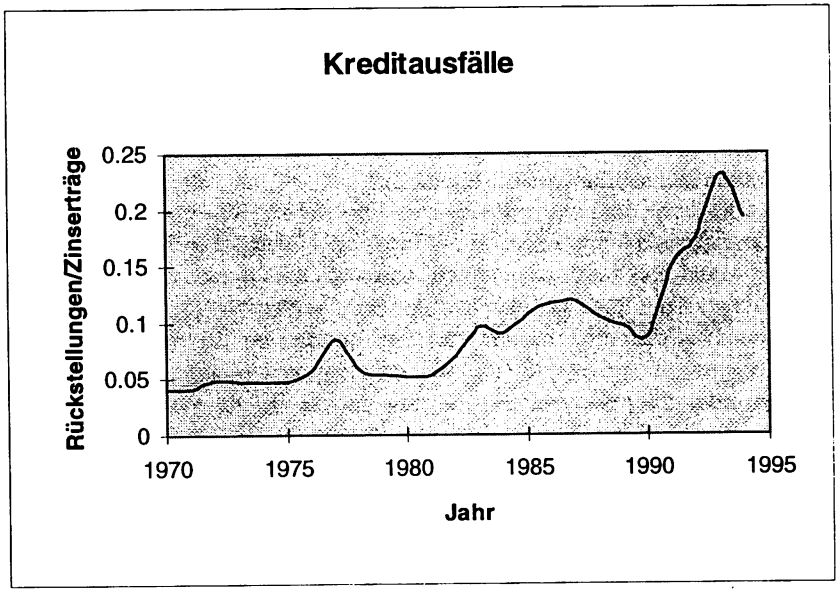


Figure 2: Relative Bank Losses – Swiss Banks



Apparently, banking has become riskier also in Switzerland. This development undoubtedly is a consequence of intensified (international) competition. But why did competition not merely affect bank profits but also the quality of bank assets? Have Swiss bankers changed their attitude towards risk or did they reduce their credit monitoring activities? Clearly, these are challenging questions that cannot be answered on the basis of the published data. For a small subset of Swiss banks, however, SHELDON (1996) seems to find some evidence against significant risk-shifting behaviour. Under such circumstances it would seem that competition did negatively affect the monitoring of loans in recent decades. The sequel provides a discussion of the relation between market structure and monitoring incentives.

3. A MODEL OF THE BANKING INDUSTRY

As delegated monitors banks perform an important economic function in the production of information about investment projects. According to DIAMOND (1984) banks are transaction-cost minimizing institutions in a world where state verification is costly and occurs ex-post. In contrast, this paper concentrates on the initial screening of loan applications in the form of creditworthiness tests. In a world with good and bad projects creditworthiness tests produce information about the likely type of an applicant and help banks in their lending decision. We only consider firms that have no access to capital markets, since presumably in this market segment the role of banks is socially particularly important. Accordingly, the two sides of the loan market are (small) firms and banks.

Firms

Firms are characterized by a single project which requires 1 unit of funding. A good firm generates a random return $\tilde{x}_g$, which for convenience is characterized by a binary random variate $\tilde{x}_g \in \{x, 0\}$. The good realization $\tilde{x}_g = x$ occurs with probability π. A bad firm will never repay any money, i.e. $x_b = 0$. From this specification it follows immediately that a bank will always want to monitor, when there are sufficiently many bad projects. The restriction to two types of borrowers is not essential for the analysis. What matters is the fact that in the absence of monitoring or screening the bank will loose money on some project types with certainty. Monitoring helps the bank to identify the profitable firms.

Firms are located uniformly along a circle of unit length. Travelling along the circle involves transaction costs (transportation costs) of $t > 0$ per travel unit. The proportion of good firms in each location is $\lambda > 0$, while $1 - \lambda$ is proportion of bad firms in each location. The location model may be interpreted in the purely regional sense but it can also be interpreted as a model of different industrial specializations of firms (and banks). It generates horizontal differentiation across bank customers. The transaction cost

parameter t reflects technological conditions that impede borrower mobility. As the mobility of borrowers increases t declines.

Banks

Banks are the sole providers of funds. There are n banks equidistantly distributed along the circle. The number n captures the market structure in the banking industry. In a regulated market system a regulator determines n directly or indirectly by defining suitable licensing requirements. In a free market n is determined by free entry of banks and the fixed costs F necessary for running a bank.

Banks compete for borrowers by quoting loan rates $r_i \geq 0, i = 1, ..., n$. Since banks cannot observe the borrower's specific location they announce unconditional loan rates. Firms apply to one specific bank at a time.[7]

Before granting loans banks can perform a *creditworthiness test*. Only borrowers that actually pass the test receive a loan at the prespecified rate. Borrowers that fail may have to apply to another bank. The creditworthiness test is costly and banks may prefer to choose the accuracy of the test strategically. Assume that banks can select an intensity variable $m \in [0, 1]$ and call it *monitoring intensity*. The associated costs are given by the cost function $C(m)$. These costs include real resources needed for checking applications and the financial situation of the borrower as well as private effort of the bank management, needed to elicit extra, possibly soft, information about the project quality. Assume that $C(.)$ is strictly convex. Furthermore, monitoring at intensity 0 is costless, i.e. $C(0) = 0$, and monitoring at intensity 1 is extremely costly, i.e. $\lim_{m \to \infty} C(m) = \infty$. Accordingly, banks will always choose imperfect screening at an intensity $m < 1$.

The benefits of screening are twofold. First, screening reduces the probability of erroneously rejecting good projects. Define the conditional probability of accepting a truly good project $\alpha(m) :=$ prob [accept | good]. Accordingly, $1 - \alpha(m)$ is a type-I error of the screening technology. Now assume that screening at intensity 0 is completely uninformative and at intensity 1 is completely informative, i.e. $\alpha(0) = \lambda$ and $\alpha(1) = 1$. Furthermore assume that the screening technology is monotonic, i.e. $a'(m) \geq 0, \forall m$.

Second, screening reduces type-II errors, i.e. the probability of erroneously accepting bad projects. Type-II errors are costly for banks since bad loans are definitely nonperforming. Define $\beta(m) :=$ prob [accept | bad]. In line with the previous convention let $\beta(0) = \lambda$, $\beta(0) = 0$, and $\beta'(m) \leq 0, \forall m$.

7. When transportation costs are high good firms would choose to apply at the most favorable bank first and, if denied, successively try the less favourable banks. As long as banks succeed in attracting relatively more good borrowers than bad, the pool of borrowers deteriorates over time and consequently banks may actually wish not to screen at all in later periods. In the present setup only a single screening period is available.

Thus more intensive screening increases the number of worthwhile projects and reduces the number of bad loans. The assumed technology is rather general. It incorporates the imperfect screening models of BROECKER (1990) and RIORDAN (1993). In contrast to these authors, however, the monitoring decision feeds back to the pricing decision in the loan market. While Broecker concentrates on the strategic pricing decision when banks cannot adjust the filter sensitivity, Riordan concentrates on the strategic choice of filter characteristics that simultaneously determine the probabilities α and β. In this analysis banks select the monitoring intensity strategically and prior to the lending stage.

Banks have access to a large competitive deposit market. Therefore, their funding costs consist of the risk free rate r_0 and a fair risk premium that incorporates the bank's specific failure risk.[8]

Bank managers maximize personal utility, which consists of the dividends of their share of bank equity and the non-pecuniary costs of monitoring. Firms attempt to minimize the costs of funds gross of transaction costs.

4. THE MONITORING DECISION

A bank controlled by insiders maximizes (inside) shareholder value. This consists of revenue from lending and the non-pecuniary cost of monitoring. At stage two, for given lending rates r_i, $i = 1, ..., n$, insiders select a monitoring intensity m_i^* that maximizes the privately perceived revenues of

$$\lambda \alpha (m) (\pi (1 + r_i) - 1 - r_0) - (1 - \lambda) \beta (m) (1 + r_0) - C (m) \qquad (4.1)$$

The first summand summarizes the gains from lending to good borrowers, the second summand describes the losses from bad loans and the last term expresses the effort costs of monitoring at the given intensity level m.

Note that the optimal monitoring level is independent of the bank's market share in the loan market. This happens since, by assumption, at the monitoring stage there is no competition for borrowers any more. At this stage screening of applications essentially serves the purpose of controlling the costs of lending. Also, in a subgame perfect Nash equilibrium lending rates are independent of the monitoring intensity of rival banks.[9] Thus under the conditions of Result 1 existence of equilibrium at the monitoring stage can be established.

8. See YANELLE (1989) and GEHRIG (1996) for discussions of the complications that may arise when also competition for deposits is imperfect.
9. Naturally, the correct anticipation of non-optimal monitoring behaviour of rival banks will affect a banks lending rate since the monitoring intensity determines the marginal costs of the lending activity. As long as banks screen at optimal intensities such beliefs contradict sequential rationality.

Result 4.1 (Equilibrium at the Monitoring Stage)

a) *If* $\alpha''(m) \leq 0$ *and if* $\beta''(m) \geq 0$ *an equilibrium exists at the monitoring stage for any constellation of* r_i, $i = 1, ..., n$.

b) *If in addition* $C'(0) = 0$ *any equilibrium at the monitoring stage involves a positive screening intensity* $m_i > 0$ *for all banks* i *with positive lending activity (market share).*

Proof:

a) Under the hypothesis insiders' revenue functions are continous and quasi-concave[10] and the domain of m is a compact set. Hence a standard optimization result applies.

b) This follows immediately from the first-order conditions below that apply for banks with positive market shares and from the boundary conditions $\alpha(0) = \beta(0) = \lambda$.

$$\alpha'(m)\lambda(\pi(1 + r_i) - 1 - r_0) - \beta'(m)(1 - \lambda)(1 + r_0) = C'(m) \tag{4.2}$$

Q.E.D.

Result 4.1 provides sufficient conditions for the existence of an optimum at the monitoring stage. When the costs curve $C(m)$ is sufficiently convex equilibrium can also be established for any monotonic functions $\alpha(m)$ and $\beta(m)$.

The structure of the first-order condition (4.2) is more revealing. It shows that any increase of the profitability of lending improves monitoring incentives. For example, an increase of the success probability of good projects π raises the marginal benefits of monitoring (at given interest rates). Also an increase in the lending rate renders monitoring more attractive. Result 4.2 summarizes.

Result 4.2 (Profitability of Lending)

Let $\alpha''(m) \leq 0$ *and* $\beta''(m) \geq 0$. *Then*

$$D_\pi m^* > 0, D_{r_i} m^* > 0$$

Proof:

The result follows directly from differentiating equation (4.2).

Q.E.D.

10. By the above argument r_i are independent of m_j, $j = 1, ..., n$.

This result implies that oligopolistic rents increase monitoring incentives. Surprisingly, the result holds even when monitoring merely increases $\alpha(m)$ or when it merely decreases $\beta(m)$ keeping the other probability fixed. In other words, as competition intensifies, banks incentives to reduce the cost of lending ($\beta(.)$) fade as well as the incentives to expand lending activities ($\alpha(.)$). This result differs from BROECKER (1990) and RIORDAN (1993) who also show, but for different reason, that increasing competition in the loan market may reduce monitoring activity. While these authors rely on a winner's curse in the screening activity, the present argument emphasizes monitoring incentives of bank management.

Further comparative statics are collected in Result 4.3.

Result 4.3 (Macroeconomic Conditions)

$$\begin{aligned} &\textit{Let } \alpha''(m) \leq 0 \text{ and } \beta''(m) \geq 0. \\ &a)\ D_{r_0} m^* \geq 0 \textit{ iff } \alpha'\lambda + \beta'(1-\lambda) \leq 0. \\ &b)\ D_{\lambda} m^* \geq 0 \textit{ iff } \alpha'(\pi(1+r_i) - (1+r_0)) + \beta'(1+r_0) \geq 0. \end{aligned}$$

Proof:

The result follows directly from differentiating equation (4.2).

Q.E.D.

Accordingly, business cycle conditions affect monitoring incentives. When $\alpha'\lambda + \beta'(1-\lambda) \leq 0$ a marginal increase in the monitoring intensity reduces overall lending. Under such circumstances banks want to increase their monitoring activities as the risk free rate rises. When $\alpha'\lambda + \beta'(1-\lambda) > 0$, however, a marginal increase of the monitoring intensity increases overall lending and banks prefer to reduce their monitoring intensity when the risk free rate is high.

Also changes in the pool of good and bad borrowers have ambiguous affects of the equilibrium monitoring intensity, depending on whether the monitoring gains from good projects exceed the monitoring gains from financing less bad projects, or vice versa.

In the presence of outside shareholders, monitoring incentives of bank insiders are reduced to the extent that the costs of monitoring are non-pecuniary, or private costs of the insiders. Let $\mu \in [0, 1]$ denote the stake of insiders. In this case insiders bear the full cost of monitoring and only earn a proportion μ of the returns on their efforts. Consequently, monitoring incentives are reduced.

$$\mu\left(\alpha'(m)\,\lambda\,(\pi(1+r_i) - 1 - r_0) - \beta'(m)\,(1-\lambda)\,(1+r_0)\right) = C'(m) \qquad (4.3)$$

Accordingly, public equity offerings that increase outside shareholding tend to reduce the monitoring intensity of bank insiders and therefore firm value. This results accords well with the empirical results of CORNETT and TEHRANIAN (1994), who find that equity issues of undercapitalized banks reduce stock prices and, additionally, that the amount of inside ownership determines the size of the price decline. Formally this discussion is summarized in Result 4.4.

Result 4.4 (Inside Ownership)

A uniform increase in outside ownership $d\,\mu_i = d\,\mu$, $\forall i$ *reduces monitoring incentives, i.e.* $D_\mu\, m_i^* > 0, i = 1, \ldots, n$.

The ownership structure affects the monitoring intensity of bank insiders and hence the bank's cost of lending. However, besides determining the marginal costs of lending, the ownership structure has no further effect on the banks' pricing decisions at the initial stage.

5 THE LENDING RATE DECISION

Competition between banks takes place at stage 1 when banks compete for customers by committing to (uniform) loan rates that are contingent on approval of the loan application. When choosing lending rates, banks anticipate rivals' future monitoring choice $m_i^* = m^*$. Result 3 establishes the existence of a symmetric Nash equilibrium with $r_i^* = r^*$, $i = 1, \ldots, n$.

Result 5.1 (Existence of a Symmetric Equilibrium)

When x is large enough a symmetric perfect Nash equilibrium exists. Equilibrium lending rates are

$$r_i^* = r_0 + \frac{t}{n} + \frac{1-\lambda}{\lambda}\,\frac{1+r_0}{\pi}\,\frac{\beta(m^*)}{\alpha(m^*)} \tag{5.1}$$

Proof:

The equilibrium is determined by standard techniques. Consider a bank i that potentially deviates from a candidate symmetric equilibrium with $r_j = r_{-i}$ for $j \neq i$. The corresponding revenue function is

$$\left(\lambda\alpha\,(m^*)\,(\pi(1+r_i)-1-r_0)-(1-\lambda)\,\beta\,(m^*)\;\;(1+r_0)\right)\left(\frac{1}{n}+\frac{1}{t}\,(r_{-i}-r_i)\right) \tag{5.2}$$

Differentiating equation (5.2) and using the symmetry condition $r_i = r_{-i}$ readily demonstrates the Result. The second order conditions are also verified by standard techniques. Q.E.D.

The structure of the equilibrium lending rates is quite intuitive. The first term of (5.1) reflects the bank's *cost of funding* r_0. The second term measures the *oligopoly rent* and the third term measures the *provisions for bad loans*.

Note that with a continuum of borrowers, bank loan portfolios are completely deterministic, and, in the absence of any further source of aggregate risk, banks are completely safe. Consequently, in a large and perfect deposit market depositors charge the risk free rate r_0.

The oligopoly premia is affected by technological conditions t and the market structure n. It is the standard effect of this class of horizontal differentiation models.

The interesting effect is given by the provisions for bad loans. It is precisely this term that responds to changes in the expected monitoring intensity m^*. As screening becomes almost perfect, and $m^* \to 1$, the provisions tend to zero since in the limit no bad loan is made. As the screening activity is low, i.e. $m^* \to 0$, the term attains the maximal value of $\frac{1-\lambda}{\lambda}\frac{1+r_0}{\pi}$. Note that $\frac{\beta(m^*)}{\alpha(m^*)}$ is a declining function of m^*.

Interestingly, the provisions depend on the risk free rate r_0. As the risk free rate varies over the business cycle, also provisions move with the cycle. Accordingly, the wedge between lending rate and risk free rate is a function of the risk free rate (and hence business cycle conditions) and is negatively correlated with the monitoring intensity of the banking sector.[11] Monitoring incentives are affected in an ambiguous way by business cycle conditions. According to Result 4.3, when $\alpha'\lambda + \beta'(1-\lambda) \leq 0$, an increase in the risk free rate r_0 exerts a dampening effect on monitoring, which in fact increases loan provisions even further and invigorates business cycle fluctuations. When $\alpha'\lambda + \beta'(1-\lambda) > 0$ a rise in r_0 induces tighter monitoring which partially offsets, or even overcompensates, the increase in provisions. Hence, properties of the monitoring

11. Since it turns out that the equilibrium monitoring intensity is negatively correlated with the intensity of competition, the model predicts a more volatile behaviour of provisions for bad loans in competitive markets and a smoother behaviour of lending rates in oligopolistic markets for plausible parameter values.

technology do affect management incentives and consequently the propagation of business cylces.

How does market structure affect lending rates? In general, the answer is ambiguous, since an increase in the number of active banks n reduces the oligopoly premia, but at the same time reduces the incentives to monitoring according to Result 4.2. Hence, an increase in n reduces oligpoly rents and increases loan provisions. However, when the intensity of competition is high and the oligopoly premia is small, the indirect effect via the bad loan provisions dominates the oligopoly premia. Likewise the oligopoly effect dominates for sufficiently oligopolistic conditions.

Result 5.2

a) *For given* λ, π, r_0 *there are critical values* $\underline{t}(n)$ *and* $\bar{n}(t)$ *such that* $D_t r_i^* < 0$ *and* $D_n r_i^* > 0, i = 1, \ldots, n$ *for any* $t \leq \underline{t}(n)$ *or* $n \geq \bar{n}(t)$.

b) *For given* λ, π, r_0 *there are critical values* $\bar{t}(n) > \underline{t}(n)$ *and* $\underline{n}(t) < \bar{n}(t)$ *such that* $D_t r_i^* > 0$ *and* $D_n r_i^* < 0, i = 1, \ldots, n$ *for any* $t \geq \bar{t}(n)$ *or* $n \leq \underline{n}(t)$.

Proof:

The Result follows immediately from differentiating equations (4.2) and (5.1).

Q.E.D.

Finally, the degree of outside ownership decreases equilibrium monitoring efforts and thus increases the provisions for bad loans. Accordingly, lending rates are declining in μ.

Result 5.3 (Outside Equity)

An industry-wide (uniform) increase of outside equity increases equilibrium lending rates, i.e. $D_\mu r_i^* < 0$

Proof:

A uniform increase in outside equity uniformly reduces the monitoring incentives in stage 2 according to Result 4.4. Hence, the provisions for bad loans in equation (5.1) increase.

Q.E.D.

If a single bank is forced to attract outside shareholders, the disincentive in monitoring increases its relative costs of lending relative to its competitors. This reduced competitiveness in the credit market creates a further disincentive to monitoring. In this case, the

credit market equilibrium will be asymmetric with the disadvantaged bank charging higher lending rates and serving a smaller market than its immediate neighbors.

6. AGGREGATE RISK AND BANK FAILURES

In the preceding analysis bank failures cannot occur because of the law of large numbers bank portfolios are perfectly diversified[12] and, consequently, the returns in the credit market are deterministic. This ideal world is useful for the discussion of the relation between market structure, monitoring and equilibrium pricing, but it gets rid of the phenomena that are so central for regulatory concern. However, these concerns can easily be accommodated when *aggregate risk* is introduced in addition to the *idiosyncratic*, or project specific risk analyzed so far. Indeed regulators seem to be particularly concerned about systemic crises triggered by aggregate shocks (interest rates, exchange rates).

A simple way of introducing aggregate risk into the present analysis has been suggested by GEHRIG (1996). Assume that in addition to the project specific risk analyzed so far, there is a probability $\phi \in]0, 1[$ such that projects within a convex line segment of length $\tilde{\tau} < 1$ and random location will be completely wiped out. This aggregate shock can be usefully interpreted as a natural disaster, or an industry-specific shock. The larger the realization of $\tilde{\tau}$ the larger the impact of the shock on related industries.

In such a framework, bank failures will occur with positive probability, when $\tilde{\tau}$ is large enough.[13] However, banks' rents serve as a buffer against failure risk. Accordingly, any measure that affects rents also affects the probability of insolvency.

In this case, banks' funding costs (5.1) have to be amended by a risk premia that reflects banks failure risk. To the extent that the oligopoly premia is reduced by technological developments or deregulation of entry, equilibrium lending rates will reflect an increased exposure of banks to aggregate risk in the form of an increased risk premia for banking risk.[14]

7. THE EFFECTS OF CAPITAL ADEQUACY REGULATION

Capital adequacy rules are largely seen as instruments that contribute to the safety and soundness of the banking system. In their favour it is typically argued that capital rules provide a cushion against loan losses and, in addition, that capital rules mitigate risk–taking incentives.[15] Furthermore, BALTENSPERGER (1995) and CROCKETT (1995)

12. Each bank with a positive market share attracts a continuum of borrowers.
13. For example, when $\tilde{\tau}$ is larger than the market share of a single bank with a positive probability one bank will fail because none of its customers can repay her loan.
14. Of course, to the extent that government guarantees and regulatory intervention reduce bank failure risk this premia may be small. In this case the tax payer may have to bear certain realizations of aggregate risk.

argue that other regulatory instruments may no longer be effective in an increasingly globalized banking market. Accordingly, two questions arise. Is it true that judiciously chosen[16] capital rules will always promote bank safety? And, how will capital rules affect market outcomes in the banking industry and the cost of investment? To a large extent these questions can be addressed within the simple framework discussed so far.

Within the present framework asset-substitution cannot occur and, hence, risk-taking is not a concern. Rather banks are providers of socially valuable information on investment projects. Accordingly, efficient monitoring is the social concern. Since monitoring is provided by insiders, they have to be given appropriate monitoring incentives. At a first step I analyze the effects of capital rules on the equilibrium monitoring intensity.

Capital adequacy rules affect banks capital structure. When insiders' wealth is sufficiently large the capital restrictions are not binding since insiders can always provide the desired amount of equity. When insiders' wealth, however, is limited, a re-capitalization or an increase in capital requirements forces insiders to issue new equity. In this case their interests are diluted. As insiders' stakes μ_i decline also monitoring incentives deteriorate. Accordingly, capital requirements tend to decrease the amount of equilibrium monitoring.

Result 7.1 (Capital Requirements)

Capital requirements are ineffective when insiders are wealthy enough. They reduce equilibrium monitoring and they increase equilibrium lending rates when insiders' wealth is strictly limited.

This statement follows directly from result 5.3. A marginal increase in capital requirements has the same effect as a marginal and uniform increase in outside shareholdings. Even in the presence of aggregate risk, at best, capital requirements leave banks' lending and monitoring decisions unaffected. However, even in the most favourable case, capital requirements will only marginally reduce banks' failure risk.[17]

When insiders' wealth is limited, however, capital requirements tend to impair monitoring incentives. As a consequence the quality of banks' loan portfolios deteriorates and lending rates increase. Since, according to equation (5.1), the bad loan provisions are proportional to the risk free rate r_0, capital requirements tend to increase the volatility of lending rates. When x is large enough the increased volatility does not affect firms' investment behaviour. In a more general framework with interest sensitive investments,

15. See for example the panel statements of BALTENSPERGER, BIRCHLER, CROCKETT and HAURI (1995).
16. i.e. risk weighted
17. To be precise, at most the solvency of the two banks at the end of the catastrophic region $\tilde{\tau}$ that are only partially affected by the aggregate shock can be enhanced via the capital buffer. The solvency risk of the remaining $n-2$ banks remains unchanged.

however, the increased volatility of interest rates will affect aggregate demand and thus amplify business cycles. Thus capital requirements amplify the wedge between lending rate and deposit rate and thus reinforce business cycle phenomena.[18] In particular, capital requirements may have undesirable macroeconomic implications.[19]

The procyclical effects of the interest rate wedge are more pronounced under fairly competitive conditions, when $\frac{\beta(m)}{\alpha(m)}$ is fairly large. In a concentrated banking industry the ratio $\frac{\beta(m)}{\alpha(m)}$ is rather low and the corresponding interest rate wedge is relatively small. Accordingly, market structure, or more generally, the intensity of competition in the loan market should be an important determinant of the business-cycle properties of lending rates based on the monitoring model.

To the extent that banks specialize in the provision of borrower specific information a decline in the monitoring intensity renders them more vulnerable to competition from capital markets. In fact, when loan markets are very competitive, the optimality condition (4.2) implies a monitoring intensity close to 0. Under such conditions, the relative monitoring (screening) advantage of banks relative to capital markets is low and capital requirements may even contribute to lower it further. In other words, if depositors were allowed to finance the investment projects directly, the fair rate based on zero monitoring would be close to the banks' lending rates, particularly, since banks monitoring advantages are partially offset by a (small) oligopoly premium. In an oligopolistic market banks' lending rates can be lower because of active monitoring, despite a higher oligopoly premium. In this case the threat of competition from capital markets would be less severe.

8. CONCLUDING REMARKS

The present analysis addresses the question whether capital requirements are a suitable regulatory instrument to reduce failure risk of banks. The findings cast some serious doubt on the presumption that capital rules will in fact do, despite their role as loss buffers. In the framework under consideration capital requirements tend to reduce monitoring incentives of bank managers and thus directly contribute to the deterioration of banks' assets. The degree of the reduction in equilibrium monitoring effort is a function of the market structure and increases as the competition intensifies in the loan market.

In the present framework capital regulation is not a desirable instrument since the potential source of market failure is effort-aversion moral hazard of the bank management. Different means of regulatory intervention are preferable in this context. In particular, structural regulation may provide managers with better monitoring incen-

18. See also BLUM, HELLWIG (1995) for a discussion of the procyclical effects of capital requirements.
19. Again capital requirements can enhance the solvency of at most two institutions (out of n) and thus reduce failure risk only to a small extent.

tives.[20] The analysis suggests a potentially complementary role for prudential and structural regulation.

Furthermore, undesirable business cycle implications have been identified. Because of their perverse monitoring incentives, capital requirements may amplify business cycles and hence increase aggregate risk. This perverse effect becomes increasingly pronounced as competition intensifies in the loan markets.

Taken together, the present analysis suggests that the particular sequencing of regulatory change in the European context, by first liberalizing entry (single licence), and second harmonizing capital standards, may have contributed to worsening banks' loan portfolios. Thus European banks may have in fact become riskier and also more vulnerable to competition from capital markets. They may have lost much of their specificity and it takes little wonder that the 1988 Basle Accord is in urgent need of amendment to incorporate market risk.

REFERENCES

BALTENSPERGER, E., 1995: Panel Discussion – Statements and Comments, Conference on Capital Adequacy Rules as Instruments for the Regulation of Banks, Basel, July 7, 1995, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, 4/2, 823–825.

BERNANKE, B. and M. GERTLER, 1995: «Inside the Black Box: The Credit Channel of Monetary Policy Transmission», *Journal of Economic Perspectives* 9:4, 27–48.

BESANKO, D and G. KANATAS, 1993: «Credit Market Equilibrium with Bank Monitoring and Moral Hazard», *Review of Financial Studies 6*, 213–232.

BIRCHLER, U., 1995: Panel Discussion – Statements and Comments, Conference on Capital Adequacy Rules as Instruments for the Regulation of Banks, Basel, July 7, 1995, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, 4/2, 823–825.

BLUM, J. and M. HELLWIG, 1995: «The Macroeconomic Implications of Capital Adequacy Requirements», *European Economic Review* 39, 733–749.

BOOT, A. and S. GREENBAUM, 1993: «Bank Regulation, Reputation and Rents: Theory and Policy Implications», in C. Mayer and X. Vives (eds.): *Capital Markets and Financial Intermediation*, Cambridge University Press, 69–88.

BROECKER, T., 1990: «Creditworthiness Tests and Interbank Competition», *Econometrica* 58, 429–452.

COOKE, P. (ed.), 1991: «International Convergence of Capital Measures», in: *Bank Capital Adequacy and Capital Convergence*, Price Waterhouse, 90–106.

CORNETT, M. and H. TEHRANIAN, 1994, «An Examination of Voluntary Versus Involuntary Security Issues by Commercial Banks», *Journal of Financial Economics* 35, 99–122.

20. See also GEHRIG (1996) for similar arguments.

CROCKETT, A., 1995: Panel Discussion – Statements and Comments, Conference on Capital Adequacy Rules as Instruments for the Regulation of Banks, Basel, July 7, 1995, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, 4/2, 823–825.

DEWATRIPONT, M., J. TIROLE, 1995: *The Prudential Regulation of Banks*, MIT-Press, Cambridge.

DIAMOND, D., 1984: «Financial Intermediation and Delegated Monitoring», *Review of Economic Studies* 51, 393–414.

GEHRIG, T., 1995: «Capital Adequacy Rules: Implications for Banks' Risk Taking», *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, 4/2, 747–764.

GEHRIG, T., 1996: «Excessive Risks and Banking Regulation», mimeo, Universität Basel.

GENOTTE, G. and D. PYLE, 1991: «Capital Controls and Bank» Risk», *Journal of Finance* 15, 805–824.

GRENADIER, S. and B. HALL, 1995: «Risk-Based Capital Standards and the Riskiness of Bank Portfolios: Credit and Factor Risk», NBER Working Paper No. 5178.

HAURI, K., 1995: Panel Discussion Statements and Comments, Conference on Capital Adequacy Rules as Instruments for the Regulation of Banks, Basel, July 7, 1995, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, 4/2, 823–825.

JENSEN, J. and W. MECKLING, 1976: «The Theory of the Firm: Managerial Behaviour, Agency Costs, and Capital Structure», *Journal of Financial Economics* 3, 379–401.

KAHANE, Y., 1977: «Capital Adequacy and the Regulation of Financial Intermediaries», *Journal of Banking and Finance* 1, 207–218.

KOEHN, M. and A. SANTOMERO, 1980: «Regulation of Bank Capital and Portfolio Risk», *Journal of Finance* 43, 1219–1233.

MERTON, R., 1977: «An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees», *Journal of Banking and Finance* 1, 3–11.

RIORDAN, M., 1993: «Competition and Bank Performance: A Theoretical Perspective», in C. Mayer and X. Vives (eds.): *Capital Markets and Financial Intermediation*, Cambridge University Press, 328343.

SCHWEIZERISCHE NATIONALBANK, 1996: *Das schweizerische Bankwesen im Jahre 1995*, Nr. 80., Zürich.

SHELDON, G., 1996: «Capital Adequacy Rules and Risk Behaviour: An Empirical Analysis», in this volume.

YANELLE, M., 1989: «The Strategic Analysis of Intermediation», *European Economic Review* 22, 294–304.

ZUSAMMENFASSUNG

Der Aufsatz diskutiert die Rolle von moralischem Risiko im Bankgewerbe. Konkret wird eine Form der Leistungsverweigerung des Bankmanagements besprochen. Erfordert die Überwachung von Banken den persönlichen Einsatz des Managements, so wird der

Leistungseinsatz zur Kreditüberwachung von der Wettbewerbsintensität im Kreditmarkt abhängen. Die gleichgewichtigen Kreditzinsen beinhalten eine Oligopolmarge sowie einen Risikoaufschlag für Problemkredite. Zunehmender Wettbewerb reduziert die Oligopolmarge und gleichzeitig die Anreize zur Kreditüberwachung des Managements. Daher werden Kreditportefeuilles riskanter, und Risikoaufschläge für Problemkredite müssen erhöht werden. Dieser Effekt ist tatsächlich in aggregierten Daten der schweizerischen Bankenindustrie zu beobachten. Die Reaktion der gesamten Finanzierungskosten für Kreditnehmer auf zunehmenden Wettbewerb ist nicht eindeutig zu bestimmen. Eigenkapitalregulierung verschärft tendenziell das betrachtete Moral-Hazard Problem. Darüber hinaus kann die Eigenmittelregulierung prozyklisch wirken und Konjunkturschwankungen verstärken. Das Modell suggeriert eine gewisse Komplementarität zwischen Regulierung im Sinne des Gläubigerschutzes und einer Strukturregulierung im Bankensektor.

SUMMARY

The paper discusses effort-aversion moral hazard in banks. When the evaluation and monitoring of loans requires private management effort, monitoring efforts are sensitive to the intensity of competition in the credit market. Equilibrium loan rates incorporate an oligopoly premium and a provision for bad loans. While competition reduces the oligopoly premium it also reduces monitoring incentives. Therefore, in line with recent evidence from Switzerland, loan provisions increase under deregulation, leaving the overall effect on firms' cost of finance ambiguous. Capital adequacy regulation tends to increase effort-aversion moral hazard. Furthermore it is shown that capital standards may amplify business cycles and, counter-productively, increase systemic risk. The model suggests a certain degree of complementarity between prudential and structural regulation for the banking industry.