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Why do banks hold capital in excess of regulatory requirements? A functional approach

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Abstract

This paper provides an explanation for the observation that banks hold on average a capital ratio in excess of regulatory requirements. We use a functional approach to banking based on Diamond and Rajan (2001) to demonstrate that banks can use capital ratios as a strategic tool for renegotiating loans with borrowers. As capital ratios affect the ability of banks to collect loans in a nonmonotonic way, a bank may be forced to exceed capital requirements. Moreover, high capital ratios may also constrain the amount a banker can borrow from investors. Consequently, the size of the banking sector may shrink.

JEL: G21, G28

Keywords: incomplete contracts, minimum capital requirements, bank capital, disintermediation, pro-cyclicality

1 Introduction

In 1999, the Basel Committee on Banking Supervision released a proposal for a new capital adequacy agreement (Basel II), which shall displace the existing agreement presumably by 2006. Basically, either regulation stipulates that banks maintain a minimum capital adequacy ratio of 8 percent of their standardized risk weighted assets to enhance the stability and soundness of the banking industry. Unlike the existing regulation, however, the new Basel accord allows for a stricter orientation of capital to the specific risks associated with a bank's assets.

While improving risk weighting, the Basel Committee is anxious to keep the capital requirement associated with an average risky portfolio more or less unchanged. This concern has been caused partly by observations that capital-to-asset ratios increased considerably in the aftermath of the launch of the first Basel accord. Figure 1 provides such evidence for an unbalanced sample of 16 European banks. On average, both tier 1 (core capital) and tier 1 through 3 (total capital) capital-to-asset ratios have been increasing. Such evidence is also presented in *Jackson* (1999) for a number of G-10 banks; the average capital-to-asset ratio of major banks in G-10 countries rose from 9.3 % in 1988 to 11.2 % in 1996. In a more recent study, the Banking Supervision Committee of the European System of Central Banks assesses the capital cushion of banks in the EU to more than 50 percent on average in 2002 while the risk-weighted asset share of banks with a total regulatory capital ratio below 9 % was only 3.5% of all institutions (*European Central Bank,* 2003).[1] Similar results are reported for Switzerland (*Rime*, 2001), Spain (*Ayuso*, *Pérez*, *Saurina*, 2004) and the U.S. (*Peura*, *Jakivuolle*, 2004)).

At first sight, one possible reason for these observations might be the exceptional rise in the stock markets during the period under consideration. At this time, banks were clearly in a comfortable position to raise new funds through issues of shares and the rise in the market also indicates that banks were able to reinvest earnings considerably.

Another line of arguments to rationalize the observations stems from portfolio management considerations taking into account costs of approaching or falling below the minimum requirement. In general, banks trade off these costs with those associated with raising capital up-front or with recapitalization when the requirement is violated. As a result, banks may choose to exceed the minimum capital-to-asset ratio. *Furfine* (2000), e.g., argues that these costs might come in form of intensified supervisory review, a weakened reputation or immediacy of the need to restore the capital position either by cutting lending or trying to obtain new external capital. *Jokivuolle* and *Kauko* (2001) show that even under the new Basel Accord risk averse banks may want to further increase the

[1] The capital cushion is defined as the percentage actual capital in excess of the minimum requirement.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Deutsche Bank	core							5,4	5,3	6,3	5,9	7,8	8,1	9,6
	total	10,7	10,7	10,5	11,3	10,4	10,1	9,9	10,6	11,5	12	13,1	12,1	12,6
Dresdner Bank	core								5,7	6	6,6	6	5,5	6
	total			9,5	11,2	10,2	9,7	9,4	11	11,7				
HVB Group	core								5,4	6	6,4	6,6	6	5,6
	total								9,5	9,5				
Commerzbank	core								5,9	6,3	6,3	6,5	6,2	7,5
	total								9,5	8,7				
ABN AMRO Holding	core			5,91	6,85	6,74	6,51	7,21	6,96	6,94	7,2	7,2	7,8	9,3
	total			9,88	11,2	11	10,8	10,9	10,7	10,5	10,9	10,4	10,2	11,7
BNP Paribas	core				5,6	5,7	5,5	5,4	5,9	6,4	7,1	7,5	7,3	8,1
	total							n.a.						
Fortis	core										7,6	7,3	8,5	8,2
	total										12,2	11,8	13,5	13
Societe General	core		4,6	5	5	5,5	5,7	6,1	6,5	6,5	7,6	8,9	8,4	8,1
	total		9	9,1	9,1	9,3	9,2	10,2	11,1	11,1	11,9	12,5	11,5	11,1
UniCerdito Italiano	core										7,6	6,85	7,74	9,13
	total										6,55	8,52	11	11,6
Banca Commerciale	core									7,45	7,05	6,76	6,01	6,8
	total									10,3	9,93	9,99	9,33	11,1
Banca Intesa	core												7,4	8,7
	total												12,7	15,2
Bayerische Landesbank	core											5,8	6	6,4
	total							n.a.						
Credit Lyonnais	core						4,5	4,6	4,8	5,4	6,8	7	6,9	8,2
	total						8,6	8,7	9,4	10,4	10,7	11	10,1	11,2
Radobank	core							10,6	10,4	10,3	10	10,3	9,9	10,3
	total							11,3	11,1	11,1	10,5	10,6	10,2	10,5
credit agricole	core					7,6	8,2	7,7	9,2	9,4	9,6	9,6	10,8	8,8
	total					10,2	10,5	10,4	10,8	11	10,5	10,2	11,8	9
BBVA Group	core									9	8,5	8,9	8,5	8,4
	total									12	11,3	11,9	12,6	12,5

Figure 1: Capital-to-asset ratios for 16 European banks
Source: Annual Reports of respective banks (several volumes).

capital cushion above the minimum level. They suggest that increased risk-sensitivity of the capital charge would increase the likelihood that, ceteris paribus, an institution hits the 8 per cent minimum ratio for some time in the future as ratings of their borrowers, either internal or external, fluctuate unexpectedly.[2]

Most of these explanations of holding capital-to-asset ratios in excess of those required by regulation suffer from a common shortcoming: they do not account for the functions banks perform in an environment of imperfect financial markets characterized by informational lacks and enforcement problems in financial contracting.

This paper aims to contribute overcoming this shortcoming. It provides a rationale (based on a functional approach to banking) for holding a capital cushion, e.g. capital in excess of regulatory requirements. In addition, it shows why disintermediation may appear as a consequence of it. The starting point of our analysis is the incomplete contracts approach to banking offered by *Diamond* and *Rajan* (2001). In their setting depository institutions (banks) exist as liquidity creators in a world of incomplete financial contracts. They assume that a banker acts as a relationship lender who is endowed with specific skills.

[2]For related portfolio approaches see also *Estrella* (2004) and *Peura* and *Keppo* (2003).

These skills allow her to enhance the ability of a borrower to commit himself to fulfill loan obligations even if his ultimate lenders are in need of funds at short notice. The banker can do so because she knows at best how to extract payments from the project's assets without employing the borrower's specific skills. Therefore, a borrower's threat to withdraw his specific knowledge from the project once the investment is placed looses bite and he can credibly commit to pay out a larger share of his return to his lender if he is bound to a banker.

On the other hand, by construction of the demand deposit contract, a banker can credibly commit herself not to hold up her financiers since any attempt to hold up depositors results in a bank run. Owing to this special characteristic of a deposit contract, deposits strictly dominate bank capital as long as project returns are certain. However, *Diamond* and *Rajan* (2000) argue that a mixed capital structure may emerge if project returns are stochastic. There, bank capital not only reduces the ability of a banker to commit her specific skills but serves also as a buffer against shocks to asset values. In their analysis the optimum capital-to-asset ratio therefore depends on a tradeoff between a bank's solvency and credibility. Moreover, in a multi-period version of their model *Diamond* and *Rajan* show that a banker's ability to extract payments from her borrowers depends non-monotonically on her capital structure.

Nevertheless, *Diamond* and *Rajan* were not able to explain why banks tend to exceed regulatory capital requirements once they are introduced. The reason is that a banker who is obliged to fulfill a capital-to-asset ratio that is higher than the optimal ratio when regulation is absent can extract more rents, which in turn always reduces the amount she can pledge to her financiers.

The main point of this paper is that the amount a banker can pledge to ultimate financiers may also depend on her capital structure in a nonmonotonic way. We will show that this result arises when (1) renegotiations are risky since they may break down, and (2) the banker behaves risk averse with decreasing absolute risk aversion. In our setting, capital does not serve as a buffer against shocks to project returns but as a strategic tool for renegotiations with borrowers. When the capital-to-asset ratio is exceeding some critical value, the banker can share her risk of a renegotiation breakdown with her shareholders to an increasing degree, which makes her less reluctant to assume the risk of a renegotiation breakdown. Hence, she is able to extract even higher payments from her borrower. On the other hand, as in *Diamond* and *Rajan* (2000), an increasing capital-to-asset ratio also improves her ability to extract rents at the expense of equity claimants. Hence, whether payments, which can credibly be pledged to ultimate financiers, are increasing or not depends on a tradeoff between enhancing the bankers ability to extract payments from borrowers and capturing rents.

The argument that the capital structure can be used strategically for negotiations with a third party is not novel. For example, *Perotti* and *Spier* (1993) suggest that an entrepreneur makes use of senior debt claims as a bargaining tool to extort his contracting party. However, *Perotti* and *Spier* focus on the strategic relationship between shareholders and labor unions and show how an entrepreneur can use debt-for-equity exchanges to extract wage concessions from his employees; they do not apply this idea to a banker whose economically valuable function is liquidity creation. Moreover, they argue by means of the *Nash* bargaining solution to renegotiations assuming that utility over the set of possible bargaining outcomes is convex, which leaves open why the players' attitudes towards risk may matter for renegotiations. In this paper, instead, we utilize a non-cooperative game structure with stochastic bargaining costs to provide a microeconomic rationale for that risk aversion may matter.

The paper is organized as follows: Section 2 analyzes the determinants of a bank's capital structure and asks how the amount of funds the bank can raise from her financiers depends on her capital structure. Section 3 focuses on the consequences of binding minimum capital adequacy ratios for bank lending. Section 4 discusses some policy implications. Section 5 summarizes the results.

2 Determinants of a Bank's Capital Structure

2.1 Financial Contracts with the Risk of Renegotiation Break Down

In a first step, we show in a non-cooperative game setting how, in general, the bargaining solution of renegotiations depends on the parties' attitudes towards risk if there is a possibility that renegotiations may break down. Following *Hart* and *Moore* (1994) and *Hart* (1995) we consider a financial relationship between an entrepreneur and a lender (not necessarily a bank yet). The entrepreneur runs a firm and possesses a project idea but is endowed with no own funds. His external financial needs are, thus, identical with the size I of the investment project.[3]

The project lasts for one period or two dates $T = 0, 1$ respectively. The project requires an initial investment of I at $T = 0$ and yields a non-verifiable cash flow of $Y > I$ at $T = 1$ if the entrepreneur contributes his specific skills. The physical assets created in the course of the initial investment may also have a value without the entrepreneur's specific skills. This second best alternative use is referred to as liquidation and has a verifiable return of $L \in (0, I)$ at $T = 1$.

As in *Hart* and *Moore* (1994), *Hart* (1995) and *Diamond* and *Rajan* (2000, 2001) we assume that the entrepreneur cannot commit to contributing his specific skills to the

[3] Henceforth, all payments are measured in real terms and the discount factor is normalized to 1.

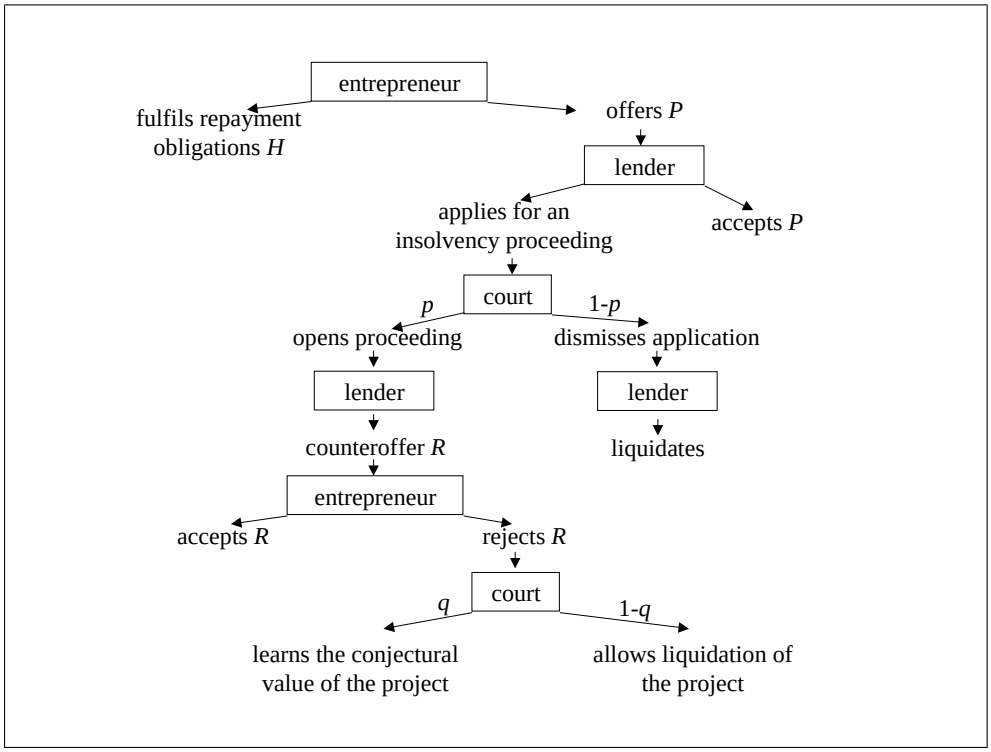

Figure 2: The renegotiation game in extensive form

project in the remote future but only for a short period of time. Hence, once the investment is placed, the entrepreneur might initiate renegotiations shortly before the project matures in order to beat down loan repayments by threatening to withdraw his specific skills. Only if both parties reach an agreement as a result of renegotiations the entrepreneur will actually contribute his specific skills and the project turns out to be successful.

The renegotiation game in extensive form is assumed to have the following general structure (*Rubinstein*, 1982): If the entrepreneur refuses to fulfil his originally given debt obligation $H \geq I$, both parties meet to start a first bargaining round. In this first round, the entrepreneur offers an alternative repayment P which can be either accepted or rejected by the lender. If the latter rejects P she makes a counteroffer R in the second round. When the entrepreneur rejects this counteroffer R, an independent arbitrator fixes a repayment $X \in (L, Y)$, which is known to both parties at the beginning of renegotiations.

However, in extension to this general structure of the *Rubinstein* game, renegotiations may break down after each bargaining round with given probabilities (figure 2). To give some intuition for this assumption, suppose that, if the lender rejects the first offer P made by the entrepreneur, she applies for an insolvency proceeding at a court of justice. Since project returns Y are non-verifiable by courts at this early stage of the hearing, the court may decide to dissmiss this application with probability $(1 - p)$ because it expects that

bankruptcy assets lack to cover the costs of the legal procedure. In this case, the lender seizes the real assets and liquidates. On the other hand, with probability $p \in (0,1)$, the court opens the insolvency proceeding and allows the lender to make a counteroffer R.

In this second round the entrepreneur decides whether or not to accept R. While deciding on accepting R the entrepreneur has to take into account that, with probability $q \in (0,1)$, the court has learned that the project's conjectural value is $\bar{Y} \in (L, Y)$. Maybe, this conjectural value $\bar{Y}$ is Y net of legal charges: Suppose the judge comes to know the true value Y of the project with probability q; having subtracted the court costs a total of $\bar{Y}$ remains to be shared between the lender and the entrepreneur. Hence, with probability q the judge will convict the entrepreneur to pay out an amount X to the lender, which is at most the original repayment obligation H (maybe plus a fine) or $\bar{Y}$, i.e. $X = \min\left\{H, \bar{Y}\right\}$. On the other hand, with probability $(1-q)$, the court has no additional valuable information on the project‘s value and, hence, allows the lender to liquidate the entrepreneur‘s assets.

By backward induction, the entrepreneur accepts the lender's counteroffer R in round 2 if

$$U(Y-R) \geq qU(Y-X) + (1-q)U(0), \tag{1}$$

where U denotes the entrepreneur's *von Neumann/Morgenstern* utility index. Thus, the lender will offer R such that the entrepreneur is just indifferent to accept, i.e. R equals the certainty equivalent of a lottery

$$\Gamma_2 = \begin{cases} Y - X & \text{with probability} \quad q \\ 0 & \text{with probability} \quad 1-q \end{cases}$$

By inspecting (1) we obtain $R \in \left(\min\left\{H, \bar{Y}\right\}, Y\right) > L$.

In the first bargaining round the lender accepts the entrepreneur's original offer P if

$$V(P) \geq pV(R) + (1-p)V(L)$$

where V denotes the lender's *von Neumann/Morgenstern* utility index. Accordingly, the entrepreneur sets P equal to the lender's certainty equivalent of a lottery

$$\Gamma_1 = \begin{cases} R & \text{with probability} \quad p \\ L & \text{with probability} \quad 1-p \end{cases}.$$

It follows $P \in (L, Y)$ irrespectively whether $H > \bar{Y}$ or not.

Consequently, whenever $P < H$ the entrepreneur will certainly refuse to meet his repayment obligation at $T = 1$ and the lender is, thus, not willing to conclude a financial contract at $T = 0$ because loan repayments do not cover the opportunity costs of the provided funds.

The subgame perfect equilibrium solution P depends on the liquidation value L, the project's cash flow Y and its verifiable part $\bar{Y}$, and the probabilities p and q, as well as on the respective attitudes towards risk of both parties: On the one hand, a more risk averse entrepreneur both accepts a higher payment R in the second round and offers a higher payment P in the first round than a less risk averse entrepreneur. On the other hand, the repayment the lender is just willing to accept in the first round will be smaller the more risk averse she behaves.

So far, we have considered the renegotiation process between the entrepreneur and a lender, given that there is a risk of breakdown in renegotiations. Next we analyze what specific role demand deposits offered by a bank play during renegotiations.

2.2 Bank Finance by Demandable Deposits

Assume that liquidation of the physical assets requires specific liquidation skills. Acquiring these skills is a time and effort consuming business so that the lender bears some (non-monetary) disutility. To economize on these costs it is optimal to mandate a single banker to acquire these liquidation skills, who acts on behalf of all financiers in financial contracting with the entrepreneur. Without loss of generality, these costs are normalized to zero.

The banker is assumed to possess no own financial wealth. Instead, to grant a loan to the entrepreneur, she has to raise money from financiers. However, this generates an overlapping hold-up problem since not only the entrepreneur may refuse to meet his loan obligations but the banker may also want to renegotiate her obligations owed to financiers. She can do so because, while accompanying the project from its very first stage, she is the only one who develops specific skills in identifying how to bring out the best liquidation value of the project, whereas anyone else yields much lower liquidation proceeds because of lacking these skills. Hence, the banker may threaten not to utilize her skills unless obligations are renegotiated.

If, however, the banker takes money from financiers by means of a deposit contract, the hold-up problem between the banker and the financiers vanishes. As mentioned in the introduction and shown by *Diamond* and *Rajan* (2001) the deposit contract creates a collective action problem among depositors such that any attempt of the banker to renegotiate deposits results in a bank run and total disintermediation. This disintermediation disables the banker to cover her initial costs of acquiring liquidation skills. Thus, she is not inclined to renegotiate demandable deposits unless it is absolutely necessary.

By issuing demandable deposits, the banker is able to attract funds from depositors needed for lending to the entrepreneur if the maximum pledgeable repayments from the entrepreneur cover the opportunity costs of funds. In the case of our model setting, the face value

of deposits D equals external financial needs I of the entrepreneur and the intermediated financial arrangement is feasible if $P \geq I$.

2.3 Mixed Bank Finance

So far, we have assumed that the bank completely finances her assets by demand deposits. Now, we consider the case when the banker uses a mixed capital structure and chooses a capital-to-asset ratio k, i.e. the share of equity E in total funds raised from financiers. To simplify matters, we assume that the banker and equity shareholders equally share the loan repayments from the entrepreneur net of deposits owed to depositors.[4] Then, the capital ratio is given by

$$k = \frac{\frac{1}{2}(P-D)}{\frac{1}{2}(P-D)+D} = \frac{P-D}{P+D}$$

implying

$$D = \frac{1-k}{1+k} \cdot P.$$

Hence, for a given capital-to-asset ratio renegotiation proof payment P satisfies:

$$\begin{aligned} &V\left(\max\left\{\frac{1}{2}\left(P-\frac{1-k}{1+k}P\right),0\right\}\right) = \\ &pV\left(\max\left\{\frac{1}{2}\left(R-\frac{1-k}{1+k}P\right),0\right\}\right) + (1-p)V\left(\max\left\{\frac{1}{2}\left(L-\frac{1-k}{1+k}P\right),0\right\}\right) \end{aligned} \tag{2}$$

and we obtain

Lemma 1 *If the banker exhibits decreasing absolute risk aversion, then the maximum pledgeable loan repayment P is decreasing in k for low k but increasing in k for high k.*

Proof.

1. *At first, suppose that k is large so that we have $\frac{1}{2}\left(L-\frac{1-k}{1+k}P\right) \geq 0$, which holds true with strict inequality at least in some neighbourhood to $k=1$. Hence, (2) becomes*

$$\begin{aligned} V\left(\frac{1}{2}\left(P-\frac{1-k}{1+k}P\right)\right) = pV\left(\frac{1}{2}\left(R-\frac{1-k}{1+k}P\right)\right) \\ + (1-p)V\left(\frac{1}{2}\left(L-\frac{1-k}{1+k}P\right)\right), \end{aligned}$$

[4] Note that renegotiations with shareholders do not impose a stochastic bargaining process as renegotiations with borrowers do. The reason is that a banker holds a fixed claim on the cashflow of the borrower whereas the claim of shareholders on a bank is not fixed. In general, a default on a fixed claim causes insolvency, while bargaining between shareholders and the executive board of a bank takes place in the course of a shareholders meeting (where refusing to pay out shareholders does not cause a default or any legal action per se).

where the RHS is the expected utility of the lottery

$$\tilde{\Gamma}_1 = \begin{cases} \tilde{W}_1 := \frac{1}{2}\left(R - \frac{1-k}{1+k}P\right) & \textit{with probability} \quad p \\ \tilde{W}_2 := \frac{1}{2}\left(L - \frac{1-k}{1+k}P\right) & \textit{with probability} \quad 1-p \end{cases},$$

Without loss of generality this lottery can be transformed to

$$\hat{\Gamma}_1 = \begin{cases} \hat{W}_1 := W + \frac{1}{2}(1-p)\,(R-L) & \textit{with probability} \quad p \\ \hat{W}_2 := W + \frac{1}{2}p(L-R) & \textit{with probability} \quad 1-p \end{cases},$$

where $W := \frac{1}{2}\left[pR + L(1-p) - \frac{(1-k)}{1+k}P\right]$ *denotes the common expected value of the lotteries* $\tilde{\Gamma}_1$ *and* $\hat{\Gamma}_1$*. If the utility function* V *exhibits decreasing absolute risk aversion, then the certainty equivalent of the lottery* $\hat{\Gamma}_1$*, given by the amount* C *at which*

$$V\,(C) = pV(\hat{W}_1) + (1-p)V(\hat{W}_2)$$

holds true, is such that the difference between the expected value W *of the lotterie and the corresponding certainty equivalent* C *is decreasing in* W *(Mas-Colell; Whinston; Green, 1995, p. 193; also see Pratt, 1964). Since* W *itself is an increasing function of the capital ratio* k *this implies*

$$\frac{\partial C}{\partial k} > \frac{\partial W}{\partial k} = \frac{P}{(1+k)^2}.$$

Note that C *is given by*

$$C = \frac{1}{2}\left(P - \frac{1-k}{1+k}P\right)$$

which, for a given P*, is increasing in* k *by* $P/\,(1+k)^2$*. Hence, maximum pledgeable loan repayments* P *are increasing in the capital ratio* k*.*

2. *At second, consider* $k < \hat{k}$*, where* $\hat{k}$ *and the corresponding* $\hat{P}$ *satisfy*

$$\frac{1}{2}\left(L - \frac{1-\hat{k}}{1+\hat{k}}\hat{P}\right) = 0$$

implying that for all $k < \hat{k}$ *we have* $\max\left\{\frac{1}{2}\left(L - \frac{1-k}{1+k}P\right), 0\right\} = 0$*. The lottery the banker faces now is given by*

$$\bar{\Gamma}_1 = \begin{cases} \bar{W}_1 := \frac{1}{2}\left(R - \frac{1-k}{1+k}P\right) & \textit{with probability} \quad p \\ \bar{W}_2 := 0 & \textit{with probability} \quad 1-p \end{cases}.$$

Without loss of generality, set $V(0) = 0$*. The maximum pledgeable loan repayment* P *is thus determined by*

$$V\left(\frac{1}{2}\left(P - \frac{1-k}{1+k}P\right)\right) = pV\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}P\right)\right)$$

for which, by the implicit function theorem, we obtain

$$\frac{dP}{dk} = -\left(\frac{P}{1+k}\right) \frac{V'\left(\frac{1}{2}\left(P - \frac{1-k}{1+k}P\right)\right) - pV'\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}P\right)\right)}{V'\left(\frac{1}{2}\left(P - \frac{1-k}{1+k}P\right)\right) + p(1-k)V'\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}P\right)\right)} \tag{3}$$

where the denominator is strictly positive. Hence, $dP/dk < 0$ for all concave utility functions V since for all $P \leq R$ we have

$$\begin{aligned} V'\left(\frac{1}{2}\left(P - \frac{1-k}{1+k}P\right)\right) &\geq V'\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}P\right)\right) \\ &> pV'\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}P\right)\right). \end{aligned}$$

■

The interpretation of lemma 1, part 1, is apparent: Because the banker can renegotiate with shareholders, loan repayments net of deposits are divided between them. As a consequence, if renegotiations with the borrower fail, the banker can share the risk of this renegotiations breakdown with shareholders. If, on the other hand, renegotiations succeed, the loan repayments collected by the banker (net of deposit repayments) are divided equally between shareholders and the banker. Hence, the banker's risk burdens are less meaningful for a higher capital ratio if she exhibits decreasing attitudes towards risk. This, in turn, strengthens her bargaining position vis-à-vis borrowers.

This implies that the risk premium defined as $W - C$ is decreasing in k. This risk premium can be approximated by $-\frac{V''(\tilde{X})}{V'(\tilde{X})}\frac{\tilde{\sigma}^2}{2}$, where $\tilde{\sigma}^2 = \frac{1}{4}\{p(1-p)^2 + p^2(1-p)(R-L)^2\}$ is the variance of the lotteries $\tilde{\Gamma}_1$ and $\hat{\Gamma}_1$. Hence, the response of the maximum pledgeable loan repayments P to a variation in k is the stronger

- the more sensitively the bank's absolute risk aversion reacts to changes in W,
- the higher the risk associated with debt renegotiations is, i.e. the larger the verifiable part of project returns $\bar{Y}$ is.

Part 2 of lemma 1 deals with the situation that the capital-to-asset ratio k is low such that the banker gets nothing if renegotiations break down (because everything she collects from liquidation is forwarded to depositors). Then, the maximum pledgeable loan repayments are a decreasing function of k if the banker behaves risk avers. The reason for this is that a variation in k does not affect the banker's net income position in case of a renegotiations breakdown but only if renegotiations succeed. But a risk averse banker is less willing to accept a higher risk of a renegotiation breakdown, i.e. the certainty equivalent of the lottery does not increase proportionally and therefore P decreases. To put it the other

way round, maximum pledgable loan repayments increase if the capital ratio decreases and reach a local maximum at $k = 0$, i.e. if the banker completely refinances herself by deposit contracts.

We further conclude:

Lemma 2 *Pledgeable loan repayments P are maximized if the bank chooses a capital structure given by $k^* = 0$.*

Proof. Because P is decreasing in k for small k and increasing in k for large k it is sufficient to compare the maximum pledgeable loan repayments at $k = 0$ and at $k = 1$. To simplify notations define $\pi(k, L)$ as the renegotiation proof payment P associated with k and L according to lemma 1. At $k = 0$ the maximum pledgeable loan repayments are given by

$$V(0) = pV\left(\frac{1}{2}(R - \pi(0, L))\right) + (1 - p)V(0),$$

i.e. we have $\pi(0, L) = R$. At $k = 1$ the maximum pledgeable loan repayments are given by

$$V\left(\frac{1}{2}\pi(1, L)\right) = pV\left(\frac{1}{2}R\right) + (1 - p)V\left(\frac{1}{2}L\right)$$

i.e. we have $\pi(1, L) \in (L, R)$ which is strictly less than R. Hence, $\pi(0, L) > \pi(1, L)$. ■

Since the loan repayment $P = \pi(k, L)$ is divided up between depositors, shareholders and the banker, these three parties receive the following amounts:

- The depositors:

$$D = \frac{1 - k}{1 + k}\pi(k, L);$$

- the suppliers of equity finance:

$$E = \frac{1}{2}(P - D) = \frac{k}{1 + k}\pi(k, L);$$

- the banker:

$$Q = \frac{1}{2}(P - D) = \frac{k}{1 + k}\pi(k, L),$$

Hence, the maximum amount of funds the banker can attract for a given capital ratio is $Z = E + D = \frac{\pi(k,L)}{1+k}$. Since

$$\frac{dZ}{dk} = \frac{\frac{d\pi(k,L)}{dk}(1 + k) - \pi(k, L)}{(1 + k)^2} \lesseqqgtr 0,$$

the amount of funds a banker can raise depends on the capital ratio in a non-trivial matter: At first, if $k < \hat{k}$, for which we have $d\pi(k, L)/dk < 0$, it follows unambiguously $dZ/dk < 0$. However, if $k > \hat{k}$ we have $d\pi(k, L)/dk > 0$ and the sign of dZ/dk is a priori not clear. Two effects work in opposite directions: A risk sharing effect and a holdup effect. By the former an increase in k increases P, i.e. the risk sharing effect improves the ability of the banker to raise funds. But an increase in k also leads to a rise in the rent the banker can extract from renegotiations with shareholders (holdup effect):

Lemma 3 *The rent of the banker is monotonically increasing in k.*

Proof. *We have to show that*

$$\frac{dQ}{dk} = \frac{\pi(k, L)}{(1+k)^2} + \frac{k}{1+k}\frac{d\pi(k, L)}{dk} > 0$$

holds. Because of (3), this can for $k < \hat{k}$ be rewritten as:

$$\frac{dQ}{dk} = \frac{\pi(k, L)}{(1+k)^2}(1 - k\Omega)$$

where

$$\Omega := \frac{V'\left(\frac{1}{2}\left(\pi(k, L) - \frac{1-k}{1+k}\pi(k, L)\right)\right) - pV'\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}\pi(k, L)\right)\right)}{V'\left(\frac{1}{2}\left(\pi(k, L) - \frac{1-k}{1+k}\pi(k, L)\right)\right) + p(1-k)V'\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}\pi(k, L)\right)\right)}$$

Since the numerator in Ω is smaller then the denominator and because $k < 1$, the term in the last bracket is strictly positive. Moreover, since for $k \geq \hat{k}$ we have $d\pi(k, L)/dk > 0$, it follows that $dQ/dk > 0$ holds in the domain $[0, 1]$. ■

3 Bank Competition and the Effects of Minimum Capital Adequacy Ratios

So far we have not allowed for regulatory capital requirements. To analyze the effects of those regulations we have to distinguish between different competitive structures in the banking industry. At first, suppose that the banker possesses some monopoly power vis-a-vis her borrowers. For this case, we conclude:

Proposition 4 *Suppose the banker possesses monopoly power vis-a-vis her borrowers. Since the rent the banker can extract increases monotonically in k she chooses a capital-to-asset ratio $k^* = \max\{k : \pi(k, L)/(1+k) \geq I\}$ if there is no minimum capital adequacy ratio. In the presence of a capital adequacy requirement k^{reg}*

1. *the bankers choice of k^* is unaffected by those requirements if $k^* \geq k^{reg}$,*
2. *there is disintermediation if $k^* < k^{reg}$.*

Proof. The proof follows directly from lemmata 1 through 3. ■

The intuition behind the first result is that a banker, who extracts the largest rent at the expense of her contracting partners, chooses a capital-to-asset ratio k^* that maximizes that rent provided that it still allows her to raise funds just sufficient to finance the investment project. Further, if a regulatory capital-to-asset ratio is imposed it does either not matter or leads to total disintermediation depending on how large the required ratio is. Disintermediation comes into effect when the required ratio exceeds the maximum capital-to-asset ratio that just allows the banker to raise sufficient funds for investment finance.

Positive rents, however, attract new bankers into the marktet and banking competition will melt down a banker's rents to zero. Since the capital-to-asset ratio k is the only instrument variable, in a competitive equilibrium without regulatory requirements every banker chooses $k = 0$, i.e. competition force them to forward the maximum pledgeable loan repayments to their respective depositors. This competitive equlibrium, however, is not independent from banking regulation, and imposing a minimum capital adequacy ratio may have an impact on the banker's choice of k in a way that is not intended by the regulator.

Proposition 5 *In a competitive banking industry the banker chooses a capital-to-asset ratio $k^* = 0$ if there is no minimum capital adequacy ratio. However, in the presence of a capital adequacy requirement k^{reg}*

1. *the banker will choose $k^* = \min\{k : \pi(k, L)/(1 + k) \geq I \wedge k \geq k^{reg}\}$ if $\{k : \pi(k, L)/(1 + k) \geq I \wedge k \geq k^{reg}\} \neq \varnothing$,*
2. *there is disintermediation otherwise.*

Proof. Again, the proof follows from lemmata 1 through 3. ■

Part 1 of the proposition says that the banker chooses the minimum out of a set of capital-to-asset ratios that both meet the regulatory requirement and enables her to credibly commit to pay out financiers at least the invested amount I. This formulation includes the case where the banker just meets the regulatory requirement if and only if $\pi(k^{reg}, L)/(1 + k^{reg}) \geq I$. But it also includes that the banker may choose even a larger k^* satisfying $\pi(k^*, L)/(1 + k^*) = I$ if $\pi(k^{reg}, L)/(1 + k^{reg}) < I$, i.e. the actual capital-to-asset ratio is in excess of the required minimum ratio. She will do so because satisfying the requirement with equality leads to an insufficient amount she can credibly commit to repay. However, increasing her capital-to-asset ratio allows her to collect even more from her borrower and thereby to repay at least I to the ultimate financiers. If either condition cannot be met there will be disintermediation.

To illustrate our main results we use the following example:

Example 1 *Assume* $V(x) = \sqrt{x}$, $p = 0.7$, $R = 950$, $L = 705$. *Then, the shapes of the resulting* P *and* Z *curves are given as presented in figures 3 and 4 (please note the different scaling of the y-axis).*

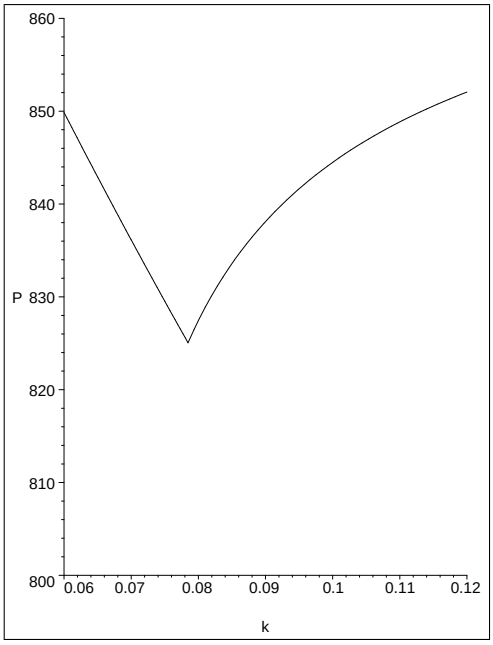

Figure 3: Maximum pleadeable payments of an entrepreneur

Suppose the mandatory capital requirement is $k = 0.08$. *Then, figure 4 allows to separate three cases which differ in the size* I *of the investment project the banker has to finance:*

- *If* $I = 764$ *a monopolist banker chooses* $k^* \approx 11.2\,\%$ *given by the intercept of the* Z*-curve and the lowest horizontal line in figure 4 irrespective whether there are regulatory capital requirements or not. Under competition, however, the banker's chooses an* k *equal to the mandatory capital requirement instead of* $k = 0$ *and, therefore, extracts some rents.*
- *If* $I = 767$ *a monopolist banker chooses* $k^* \approx 10.3\,\%$ *given by the rightmost intercept of the* Z*-curve and the middle horizontal line again irrespective whether there are regulatory capital requirements or not. Under competition, she chooses the smallest* k *for which she is just able to repay* I*, i.e.* $k \approx 8.1\,\%$ *which (slightly) exceeds the regulatory requirement.*
- *If* $I = 770$*, the banker is not able to fulfil the capital requirement and the project cannot be financed because financiers are not willing to supply an amount of funds which equals the size of the investment. In this case, minimum adequacy ratios lead to disintermediation irrespective whether there is competition or not in the banking industry.*

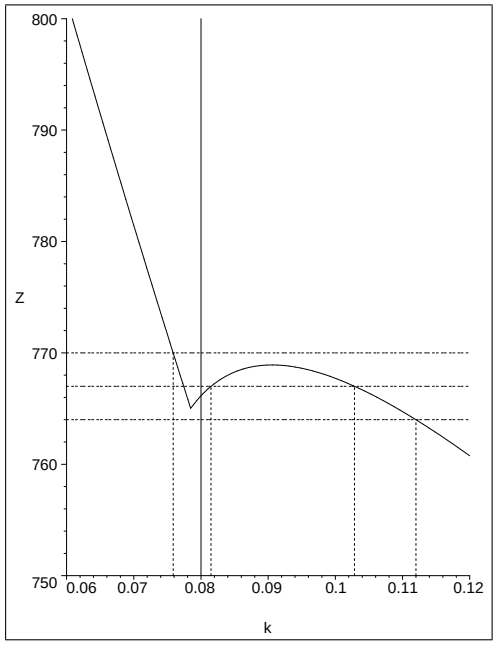

Figure 4: Maximum pleadeable payments of a banker

4 Policy Implications

Our considerations also allow to lend some additional support for the *cyclicality hypothesis* expressed by academics, practitioners as well as policy makers.[5] According to this hypothesis, Basel II capital standards will exacerbate business cycle fluctuations because borrowers may be downgraded under Basel II in the course of an economic downturn. In response, this forces a bank to hold more capital against her current loan portfolio and to curtail her lending, thereby amplifying macroeconomic distortions.

Criticism of that procyclicality hypothesis basically rest on two arguments calling its main assumptions into question. First, it is at least arguable whether credit risks really worsen in the course of an economic downturn (*Ayuso*, *Pérez* and *Saurina*, 2004). Taking changes in credit risk as a change in the probability density function associated with future credit earnings, it is not clear cut why risk changes, and if it changes whether it actually does so in that predicted direction. It is also conceivable, instead, that banks simply assume high risks in a boom which then realize in the following downturn. In that sense, risk-sensitive capital-to-asset ratios may effectively work anti-cyclical. Second, banks hold capital cushions that may enable them to maintain lending even if loan portfolios become more risky in a recession (*Borio et al.*, 2001, *Lowe*, 2002).

[5]See, e.g., *Danielsson et al.* (2001), *Erwin* and *Wilde* (2001), *Estrella* (2004), *Gordy* and *Howells* (2004), *Kashyap* and *Stein* (2004) and *PWC PricewaterhouseCoopers* (2004).

The argument made in this paper, however, implies that the existence of a positive capital cushion might not be sufficient to prevent pro-cyclicality in bank lending even if risk-weighted capital-to-asset ratios remain unchanged in the course of a business cycle. The reason is that banks need their capital buffers to raise sufficient funds from investors. Therefore, the Basel regulatory frameworks may have consequences for macroeconomic stability and makes it more difficult for policy makers to prevent deep recessions. This even holds for the existing regulatory framework and explains why a pro-cyclicality in capital cushions can already be detected in existing data (*Ayuso, Pérez, Saurina*, 2004).

To figure out the responses of capital holdings to business cycles, we ask what happens to a banker's maximum pledgeable payments Z if the liquidation value L falls, a phenomenon that is typically related to economic downturns. Since a fall of L weakens a banker's bargaining position vis-á-vis her borrower, the subgame perfect equilibrium solution to renegotiations P decreases, i.e. the entrepreneur's maximum pledgeable payments fall. This leads to a decrease in Z, i.e. the amount a banker can credibly commit to pay to her investors. When the regulatory capital-to-asset ratio is binding, a banker can (if at all) re-strengthen her bargaining position vis-á-vis her borrower only by choosing an even higher capital-to-asset ratio because this makes her less reluctant to engage in risky renegotiations. As a result, there will be either disintermediation or an increase in the capital cushion.

These considerations yield in:

Proposition 6 *In a competitive banking industry and in the presence of a capital adequacy requirement, a decrease in the liquidation value of assets to $\bar{L} < L$ results in*

1. *an unchanged capital-to-asset ratio*

$$k^{**}(= k^* = k^{reg}) if \pi(k^{reg}, \bar{L})/(1 + k^{reg}) \geq I,$$

2. *an increase in the capital-to-asset ratio*

$$k^{**} = \min\left\{k : \pi(k, \bar{L})/(1 + k) \geq I \wedge k \geq k^{reg}\right\} > k^*$$

if $\left\{k : \pi(k, \bar{L})/(1 + k) \geq I \wedge k \geq k^{reg}\right\} \neq \varnothing$,

3. *disintermediation otherwise.*

Proof. Note that $dZ/dL = \frac{d\pi(k,L)/dL}{1+k}$. An equivalent condition for the results in the proposition is therefore to show that $d\pi(k, L)/dL > 0$ for high k and $d\pi(k, L)/dL = 0$ for low k.

1. First, suppose that k is large so that $\frac{1}{2}(L - \frac{1-k}{1+k}P) \geq 0$ holds (see lemma 1). Then, P is implicitly defined as a function of L according to

$$V\left(\frac{1}{2}\left(P - \frac{1-k}{1+k}P\right)\right) = pV\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}P\right)\right) + (1-p)V\left(\frac{1}{2}\left(L - \frac{1-k}{1+k}P\right)\right),$$

for which the implicit function theorem yields

$$\frac{dP}{dL} = \frac{(1-p)\frac{1}{2}V'\left(\frac{1}{2}(L - \frac{1-k}{1+k}P)\right)}{\Psi} > 0.$$

where

$$\Psi := \frac{k}{1+k}V'\left(\frac{1}{2}(P - \frac{1-k}{1+k}P)\right) + \frac{p}{(1+k)^2}V'\left(\frac{1}{2}\left(R - \frac{1-k}{1+k}P\right)\right) + \frac{1-p}{(1+k)^2}V'\left(\frac{1}{2}\left(L - \frac{1-k}{1+k}P\right)\right)$$

2. Second, consider $k < \bar{k}$ where $\bar{P} = \pi(\bar{k}, \bar{L})$ satisfies

$$\bar{L} - \frac{1-\bar{k}}{1+\bar{k}}\bar{P} = 0.$$

(Note that $\bar{k} > \hat{k}$ for $\bar{L} < L$, where $\hat{k}$ is defined as in lemma 1.) In that case we obviously have $dP/dL = 0$ since the lottery the banker faces if k is low does not depend on L.

■

This result can be further clearified by means of our previous example.

Example 2 (cont.) *Suppose that collateral damages such that L decreases to 700. Then, figure 5 illustrates the effects of capital requirements for a competitive banking industry.*

- *If $I = 764$ the banker's chooses an $k^* = 8.5$ which is higher than in the benchmark case.*
- *If $I = 767$ the banker cannot provide funds because of binding capital requirements even though she could for $L = 705$.*
- *If $I = 770$ the project cannot get funds either.*

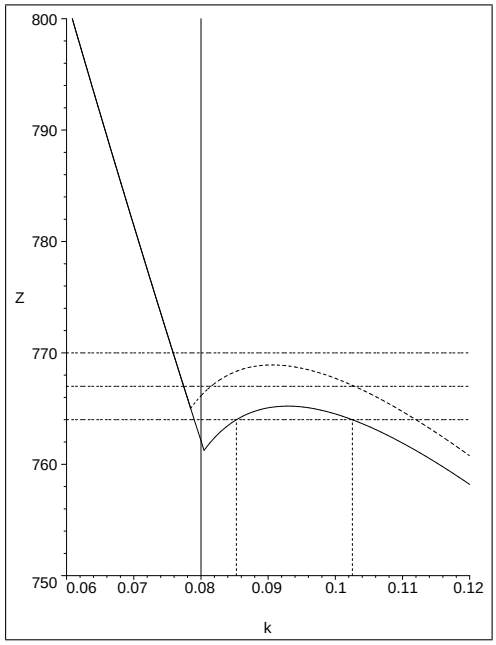

Figure 5: Effects of a collateral damage.

5 Summary

This paper offers an explanation for why banks hold capital-to-asset ratios in excess of regulatory minimum requirements. We argue that a banker's bargaining position vis-à-vis borrowers depends on her capital structure if renegotiations causes risky bargaining costs. In consequence, both the banker's maximum enforceable loan repayments as well as the maximum pledgeable payments to her financiers depend on the chosen capital structure.

The main results of our analysis are as follows: If the bank possesses some monopoly power she will choose an equity ratio that maximizes her rents given that the project can just be financed. This choice is unaffected by regulatory standards as long as these standards are not too strong which leads to disintermediation. Under competition, however, a banker chooses $k = 0$ and forwards maximum pledgable loan repayments to her depositors as long as there are no minimum adequacy ratios. If, on the other hand, regulators have chosen mandatory capital adequacy ratio above a certain level, bankers are either forced to hold an even higher capital ratio or to drop out of the market.

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