

January 2003
Preliminary

Capital Requirements and the Supply of Liquidity

J. Kimball Dietrich
University of Southern California

Clas Wihlborg
Copenhagen Business School

ABSTRACT

We investigate the effect of changes in capital regulation using a simple model of bank capital requirements and asset quality examinations. Banks offer different levels of “liquidity” in the sense of willingness to offer borrowers forbearance on loan terms in the presence of temporary difficulties. Banks offering liquidity services must have higher initial levels of capital and charge higher loan rates. When capital requirements are increased, banks offering liquidity must have proportionately higher levels of initial capital than banks not offering these services and must raise loan rates proportionately higher to earn comparable rates of return, suggesting that counter-cyclical stringency in capital regulation may exacerbate shortages of liquidity in cyclical downturns.

Finance and Business Economics Department
Marshall School of Business, MC#1421
University of Southern California
Los Angeles, CA 90089-1421
e-mail: kdietrich@sba.usc.edu
Telephone: 213-740-6539

Department of Finance
Copenhagen Business School
Solbjerg Plads 3
DK-2000 Frederiksberg
Denmark
e-mail: cw.fi@cbs.dk
Telephone: 45-3815-3628

Capital Requirements and the Supply of Liquidity

1. Liquidity and Capital Regulation

This paper focuses on two aspects of bank regulation currently of great policy interest: capital regulation and asset quality examination, specifically loan quality review. The two regulatory initiatives are mutually connected, since when loans are “classified” by regulators, they require additions to loan loss reserves, thereby reducing the book value of assets and hence measured capital. The model we develop stylizes this process by assuming that bank managers make loan and capital decisions before their assets are examined. Assets are examined after one period so that asset quality, modeled here as loans financing projects that have succeeded or failed after one period, is observable and capital is measured to reflect banks realized or unrealized losses on loans. Banks may realize their loan losses by liquidating projects securing loans and reducing assets by the loss on project liquidation. If they have sufficient measured capital, banks may renew loans for one more period if projects’ second period expected returns are such that the loan has a higher value than its liquidation value.

The model we develop below is kept simple to illustrate how the combination of capital requirements and asset examination interact to determine the cost of funds financing projects with differing two-period expected returns. The model assumes that banks’ actual capital can differ without penalty at the times loans are made, but that at the time of examination, banks must have the regulatory minimum capital to continue in operation. In practice, of course, most banks have capital such that minor unexpected variations in earnings and/or loan quality can be

absorbed, and examinations cannot be times precisely as is assumed here. The model makes clear how one channel connects minimum capital requirements, loan quality review, and bank loan pricing and the willingness of some banks to work out loans by continuing rather than liquidating projects. It does not capture all aspects of banks capital or leverage decisions.

Thakor and Wilson (1995) examine bank capital requirements with a multi-period model of projects that succeed or fail after one period. If projects fail, they may pay off after one more period, similar to the projects used in this paper. However, in Thakor and Wilson successful first-period projects become risk-free in periods two and three, while successful projects in our model are terminated (loans are paid off). They are analyzing project managers' multi-period financing choices and include competitive sources of funds from banks and capital markets, where we focus on bank loans with two possible loan terms (loan rates and loan renewability after one period). In their model loan and capital market rates financing projects are determined in competitive markets: we examine the connection between capital requirements and loan rates for unsuccessful period-one projects with different expected period-two payoffs.

Deposit insurance or other bank liability guarantees require bank examination and limitations on investment authorities and capital standards to control the principal-agent problem inherent in shifting the risk of liabilities to the government or monetary authorities. Capital regulation has evolved over a tortuous history in the United States (see Vojta (1973) for a classic study of bank capital needs or Dietrich (1996) or Berger *et al* (1995) for surveys of capital regulation standards).

Global interest in capital regulation has intensified with capital and banking market integration in recent decades. The Cooke Committee working with the Bank for International Settlements (BIS) in 1988 worked out capital standards that have been adopted by most developed economies as a standard. The Basle or BIS capital requirements were phased in gradually in the United States from 1990 to 1992. The Basel approach is to assess minimum capital requirements as a ratio of *risk-weighted* assets, where the risk weights are determined by perceived credit risk of different classes of loans. The 1988 Basle capital standards have been viewed as a tightening of capital standards for banks around the world. A new round of negotiations for revised capital regulation is now being conducted through the BIS framework with the new capital standards, the so-called Basle II capital requirements, scheduled for implementation by Group of 10 and other countries by 2006¹.

Capital regulation is controversial and changes in capital regulation or the strictness of the enforcement of capital requirements are debated actively. For example, in 1981, the face of earnings problems and increasing interest rates, capital requirements for thrifts in the United States were *lowered* from 6 to 3 percent of assets. With the adoption of the Basle capital standards and stricter enforcement of standards, asset quality, and closure rules in the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) (1989) and the Federal Deposit Insurance Corporation Improvement Act (FDICIA) (1991), stricter capital standards were applied to all deposit-taking institutions and regulatory forbearance of capital standards sharply circumscribed.

¹ See Bank for International Settlements (BIS) (2001) for an outline of the planned revisions of the 1988 capital standards and BIS (2002) for details on schedule of implementation and review of some current

Substantial controversy surrounds the economic benefits of these changes in capital requirements and the strictness of capital regulation over the business cycle. Easing standards during the recession in the United States in the early 1980's was advocated as a way to allow deposit-taking thrift institutions to survive a temporary crisis. Restricting standards later in the decade was viewed as a necessary change to avoid future crises. On the other hand, increasing capital standards in the early 1990's was blamed for a drying up of bank credit, causing a so-called "credit crunch" and possibly exacerbating the recession of 1990 to 1992 in the United States.

Some banking market observers and policy analysts were also convinced that loan quality review became more severe in the United States following the savings and loan crisis and the tighter standards included in FIRREA and FDICIA during the period of the early 1990's. On the other hand, observers of banks in Asia, mainly Japan and China, argue that lax asset quality review and loss provisioning have prolonged their economic recoveries or inhibited growth in the late 1990's. This paper focuses mainly on the loan rate implications of rigid capital enforcement and asset quality review.

The evidence on the relation between the enforcement of more stringent capital standards, asset quality review, and economic activity and/or bank lending is not clear over the business cycle². Nonetheless, many credit market observers are convinced that stricter enforcement of bank capital standards reduces the supply of credit and liquidity during economic slowdowns. The effectiveness of counter-cyclical monetary policy operating through

issues in the capital regulation debate .

² See, for example, Berger and Udell (1994) for a review of the evidence and literature on the relation between

bank lending is assumed by many market participants to be reduced by stricter bank supervision.

The need for capital regulation suggests that banks attempt to minimize capital. Many banks, however, have capital well above minimum capital requirements. For example, Brinkman and Horvitz (1995) document that many banks had capital levels well above regulatory requirements in 1990 even before the higher requirements were implemented. In general, many smaller banks have capital that exceeds regulatory guidelines. The model in this paper may help explain why banks may have differing loan market strategies such that some banks prefer more capital than others given minimum required capital levels.

Another controversy in bank capital regulation concerns the effects of different capital requirements on different types of loans. The revised capital requirements being discussed for implementation as part of the Basel II capital requirement revisions will increase the number of bank asset risk categories to account for differences in perceived credit risk for loans of different types. For example, loans to business may have asset risk weights between .5 and 1.5 of the loan amounts³. The importance of different capital requirements for different types of loans could be a very significant factor determining the amounts and terms at which credit is available for different sectors of an economy.

The relation between capital standards and liquidity has not been examined extensively. Dietrich (2003) develops a model of capital regulation and its relation to lending which is applied in this study to the effects of changes on capital requirements on the provision of liquidity

the new Basel capital standards and credit availability during the recession of 1990 to 1992.

³ See BIS (2001) for a discussion of capital requirements for different types of loans.

by banks. It is important to define what is meant by liquidity in this context. For example, Kashyap *et al* (2002) define liquidity in terms of making cash available to borrowers or depositors when needed on demand through demand deposit withdrawals or takedowns on loan commitments.

The demand for liquidity can also be interpreted as the need for cash to make contractual payments but where the inability to realize the full value of assets through sale in the short term makes covering the cash needs costly. If payment can be delayed with the expectation of higher asset values in the future because the counterparty is willing wait, the counterparty has provided liquidity by not requiring the costly liquidation of assets. It is this sense that we mean by the supply of liquidity in this analysis. We define banks which do not require borrowers to repay loans when asset values are low as supplying liquidity services. We analyze the relation between the loan rates banks must charge for liquidity or leniency in lending under capital regulation.

2. A Model of Bank Optimal Capital with Two Types of Borrowers

Analysis of the effect of minimum capital requirements on liquidity first requires a characterization of the market for loans. We present first a model of borrowers who differ in their willingness to pay for liquidity, defined in line with the previous discussion as a willingness of a bank to not call a loan when projects do not pay off as quickly as hoped. Liquidity demand is a temporary inability to repay a loan to the lender. We then present a model of banks that have minimum capital requirements on assets net of loan losses. The solution of the

model of loan demand and the willingness of banks to provide liquidity at different required capital levels is the basis for our discussion in the third section of the paper.

We assume there are two types of borrowers and that banks cannot distinguish between them. Banks can offer two types of loan contracts: a one-period loan with non-recourse by the lender to the borrower's assets beyond the project and a loan that is renewable at the end of period one. All borrowers use 100 percent bank financing to invest in projects that pay a R_I percent return on the investment in one period with probability $(1-q)$ and the payoffs from the project are pledged to the bank. Risk in the model consists of the assumption that a fraction q of projects do not pay off after one period. However, some of the failed first-period projects may have economically viable payoffs in the second period as discussed below. Projects unsuccessful after one period can be liquidated by the lender for $(1-w)$ percent of the amount financed by the bank. Investors and lenders cannot determine which projects will pay off in one period at the time loans are made.

If projects that do not pay off in the first period are allowed to continue for a second period by lenders who do not call loans and liquidate investments, the projects pay off either R_{21} or R_{22} percent, where $R_{22} \geq R_{21}$, at the end of the second period of the investment. The probability of the high payoff for failed first-period projects in the second period is $(1-p)$. While investor-borrowers do not know which projects pay off in the first period, they are assumed to know the probability of the project having a high payoff and the level of that payoff (R_{22}) if allowed to continue for one more period after not succeeding in the first period.

Given the above, expected borrower-investor's return, $E(R_B^I)$, for one-period loans is given by:

$$E(R^1_B) = (1 - q)(R_1 - r^1_L) \quad (1)$$

Borrowers contracting for two-period loans with lenders who do not call loans after one period, allowing projects to go one more period, have an expected return as follows:

$$E(R^2_B) = (1 - q)(R_1 - r^2_L) + q[(1 - p)(R_{22} - 2r^2_L) + p(R_{21} - 2r^2_L)] \quad (2)$$

where r^n_L denotes the n-period interest rate on the loan and $E(R^n_B)$ is the expected n-period return for the borrower. We assume in our examples below that p and R_{21} are such that two-period borrowers default on the loan with the lower payoff, and that the bank liquidates the project in period two at $1 + R_{21}$ of the loan, thereby simplifying equation (2) by dropping the final term.

Borrowers with higher expected returns in the second period are willing to pay a premium for renewable loans. The loan market equilibrium will be characterized by borrowers willing to pay different loan rates if some banks can make economic returns by offering renewable loans at higher rates than one-period loans.

We are interested in the effect of capital requirements on the ability of lenders to carry borrowers whose projects have not paid off after one period for one more period. Bank lenders committed to financing projects for up to two periods, on the other hand, will be holding non-performing loans subject to mandatory write-downs or additions to reserves required by regulators. These write-downs or additions to reserves reduce regulatory capital. Depending on the probability and level of second-period returns on projects, some borrowers will be willing to pay lenders a higher rate of interest on loans to guarantee that loans will not be called and liquidated after one period. In the following discussion, we will identify with the superscript

s loans from lenders that are "strict" with respect to loan terms in that if the project is does not pay off after one period, the lender calls the loan and liquidates the project. The superscript l indicates that the lender is "lenient" and carries the borrower for one more period at the loan's original interest rate, allowing the borrower to realize the second period investment return R_{21} or R_{22} .

The expected returns for borrowers given in equation (1) and (2) suggest that borrowers will prefer lenient lenders whenever:

$$r^s_L \geq R_1 - \frac{E(R^2_B)}{(1-q)}. \quad (3)$$

If the expected two-period payoff from holding the project one more period compensates for the higher interest costs from a renewable loan, the borrower has a higher expected return if the loan were from a bank following a lenient policy on liquidations.

With a high enough probability $(1-p)$ and high enough payoffs R_{22} some investor-borrowers would be willing to pay a higher loan rate to assure the completion of the project if it should not pay off after one period. For example, if $R_1 = 40$ percent, $R_{22} = 40$ percent, assuming the outcome R_{21} has a 0 percent return to the borrower, with $q = .1$ and $p = .5$, a loan rate r_L of 8.89 percent from the strict lender provides the same expected return (28 percent) to the investor as a 10 percent rate from the lenient lender. The rate differential of 1.11% in the example is analogous to a *liquidity* premium on a loan with the option to be renewed at the same terms after one period.

Bank capital regulation is assumed to require a minimum amount of capital as a ratio to total assets, k^* , at the time loan portfolio quality is reviewed by regulators. Between

examinations, banks may be above or below the required capital level but banks plan to meet their minimum capital at the time of examination. Banks finance the loans they make at period t , L_t in part with an infinitely elastic supply of deposits, D_t , at a fixed interest cost of r_D , and beginning-of-period capital K_t such that:

$$L_t = D_t + K_t \quad \text{and} \quad K_t = k_t L_t \quad (4)$$

Bank managers' lending and leverage decisions at the beginning of the period then are summarized for period t :

$$L_t = \frac{1}{k_t} K_t \quad (5)$$

where k_t represents bank management's choice of leverage at the beginning of the first period and, while capital will satisfy regulatory requirements when the bank is reviewed, initial capital can be $k_t \geq k^*$.

Given the risk characteristics described above, q percent of loan customers have payment difficulties after one period. Loan examiners qualify these loans as problem loans. Lenders following the strict policy call the loans, reducing their banks' income by the following provision for loan losses⁴:

$$PLL_t = qw L_t \quad (6)$$

The strict loan strategy implies a change in equity capital for banks following that strategy as follows:

$$\Delta K_t^s = (1 - q) L_t r_L - qw L_t - D_t r_D \quad (7)$$

⁴See Walter (1991) for a discussion of the practice in the United States.

The rate of return on equity invested in period t for strict banks, ρ_{ts} , can be expressed in terms of the above-defined variables

$$\mathbf{r}_t^s = \frac{\Delta K_t^s}{K_t} = \frac{I}{k_t}(1-q)r_L - \frac{(1-k_t)}{k_t}r_D - qw \frac{I}{k_t} \quad (8)$$

Given the above, the strict lender's end-of-period measured capital, $k_{t+1}^{m,s}$, is given by:

$$k_{t+1}^{m,s} = \frac{K_t(1 + \mathbf{r}_t^s(k_t))}{K_t(1 + \mathbf{r}_t^s(k_t)) + K_t \frac{(1-k_t)}{k_t}} \geq k^* \quad (9)$$

Since \mathbf{r}_t^s is a function of the initial capital ratio k_t , the return maximizing initial capital (producing the minimum measured capital at the end of the period) can be solved using equation (9) to obtain:

$$k_t + k_t \mathbf{r}_t^s(k_t) = k^* + k^* k_t \mathbf{r}_t^s(k_t) \quad (10)$$

where k^* is the regulatory minimum capital ratio from above. Using equations (8) and (10) and simplifying, we obtain the capital ratio producing maximum returns following the strict loan policy:

$$k_t^s = \frac{k^* - (1-k^*)((1-q)r_L - r_D - qw)}{1 + (1-k^*)r_D} \leq k^* \quad (11)$$

The beginning-of-period capital for the strict lender is shown in the second column of Table 1 for various levels of regulatory capital shown in the first column and for different interest rates in the three panels, given parameter values shown at the bottom of the table. The table also shows also the rate of return for the strict lender in the third column. For example, at a regulatory

measured capital requirement of 5% and a loan rate of 11%, the strict bank begins the period with capital 4.69% of assets and earns 6.87% net of losses on that investment⁵.

To explore the effect of required capital on banks providing liquidity by not calling loans to borrowers whose projects do not pay off in period 1, we analyze lenient banks that renew non-performing customers until the end of the second period 2. Regulators require the lenient banks to write off the entire amount of the loans on unsuccessful project. A fraction $(1 - p)$ of these loans will be successful in the second period, and the remainder will be liquidated by the bank at the low return, R_{l2} at the end of the second period. In this simple model, lenient banks are assumed to make new loans with funds repaid by borrowers with successful project at the end of the first period at the one-period rate with capital leveraged using the regulatory capital level imposed at the end of period one. Bank assets are liquidated at the end of the second period and two-period projects that are unsuccessful at the end of second period are liquidated at $I + R_{2l}$ times the loan amount⁶. The measured return on capital for the first period after accounting for write-downs required by regulators can be written:

$$\mathbf{r}_t^l = \frac{\Delta K_t}{K_t} = \frac{I}{k_t}((1-q)r_L - (1-k_t)r_D - q) \quad (12)$$

Note, however, the q term is only a *recognized* loss, not a realized loss. As with the strict banks, we can write the measured end-of-period capital ratio for the lenient bank, $k_{t+1}^{m,l}$, as:

$$k_{t+1}^{m,l} = \frac{k_t(I + \mathbf{r}_t^l(k_t))}{k_t(I + \mathbf{r}_t^l(k_t)) + (1 - k_t)} \geq k^* \quad (13)$$

⁵ Write-offs are assumed equal to actual losses in the example.

⁶ An even more realistic solution can be found for the steady-state multi-period model where new two-period loans are made each period but the solution is more complicated than is useful in this discussion; Dietrich (2003) provides these solutions and evaluations using a variety of assumptions for model

The required beginning of period capital ratio for the lenient bank is given as:

$$k_t^l = \frac{k^* - (1 - k^*)((1 - q)r_L^2 - r_D - q)}{1 + (1 - k^*)r_D} \quad (14)$$

As can easily be seen by comparing the above to the beginning capital for strict banks, the initial capital for lenient banks is larger than for strict banks. That is, since

$$k_t^l \geq k_t^s \quad (15)$$

lenient banks in the two period analysis always have higher capital ratios than strict banks.

The lenient strategy only makes sense for banks if this strategy earns the same or a higher return than a strict policy over the two periods⁷. The average two period return with the lenient policy is:

$$\bar{r}^l = \frac{1}{2} \left[\frac{r_t^l k_t^l + q}{k_t^l} + r_{t+1}^l \right], \quad (16)$$

reflecting the fact that unrealized losses do not determine the bank's real return. Under our simple assumptions, the second period return consists of net earnings on non-performing loans from the initial period plus the returns on new loans leveraged with the minimum regulatory capital thus giving and includes only *realized* losses on loans:

$$\bar{r}_{t+1}^l = \frac{r_t^l k_t^l + q + q((1 - p)2r_L^2 + p(1 + R_{12})) + (1 - q)r_L^1 - (1 - k^*)r_D - qw}{2k_t^l}, \quad (17)$$

where we have expressed the two-period return as a return on first period capital that is assumed to be tied up for both periods. The two-period return from a lenient loan policy will be

parameters.

⁷ The examples below do not compound interest to keep the analysis as simple as possible. Clearly compounding could be incorporated and would not change the results.

higher than that from the strict policy whenever the returns from holding the loans one more period balance the costs of the write-offs from calling loans.

The last two columns of Table 1 provide values for the lenient lenders beginning-of-period capital and its rate of return using the same assumptions as for the strict lender. As can be seen from the table, the lenient lender must always have higher capital than the lenient lender, in fact initial capital is higher than regulatory minimums in order to absorb loan loss provisions as required by examiners.

3. The Effect of Counter-cyclical Capital Regulation

As demonstrated in the previous sections, higher levels of required capital or stricter enforcement of capital requirements changes the returns to strict and lenient banks and changes the difference in loan rates necessary to induce banks to be lenient. Providers of liquidity must be compensated to be willing to wait for a turnaround in temporarily distressed assets. In this section, we examine changes in the level of required capital on the cost of liquidity reflected in the differential between one-period and two-period renewable loans.

Table 2 shows the initial capital ratios for strict and lenient banks that produce returns on bank capital of 20%. As before, strict banks always have initial capital less than the required capital at the time of examinations, and lenient banks have more capital in order to absorb loan write-offs. At a required level of .05 of assets in capital at the time of bank examination, strict lenders have initial capital of .0412, while lenient lenders require .227. As capital standards are increased, initial capital levels increase. Figure 1 illustrates the effects of increasing required

capital on initial capital needs for strict and lenient lenders earning a 20% return using the numbers in Table 2. For example, at required capital of .20 of assets, strict banks initial capital has quadrupled as a percent of assets to .1701, while lenient banks' capital increases less than one half to .338 of assets. On the other hand, the increase in initial capital as a percent of assets is only 13% for strict banks (i.e. from .0412 to .1613) but capital needs for lenient lenders increase by 11 percent of assets.

Table 2 shows also the loan rates required to produce the 20% return on invested capital. At a required capital of .05 of assets, strict lenders require 16.07% average loan rate while lenient lenders will need 17.71% to cover their loan losses and carry non-performing loans one more period. The difference of 1.64% or 164 basis points represents a "liquidity" premium in the sense used in this paper, a charge to lenders for willingness to carry loans one more period. Figure 2 illustrates the relation between the level of loan rates producing a return on capital of 20% and required capital. The figure illustrates how, as required capital increases, the spread between rates required by strict and lenient lenders narrows with higher capital requirements, becoming approximately equal at around .20 of assets.

Bank regulators are likely to increase capital requirements or the stringency of capital enforcement, including required write-offs, in bad economic conditions when the demand for liquidity is increasing because fewer projects are successful in one period. In cases where bad economic conditions are expected to be short-lived as part of a business cycle temporary downturn, increasing capital requirements will raise pressure on loan rates at the precise time borrowers most require forbearance. Borrowers assessing long-term prospects to be good, that is, that projects will pay off, may not be able to justify project completion at higher loan

rates. Abandonment of projects because of increased loan rates could exacerbate recession forces at play in the economy, possibly delaying recovery.

Bad economic conditions may increase investors' required returns on capital to compensate for higher economic risks, including bank investors. Figure 3 illustrates the impact of changing the required return on bank capital from 20% to 25% on the level of loan rates for strict and lenient lenders at different levels of required capital. The figure demonstrates that the effect of changes on required returns is not too great for strict lenders, but the required returns for lenient lenders shift up dramatically. The figure makes clear that raising capital standards when the required returns on capital are increasing makes the impact on the supply of liquidity even more severe.

4. Conclusions

Banks subject to capital regulation and loan quality review must anticipate that some borrowers will experience difficulties in repaying loans in the short run. Banks wishing to accommodate borrowers who have good long-run prospects no matter what happens in the short run must invest more capital in order to absorb write-offs required by capital regulation. Because of their higher capital investments and loan losses, lenient lenders providing liquidity services must charge higher loan rates to earn the same returns as lenders not providing these services.

The model presented in this paper demonstrates that increased strictness in capital standards increases the costs to banks of providing liquidity. The implication is that counter-

cyclical capital regulation when credit market conditions are fragile can aggravate economic conditions, reducing the supply of bank loans and liquidity during downturns. This argument suggests that the stringency of capital regulation should be considered in a broader context than assuring the quality of bank assets.

The model results can also be interpreted in terms of differential capital requirements on different classes of assets. If some projects are likely to require more time to be completed but are classified as riskier for purposes of capital regulation and results in interim write-offs due to not being successful within a regulatory mandated time frame, the model demonstrates that these projects will have higher costs of funds. This opens the possibility that regulatory classification of asset risk could have implications for the types of assets banks finance that go beyond simply the one-period probability of success.

The model presented in the paper does not allow an analysis of the macroeconomic tradeoffs in capital regulation. Some previous analyses have touched on these issues in terms of socially optimal amounts of banks capital (e.g. Koehn and Santomero (1980)), but have not considered the effect of capital on liquidity. However, increasing bank capital requirements can be expected to reduce the willingness of banks to provide liquidity and to raise rates, thus reducing the demand financing for projects potentially requiring longer term (i.e. two-period) loans to be completed.

References

- Bank for International Settlements. 2001. *Overview of the New Basel Capital Accord*. (January 31).
- _____. 2002. *Basel Committee Reaches Agreement on New Capital Accord* (Press Release), July 10.
- Berger, Allen N and Gregory F. Udell. 1994. "Did Risk-Based Capital Allocate Bank Credit and Cause a 'Credit Crunch' in the United States?" *Journal of Money, Credit and Banking*, Vol. 26, Issue 3, Part 2 (August), pp. 585-628.
- Berger, Allen N., Richard J. Herring, and Giorio P. Szegö. 1995. "The role of capital in financial institutions," *Journal of Banking & Finance*, 19, pp. 393-430.
- Brinkman, Emile J. and Paul M. Horvitz. 1995. "Risk-Based Capital and the Credit Crunch," *Journal of Money, Credit, and Banking* Vol. 27 (August), pp. 848-863.
- Dietrich, J. Kimball. 2003. "Bank Capital and Risky Lending: Alternative Return Maximizing Strategies", University of Southern California, Discussion Paper.
- _____. 1996. *Financial Services and Financial Institutions: Value Creation in Theory and Practice*, Prentice Hall, Upper Saddle River, New Jersey.
- Kashyap, Anil K., Raghuram Rajan, and Jeremy C. Stein. 2002. "Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-Taking," *Journal of Finance*, Vol LVII, No. 1 (February), pp. 33-73.
- Koehn, Michael and Anthony M. Santomero. 1980. "Regulation of Bank Capital and Portfolio Risk," *Journal of Finance*, Vol. XXXV, No. 5 (December), pp. 1235-1244.
- Vojta, George J. 1973. *Bank Capital Adequacy*. Citicorp. New York.
- Thakor, Anjon V., and Patricia Furlong Wilson. 1995. "Capital requirements, loan renegotiation and the borrower's choice of financing source," *Journal of Banking & Finance*, 19, pp. 793-711.
- Walter, John R. 1991. "Loan Loss Reserves," *Economic Review*, Federal Reserve Bank of Richmond, Volume 77/4 (July/August), pp. 20-30.

Table 1

**Capital Requirements, Measured Capital, and Returns
Of Strict and Lenient Lenders At Three Loan Rates***

| k^* | k^s | r^s | k^l | r^l |
|--------------|--------|---------|--------|--------|
| $r_L = 11\%$ | | | | |
| 0,05 | 0,0469 | 6,87% | 0,1257 | 12,90% |
| 0,06 | 0,0562 | 7,22% | 0,1342 | 12,30% |
| 0,07 | 0,0655 | 7,47% | 0,1427 | 11,90% |
| 0,08 | 0,0747 | 7,66% | 0,1512 | 11,50% |
| 0,09 | 0,0840 | 7,81% | 0,1597 | 11,10% |
| 0,10 | 0,0933 | 7,93% | 0,1683 | 10,70% |
| 0,11 | 0,1027 | 8,03% | 0,1768 | 10,40% |
| 0,12 | 0,1120 | 8,11% | 0,1854 | 10,20% |
| 0,13 | 0,1214 | 8,18% | 0,1940 | 9,90% |
| 0,14 | 0,1307 | 8,24% | 0,2026 | 9,70% |
| 0,15 | 0,1401 | 8,29% | 0,2112 | 9,50% |
| 0,50 | 0,4789 | 8,79% | 0,5220 | 6,50% |
| $r_L = 14\%$ | | | | |
| 0,05 | 0,0233 | 120,55% | 0,102 | 29,60% |
| 0,06 | 0,0328 | 88,30% | 0,111 | 27,70% |
| 0,07 | 0,0423 | 70,49% | 0,120 | 26,00% |
| 0,08 | 0,0518 | 59,20% | 0,128 | 24,50% |
| 0,09 | 0,0613 | 51,40% | 0,137 | 23,20% |
| 0,10 | 0,0709 | 45,69% | 0,146 | 22,10% |
| 0,11 | 0,0804 | 41,33% | 0,155 | 21,10% |
| 0,12 | 0,0900 | 37,89% | 0,163 | 20,20% |
| 0,13 | 0,0996 | 35,11% | 0,172 | 19,40% |
| 0,14 | 0,1092 | 32,81% | 0,181 | 18,70% |
| 0,15 | 0,1188 | 30,88% | 0,190 | 18,00% |
| 0,50 | 0,4660 | 14,58% | 0,509 | 9,50% |
| $r_L = 17\%$ | | | | |
| 0,05 | 0,0154 | 235,82% | 0,094 | 37,10% |
| 0,06 | 0,0250 | 149,08% | 0,103 | 34,30% |
| 0,07 | 0,0346 | 110,28% | 0,112 | 32,00% |
| 0,08 | 0,0441 | 88,28% | 0,121 | 30,00% |
| 0,09 | 0,0537 | 74,12% | 0,129 | 28,20% |
| 0,10 | 0,0634 | 64,23% | 0,138 | 26,70% |
| 0,11 | 0,0730 | 56,94% | 0,147 | 25,40% |
| 0,12 | 0,0827 | 51,35% | 0,156 | 24,20% |
| 0,13 | 0,0923 | 46,91% | 0,165 | 23,10% |
| 0,14 | 0,1020 | 43,31% | 0,174 | 22,20% |
| 0,15 | 0,1117 | 40,33% | 0,183 | 21,30% |
| 0,50 | 0,4617 | 16,58% | 0,505 | 10,60% |

Parameter values: $r_D = 9\%$, $q = .1$, $w = .1$, $p = .8$, $R_{I2} = -100\%$

Table 2**Capital Ratios and Loan Rates Yielding 20% Return**

| k^* | k^s | rL-s | kl | rL-l |
|-------|--------|--------|-------|--------|
| 0,05 | 0,0412 | 16,07% | 0,227 | 17,71% |
| 0,06 | 0,0496 | 16,21% | 0,235 | 17,74% |
| 0,07 | 0,0580 | 16,36% | 0,242 | 17,77% |
| 0,08 | 0,0664 | 16,51% | 0,249 | 17,80% |
| 0,09 | 0,0749 | 16,65% | 0,257 | 17,83% |
| 0,10 | 0,0833 | 16,80% | 0,264 | 17,86% |
| 0,11 | 0,0919 | 16,95% | 0,271 | 17,90% |
| 0,12 | 0,1004 | 17,09% | 0,279 | 17,93% |
| 0,13 | 0,1090 | 17,24% | 0,286 | 17,97% |
| 0,14 | 0,1176 | 17,39% | 0,294 | 18,00% |
| 0,15 | 0,1263 | 17,53% | 0,301 | 18,04% |
| 0,16 | 0,1350 | 17,68% | 0,308 | 18,07% |
| 0,17 | 0,1437 | 17,83% | 0,316 | 18,11% |
| 0,18 | 0,1525 | 17,97% | 0,323 | 18,15% |
| 0,19 | 0,1613 | 18,12% | 0,331 | 18,18% |
| 0,20 | 0,1701 | 18,27% | 0,338 | 18,22% |

Parameter values: $r_D = 9\%$, $q = .1$, $w = .1$, $p = .8$, $R_{I2} = -100$

Figure 1

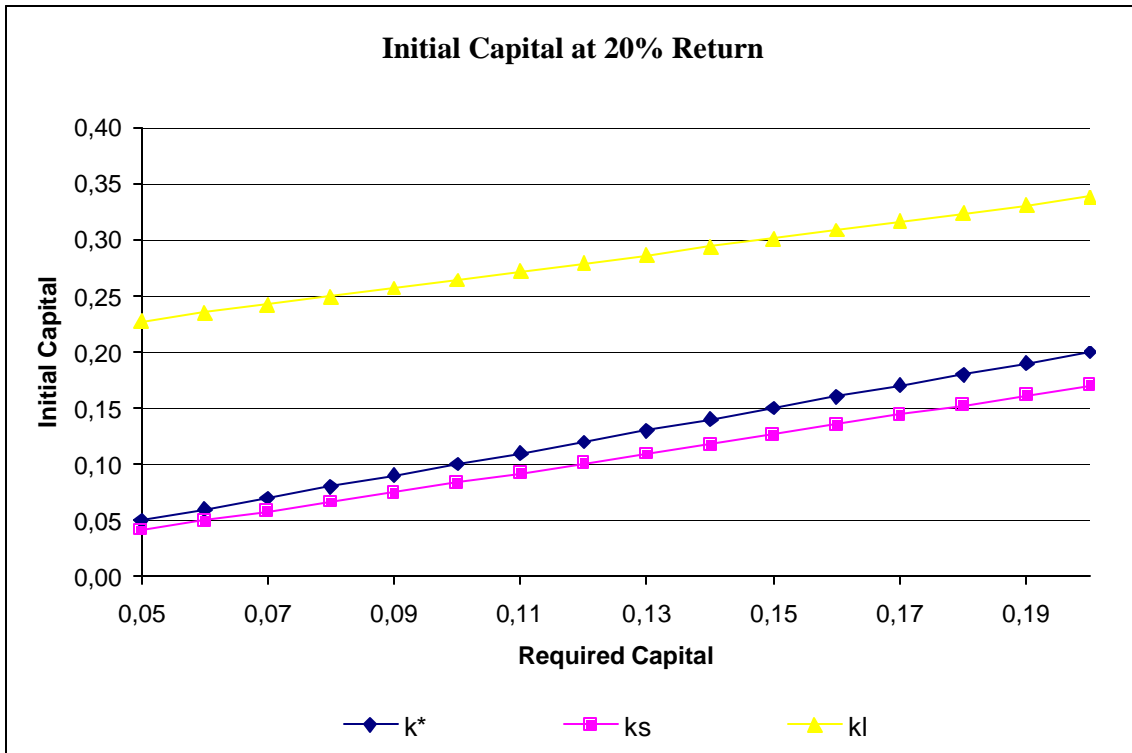


Figure 2

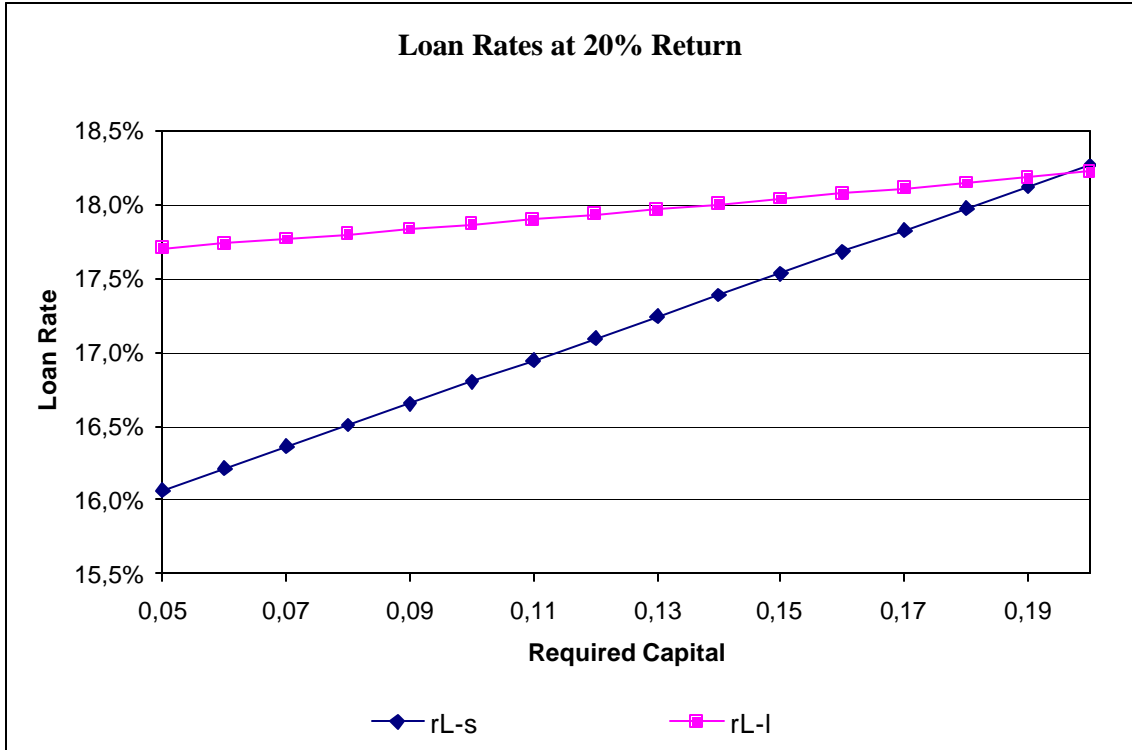


Figure 3

