Federal Reserve Bank of Chicago

# Bank Procyclicality, Credit Crunches, and Asymmetric Monetary Policy Effects: A Unifying Model

*Robert R. Bliss and George G. Kaufman*

WP 2002-18

**BANK PROCYCLICALITY, CREDIT CRUNCHES, AND ASYMMETRIC MONETARY POLICY EFFECTS: A UNIFYING MODEL**

by

**Robert R. Bliss**
Senior Financial Economist and Economic Advisor

Research Department
Federal Reserve Bank of Chicago
230 South La Salle Street
Chicago, IL 60604-1413

(312) 322-2313
(312) 322-2357 Fax

Robert.Bliss@chi.frb.org

and

**George G. Kaufman**
John Smith Professor of Finance and Economics
Loyola University Chicago and
Consultant, Federal Reserve Bank of Chicago

Loyola University—Chicago
College of Business
25 East Pearson
Chicago, IL 60611

(312) 915-7075
(312) 915-8508 Fax

gkaufma@luc.edu

November 13, 2002

JEL classification: E51, E32, G21

---

The views expressed herein are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of Chicago An earlier, shorter version of this paper was published under the title “Explaining Bank Credit Crunches and Procyclicality” in *Chicago Fed Letter,* Number 179 (Federal Reserve Bank of Chicago), July 2002.

# BANK PROCYCLICALITY, CREDIT CRUNCHES, AND ASYMMETRIC MONETARY POLICY EFFECTS: A UNIFYING MODEL


## Abstract

Much concern has recently been expressed that both large, procyclical changes in bank assets and "credit crunches" caused by bank reluctance to expand loans during recessions contribute to economic instability. These effects are difficult to explain using the standard textbook model of deposit expansion in which deposits are constrained only by reserve requirements. However, these effects follow easily if the model is expanded to include a second, capital constraint.

**BANK PROCYCLICALITY, CREDIT CRUNCHES, AND ASYMMETRIC MONETARY POLICY EFFECTS: A UNIFYING MODEL**

## Introduction

Much concern has been expressed recently about the perceived excessive procyclicality of banks that may exacerbate the cyclical behavior of the macroeconomy and, in particular, hamper recoveries from recessions. Although most industries experience cyclical movements in output and profitability in sympathy with the cyclical swings in the economy as a whole, such cyclicality in bank assets, loans, and capital tends to exceed that in the macroeconomy as well as in many other sectors of the economy, expanding faster in upturns and contracting faster in downturns. This pattern is perceived to be more important for banks than most other sectors of the economy both because banks provide demand deposits, the largest part of the money supply (M1 and M2), and are a major provider of credit to the economy. Furthermore, banks are used by the Federal Reserve as its primary channel for transmitting monetary policy. Fluctuations in bank deposits and credit thus have significant, indeed critical, effects on the macroeconomic activity and may amplify swings in the macroeconomy. As a result, among other things, the ability of the economy to recover from recessions may be restricted both because banks are unwilling or unable to increase their loans or total credit to satisfy the increasing demand for such loans or credit and because any increases in bank reserves from expansive Federal Reserve monetary policy may not be accompanied by corresponding increases in bank credit or deposits. This may result in "credit crunches" characterized by sharp increases in effective bank loan rates and widespread reports of unmet credit needs during periods of perceived expansive monetary policy. If such crunches exist, they may partial or totally frustrate the intended impact of the expansive monetary policy. The empirical evidence in support of the existence of credit crunches is inconclusive, primarily because of the inability to clearly differentiate between demand and supply forces.

Credit crunches, excessive procyclicality in bank behavior, and limited effects of expansionary Fed monetary policy in economic recessions cannot easily be reconciled with what the usual simple textbook bank deposit or bank credit expansion model would predict to be outcomes of an expansive monetary policy. This paper develops a potential structural rationale for the existence of these three observations. We demonstrate that procyclicality, credit crunches, and the observed asymmetry in the effectiveness of Fed policy actions during expansions and contractions may be a predictable outcome of a slightly more complex model that introduces a market or regulatory capital constraint in addition to the traditional reserve constraint.[1]

## The textbook model—a single constraint

In typical textbook models (e.g., Mishkin, 2001 and Kaufman, 1995), aggregate bank deposit and earning asset expansions are constrained on the supply side only by reserve requirements, usually expressed as a percent of deposits. Reserves are held by banks both voluntarily against the possible liquidity demands by depositors wishing to withdraw funds and by statute to satisfy requirements imposed by central banks. The effective reserve requirement is then the higher of that set by the regulatory agencies or that imposed by market forces. For convenience, in this paper we focus primarily on regulatory reserve requirements. We assume that any reserves held by the banking system above the effective requirement are "excess" reserves and are sub-optimal because they earn less than earning assets, such as loans and securities, and are not needed to satisfy depositor liquidity demand.

Because holding non-earning excess reserves is sub-optimal, banks will seek to convert any excess reserves to earning assets. They do this by making loans or purchasing securities. In the process, they increase their deposits up to the limits imposed by the regulatory-required reserve ratio and the total reserves in the banking system. For example, consider the base case shown in the summary balance sheet in figure 1 for a greatly simplified representation of the banking system including cash reserves, earning assets (loans and securities), deposits and capital (equity). Assume that there is no prudential capital requirement but that the banks do hold capital and that the reserve requirement set by the Fed is 10% of deposits. Banks hold as many deposits as permitted, so that excess reserves are zero. Deposits are $1,120, total and required reserves are both $112, capital is $100, and earning asset are $1,108. The system is in equilibrium.

Now assume that the Federal Reserve wishes to pursue an expansionary monetary policy in order to boost macroeconomic activity. To do so it lowers the Fed Funds rate by injecting $100 of new reserves into the system through purchasing securities from banks in open market

[1] The importance of a capital requirements on bank credit has been previously noted by, among others, Thakor, 1996, Bernanke and Lown, 1991, and Van der Heuvel, 2002, but has not been fully integrated into the bank deposit expansion model.

operations. The immediate effect on the banking system is shown in figure 2, panel A. The system is no longer in equilibrium. Total reserves increased to $212, the reserve ratio has increased to 18.9%, excess reserves increase to $100, bank earning assets have declined by $100, and deposits and required reserves have remained unchanged at $1,120 and $112, respectively. The newly created $100 in excess reserves is not optimal to the banks, which can increase profits by expanding their portfolios of earning assets through deposit creation. The banking system therefore expands lending, which creates new deposits, until excess reserves are again zero. This results in the new equilibrium balance sheet shown in figure 2, panel B. In this new equilibrium, deposits have increased by $1,000 from $1,120 to $2,120 and the earning assets of banks have increased by $900 from $1,108 to $2,008. In the process, the reserves-to-deposit ratio has returned to the required minimum of 10%, so that banks are constrained from increasing earning assets further. In this situation, expansive monetary policy is successful in increasing banks' credit, as the textbooks foretell. Note, however, that, although the dollar amount of capital in the banking system as a whole remained at $100, in percentage terms, capital has declined from 8.2% to 4.5% of assets and from 9.0% to 5.0% of earning assets.

## The reality—two constraints

In reality, banks are subject to capital requirements as well as reserve requirements. For example, for prudential purposes, bank regulators generally require banks to maintain capital at no less than a stated fraction of the bank's total assets. In the early 1990s, risk-weighted capital requirements were added to the extant regulatory capital requirements based only on total assets. Under risk-weighted capital requirements, different types of assets are assigned different weights according to their perceived risk. The greater is the perceived risk, the greater is the weight. For instance, mortgage loans count less than loans to corporations. The capital charge is then applied to the sum of the weighted assets. This means that the composition of the bank's assets as well as the total size of the portfolio matters in determining the regulatory capital charge. Proposals currently under consideration by the Basel Committee on Bank Supervision would further refine the computation of risk-weighted assets by, among other things, allowing banks to use internal models to determine the risk weights for individual loans (rather than having the weights determined by creditor type). This raises the future possibility that the risk weight of particular loans could fluctuate with changing economic conditions. Thus, even though regulatory capital ratios are fixed, the required capital that must be held depends on the size of the asset portfolio, its composition, and in the future on economic conditions.

In addition to regulatory capital requirements, markets impose capital requirements of their own, through their demand to charge higher interest rates on deposits and other funding or their unwillingness to transact with banks that are perceived to have insufficient levels of capital. Rating agencies also consider capital levels in determining the creditworthiness of institutions. Lastly, for their own internal risk-management purposes, banks self-impose minimum levels of capital for the portfolio of assets and liabilities they hold, typically scaled by the riskiness of the positions. For purposes of illustration, we analyze the effects of monetary policy on the banking system of two different regulatory capital ratio requirements—capital-to-earning-assets and capital-to-total-assets. By including capital requirements, bank deposit and credit expansions in the model are now subject to two constraints rather than only one constraint.

Returning to our previous base case (figure 1), assume that the regulatory authorities require banks to hold capital equal to 9.0% of aggregate earning assets and that banks do not want to hold capital in excess of the required minimum. The previous 10% reserves-to-deposits requirement remains in effect. In figure 1, both constraints are satisfied and, as there is no excess reserves or excess capital, the banking system is in equilibrium. To stimulate the economy, the Fed again injects $100 of new reserves into the banking system by purchasing securities from banks. The immediate effect is shown in figure 3, panel A. The banks are no longer in equilibrium. They are holding both excess reserves and, as earning assets decline**,** excess capital. As a result, the bank attempts to deploy the excess reserves by increasing earning assets through lending. However, the $100 of capital in the system can only sustain $1,108 of earning assets. Thus, once the banks have restored the $100 of earning assets lost through the sale of securities to the Fed, they can increase earning assets no further, resulting in the banking system balance sheet shown in figure 3, panel B. Even though the $90 of excess reserves is sub-optimal, the binding capital constraint prevents the banks from further improving their balance sheet. Thus, when capital constraints are binding, the Fed may be unable to increase bank earning assets through monetary policy alone.

If the binding capital requirement were in terms of the capital-to-total assets rather than to earning-assets ratio, monetary policy could be even less effective in achieving an expansion in bank credit. Suppose the capital requirement was 8.0% of total assets. Then the $100 of capital in the banking system could support at most $1,250 of total banking system assets. After the initial $100 reserve injection shown in figure 3 panel A, the efforts of the banking system to increase lending would result in the balance sheet shown in panel C. In this scenario, the capital requirement becomes binding when the level of earning assets is only $1,038. Because the constraint is on total assets, the composition of assets between earning and nonearning is irrelevant and the injection of reserves by the Fed actually has an immediate and seemingly perverse effect of actually reducing bank earning assets held by the banking system from $1,108 in the original base case in figure 1 to $1,038. Deposits, however, increase by $30.[2]

The twin constraints of reserve requirements and capital requirements mean that at times banks may hold either excess reserves or excess capital. It also means that, if monetary policy is concerned with credit provided through the banking system in addition to the level of interest rates, it is limited in its ability to increase bank credit whenever banks are capital constrained. The Fed can always make reserve requirements less binding by injecting reserves. But this will have the effect of expanding banks' assets only if the system as a whole has the excess capital necessary to support an expanded portfolio of earning assets or banks can profitably raise additional capital. To achieve the $1,000 increase in deposits following an injection of $100 of reserves that would be expected to occur if reserve requirements were the only constraint (shown in figure 2, panel B), the banking system would have to raise an additional $66 of new capital, if the capital requirement were 9% of earning assets, or $84 of new capital, if the capital requirement were 8% of total assets. This would result in the aggregate balance sheets shown in figure 4, panel A and B. In both panels, earning and total assets would be greater than in figure 2 by the amount of the increase in capital.

The relationship among bank earning assets, reserves, and capital subject to both a reserve and capital constraint is developed mathematically in the Appendix and graphed in figure 5 for both a capital-to-earning assets requirement (Case 1) and a capital-to-total assets requirement (Case 2). The graphs show the maximum dollar amount of earning assets that the banking system can support for different levels of total reserves provided by the Federal Reserve if the banks were subject to a reserve requirement of 10% of deposits and/or a capital

[2] The $100 of securities purchased by the Federal Reserve do not disappear from the economy, only from the banking system's balance sheet. When this is factored back in, the $100 injection of reserves produces a small net increase of economy-wide earning assets of $30, reflected in the $30 increase in deposits, even though bank earning assets decline slightly. The key distinction is that when the banking system is not capital constrained, a $100 injection of reserves produces a $1,000 increase in economy-wide earning assets; but when the banking system is capital constrained the increase in economy-wide earning assets is reduced to only $30.

requirement of 8% of earning assets and 9% of total assets, respectively. If there were no capital constraint, earning assets would increase linearly with reserves along the reserve constraint line. Note that, when reserves are zero, earning assets are equal to the $100 of capital. But, when a capital constraint is added, as reserves increase, earning assets increase only to the point where the capital constraint intersects the reserve constraint and becomes binding. Thereafter, earning assets increase less as reserves increase than without the capital constraint and even decrease when the capital requirement is scaled to total assets.

When the capital constraint is binding, targeted increases in bank credit and deposits by the Federal Reserve may be achieved only if the banks can profitably raise the additional capital needed to support the higher level of assets. During contractions, external capital is likely to be more costly making banks reluctant to raise external funds that they may not be able to invest profitably. As a result, capital constraints are more likely to be binding during a recession than an expansion. This interaction of capital constraints and cyclical variations in the cost of external funds can explain an excessive procyclical pattern in bank assets.

## Implications for Monetary Policy

Including a capital constraint in the bank expansion model has important implications for the effectiveness of monetary policy over the business cycle. As noted above, capital, which is not under central bank control, may become the binding constraint on banks during periods of economic recessions and monetary expansion. On the other hand, reserves, which are under central bank control, are the likely effective constraint on banks during periods of economic boom and restrictive monetary regimes. Thus, insofar as monetary policy relies on bank deposits or bank credit to achieve its objectives, it may be easier for the Fed to restrain expansions then to stimulate recoveries. That is, the ability of monetary policy to stabilize the economy is asymmetrical.[3]

In addition to limiting the potential effectiveness of monetary policy in stimulating credit expansion, capital constraints may also impose a further negative effect on banking credit expansion. During economic downturns, when monetary policy seeks to stimulate bank lending, actual levels of bank capital are likely to be declining as loans default and are charged off and

[3] Morgan (1993) provides empirical evidence of this asymmetry.

loan-loss reserves replenished. If capital constraints are binding, this forces banks to reduce lending further unless they are able to raise additional capital profitably.

The effective capital requirement may also increase during downturns if it is risk sensitive, as is currently the case under the requirements developed by the Basel Committee on Banking Supervision. Moreover, current proposals by the Committee would increase the risk sensitivity of these capital requirements further. The level of required regulatory capital would increase as the credit risk of the loan portfolio increases. In a downturn, this is likely to occur. Not only do more loans default, but the default risk of performing loans in the aggregate tends to increase, as does the expected loss when default occurs. This increases the risk-weighted value of existing assets, which in turn translates into an increase in the associated regulatory capital that must be held against those assets. As a result, in recessions, the level of earning assets that the banking system can support on the existing capital base is further reduced, giving rise to perceived credit crunches (Wagster, 1999).

Earning assets (bank credit) may be divided into loans and securities (investments) and distinctions can be made between these with respect to economic impact. Some commentators perceive increases in loans to provide more stimulus than an equal dollar increase in securities (e.g., Bernanke and Blinder, 1988). Credit crunches are then defined in terms of loan levels and/or originations rather than in terms of earning assets. The empirical studies of the reported credit crunch sightings of the early 1990s frequently focused on the adverse impact of the existing risk-based Basel capital requirements, which were being phased in at the time. Under these standards, capital requirements on loans were generally have higher than capital requirements on investment securities.[4] Indeed, if U.S. Treasury securities are assigned a zero risk weight at U.S. banks, capital constrained banks can increase aggregate earning assets by purchasing these securities but not by expanding loans. However, even without Basel requirements, the market may impose differential capital requirements on different assets. Some observers (e.g., Kashyap and Stein, 1994 and 2000) also argue that, because the demand for

[4] Because increases in loan losses in recessions often reflect risky loans made in previous expansions but viewed at the time as not risky, some analysts have recommended that loan-loss reserves accounting be changed to reserve more when loans are made rather than when they default. That is, reserving should focus more on ex-ante loss behavior rather than ex-post. Such accounting procedures would decrease reported bank capital during macroeconomics expansions but increase bank capital during macroeconomic recessions relative to current accounting practices and help reduce any excessive procyclicality in bank (Borio, 2002, and Borio, Furfine, and Lowe, 2001). This result presupposes that the market accepts the new accounting convention and that regulatory rather than market-imposed or prudential capital requirements are the binding constraint.

loans is weak in recessions, banks will expand securities rather than loans on any new reserves provided and thereby partially frustrate Fed expansionary intentions.

## Conclusion

We have shown how the simple one-constraint (reserve requirements) model of monetary policy, which changes the deposits and assets of the banking system by injecting or withdrawing reserves and thereby changes interest rates, is incomplete. In practice, banks are subject to two constraints—capital as well as reserve requirements. Where capital requirements are binding, the model clearly shows that injection of additional reserves by the Fed may not achieve the intended increase in bank deposits and earning assets.

If either constraint is binding, earning assets cannot grow further. Monetary policy can directly impact only one of the two potential constraints faced by banks—the reserve requirement—and is impotent to affect the other—capital—constraint. Where monetary policy seeks to increase earning assets, it can do so successfully through injection of reserves only if the effective capital requirement is not binding or if market conditions allow banks to raise the required additional capital profitably. On the other hand, if monetary policy seeks to constrain the growth of bank earning assets, e.g., to slow an overheated expansion, it is able to unambiguously do so by withdrawing reserves. In this case, banks must reduce their lending and investment in securities because they can no longer sustain the same level of deposits to support these investments. If, at this time, the capital constraint is not binding, banks will either hold excess capital or reduce the excess through stock buy-backs, dividend increases, or acquisitions.

Observed fluctuations in the level of bank capital through the business cycle—higher capital ratios during economic expansions and lower ratios during recessions—together with changes in the effective capital requirement if the ratio is risk-sensitive, are likely to create further procyclical changes in bank loans and earning assets and give rise to perceived credit crunches. Capital requirements are likely to become binding at just the time that the Fed is seeking to stimulate credit expansion—at the bottom of a business cycle. Thus, the introduction of the capital constraint in the bank deposit expansion model can explain the observed perceived excessive procyclicality in bank balance sheets, characterized by an expansion of bank credit and deposits that is more rapid than the growth of the economy as a whole during expansions and declines in these measures that is more rapid than declines in the macroeconomy during recessions. The two-constraint model also explains the potential for credit crunches during the early stages of a macroeconomic recovery, and the frequently greater effectiveness of monetary policy in restraining booms than in stimulating recoveries.

If, in recessions, banks cannot raise new capital at favorable prices, the only direct tool the Fed has to remove a binding capital constraint and encourage increases in bank credit and deposits is to lower the regulatory capital requirement. However, this has potential adverse consequences for bank safety and soundness and, in any case, may not be sufficient if the effective capital requirement is being determined by the market or internal bank risk-management concerns rather than by regulatory fiat.

## References


Bernanke, Ben S. and Alan S. Blinder, "Credit, Money, and Aggregate Demand," *American Economic Review*, May 1988, pp. 435-439.

Bernanke, Ben S. and Cara S. Lown, "The Credit Crunch," *Brookings Papers on Economic Activity*, No.2, 1991, pp.205-239.

Borio, Claudio, "Towards a Macro-Prudential Framework for Financial Supervision and Regulation," Working paper, Bank for International Settlements, July 2002.

Borio, Claudio, Craig Furfine, and Philip Lowe, "Procyclicality of the Financial System and Financial Stability: Issues and Policy Options," in Marrying the Macro- and Micro-Prudential Dimensions of Financial Stability (BIS Papers, No. 1), Basel: Bank for International Settlements, 2001, pp.1-57.

Bliss, Robert and George G. Kaufman, "Explaining Bank Credit Crunches and Procyclicality," Chicago Fed Letter (No. 179), July 2002.

Kashyap, Anil K. and Jeremy C. Stein, "Monetary Policy and Bank Lending," in Monetary Policy, N. Gregory Mankiw ed., University of Chicago Press, 1994, pp. 221–256.

Kashyap, Anil K. and Jeremy C. Stein, "What do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review* 90(3), June 2000, pp. 407–428.

Kaufman, George G. The U.S. Financial System ($6^{th}$ ed.), Englewood Cliffs, N.J.: Prentice-Hall, 1995.

Mishkin, Frederic S. The Economic of Money, Banking and Financial Markets ($6^{th}$ ed.), Boston: Addison Wesley, 2001.

Morgan, Donald P., "Asymmetric Effects of Monetary Policy," *Economic Review* (Federal Reserve Bank of Kansas City), Second Quarter, 1993.

Thakor, Anjan V., "Capital Requirements, Monetary Policy, and Bank Lending: Theory and Empirical Evidence," *Journal of Finance*, March 1996, 279–324.

Van der Heuvel, Skander J., "Does Bank Capital Matter for Monetary Policy?" *Economic Policy Review* (Federal Reserve Bank of New York), May 2002, pp. 259-265.

Wagster, John, "The Basel Accord of 1988 and the International Credit Crunch of 1989-1992," *Journal of Financial Services Research*, March 1999, pp. 123-193.

## Appendix: Mathematics of the Twin Constraints

The dilemma facing the Federal Reserve when it is seeking to increasing bank earning assets can be shown mathematically. Consider a simple bank balance sheet consisting of earning assets, *EA*, reserves, *R*, deposits, *D*, and capital, *C*. The accounting identity requires that $R + EA = D + C$. The bank faces a reserve requirement stipulating that the reserves-to-deposit ratio may not exceed *r*; so $r \times D \leq R$. The bank also faces a required capital ratio, *k*. If this ratio is based on earning assets, then $k \times EA \leq C$. If the ratio is based on total assets, then $k \times (EA + R) \leq C$. Using these relations, and depending on the form the capital constrain takes, it is possible to show that earning assets are constrained as follows:

$$EA \leq \begin{cases} \min\left\{R \times \left(\frac{1-r}{r}\right) + C, \frac{C}{k}\right\} & \text{if } k \times EA \leq C \\ \min\left\{R \times \left(\frac{1-r}{r}\right) + C, \frac{C}{k} - R\right\} & \text{if } k \times \left(EA + R\right) \leq C \end{cases}.$$

From these equations we can see that in the earning assets-to-capital ratio case, reserves have no effect on the capital constraint. Therefore, when this constraint becomes binding, increasing reserves cannot increase earning assets. In the total assets-to-capital ratio case, reserves have the perverse effect of reducing the ceiling on earning assets imposed through the capital constraint. In this case, the maximum possible amount of earning assets is achieved by setting $R = r \times C \times \frac{1-k}{k}$, at which point $EA = C \times \left(\frac{1-r}{k} + r\right)$.

Figure 5 illustrates these effects. For this example reserves and capital are both held fixed at $100, the reserve requirement is set at 10%, and the capital requirement is set at 9% of either earning assets (Case 1) or total assets (Case 2). The region labeled "Feasible earning assets/reserves combinations" shows the joint effect of the two constraints in limiting the possible level of earning assets at any given level of reserves.

**Figure 1: Base Case**

| | | | | |
|---|---|---|---|---|
| **Reserves** (Total) | | 112 | 1120 | **Deposits** |
| Required | 112 | | | |
| Excess | 0 | | | |
| **Earning Assets** | | 1108 | 100 | **Capital** |
| **Totals** | | 1220 | 1220 | |
| **Ratios** | **Actual** | | **Req'd** | |
| Reserves/ Deposits | 10.0% | | 10.0% | |
| Capital/ Earn. Assets | 9.0% | | N/A | |
| Capital/ Assets | 8.2% | | N/A | |

**Figure 2 (Reserve Requirement Constraint)**

**Panel A: After injection of reserves**

| | | | | |
|---|---|---|---|---|
| **Reserves** (Total) | | 212 | 1120 | **Deposits** |
| Required | 112 | | | |
| Excess | 100 | | | |
| **Earning Assets** | | 1008 | 100 | **Capital** |
| **Totals** | | 1220 | 1220 | |
| **Ratios** | **Actual** | | **Req'd** | |
| Reserves/ Deposits | 18.9% | | 10.0% | |
| Capital/ Earn. Assets | 9.9% | | N/A | |
| Capital/ Assets | 8.2% | | N/A | |

**Panel B: After increase in earning assets**

| | | | | |
|---|---|---|---|---|
| **Reserves** (Total) | | 212 | 2120 | **Deposits** |
| Required | 212 | | | |
| Excess | 0 | | | |
| **Earning Assets** | | 2008 | 100 | **Capital** |
| **Totals** | | 2220 | 2220 | |
| **Ratios** | **Actual** | | **Req'd** | |
| Reserves/ Deposits | 10.0% | | 10.0% | |
| Capital/ Earn. Assets | 5.0% | | N/A | |
| Capital/ Assets | 4.5% | | N/A | |

**Figure 3 (Reserve and Capital Requirement Constraints)**

**Panel A: After injection of reserves**

| | | | |
|---|---|---|---|
| **Reserves** (Total) | 212 | 1120 | **Deposits** |
| Required | 112 | | |
| Excess | 100 | | |
| **Earning Assets** | 1008 | 100 | **Capital** |
| **Totals** | 1220 | 1220 | |

| **Ratios** | **Actual** | **Req'd** |
|---|---|---|
| Reserves/ Deposits | 18.9% | 10.0% |
| Capital/ Earn. Assets | 9.9% | 9.0% |
| Capital/ Assets | 8.2% | N/A |

**Panel B: After increase in earning assets**

| | | | |
|---|---|---|---|
| **Reserves** (Total) | 212 | 1220 | **Deposits** |
| Required | 122 | | |
| Excess | 90 | | |
| **Earning Assets** | 1108 | 100 | **Capital** |
| **Totals** | 1320 | 1320 | |

| **Ratios** | **Actual** | **Req'd** |
|---|---|---|
| Reserves/ Deposits | 17.4% | 10.0% |
| Capital/ Earn. Assets | 9.0% | 9.0% |
| Capital/ Assets | 7.6% | N/A |

**Panel C: After increase in earning assets**

| | | | |
|---|---|---|---|
| **Reserves** (Total) | 212 | 1150 | **Deposits** |
| Required | 115 | | |
| Excess | 97 | | |
| **Earning Assets** | 1038 | 100 | **Capital** |
| **Totals** | 1250 | 1250 | |

| **Ratios** | **Actual** | **Req'd** |
|---|---|---|
| Reserves/ Deposits | 18.4% | 10.0% |
| Capital/ Earn. Assets | 9.6% | N/A |
| Capital/ Assets | 8.0% | 8.0% |

**Figure 4 (Reserve and Capital Requirement Constraints)**

**Panel A: After injection of reserves and raising capital**
**(w/ earning assets/capital requirement)**

| | | | |
|---|---|---|---|
| **Reserves** (Total) | 212 | 2120 | **Deposits** |
| Required | 212 | | |
| Excess | 0 | | |
| **Earning Assets** | 2074 | 166 | **Capital** |
| **Totals** | 2286 | 2286 | |

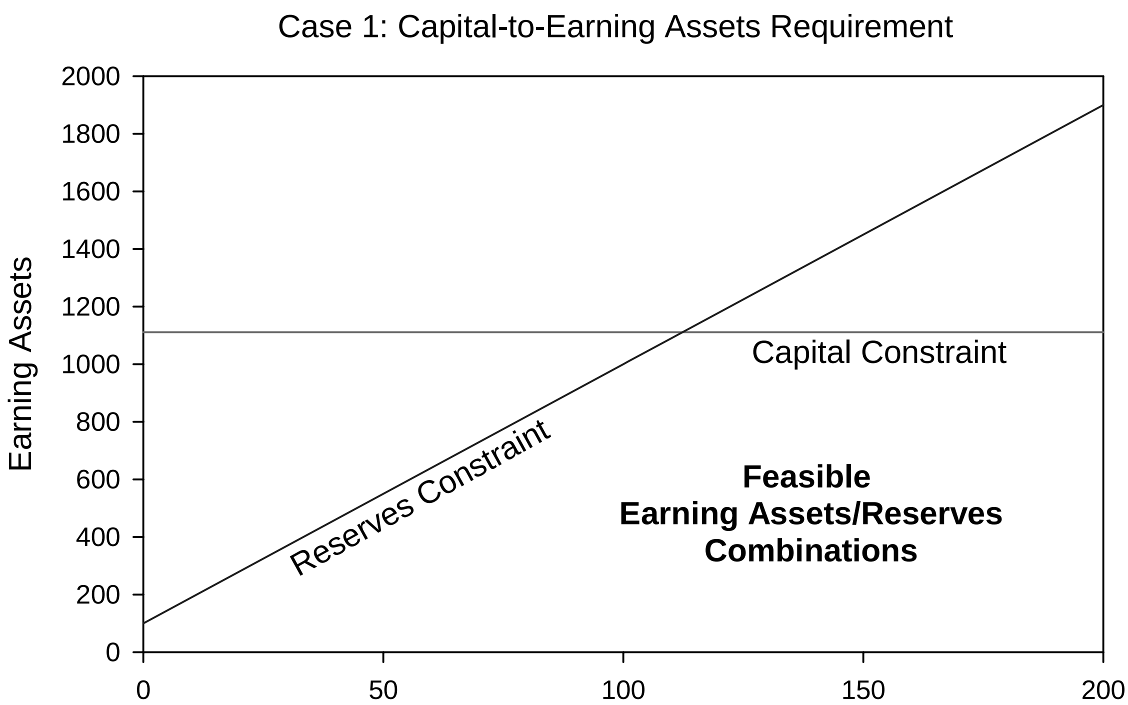
| **Ratios** | **Actual** | **Req'd** |
|---|---|---|
| Reserves/ Deposits | 10.0% | 10.0% |
| Capital/ Earn. Assets | 9.0% | 9.0% |
| Capital/ Assets | 7.3% | N/A |

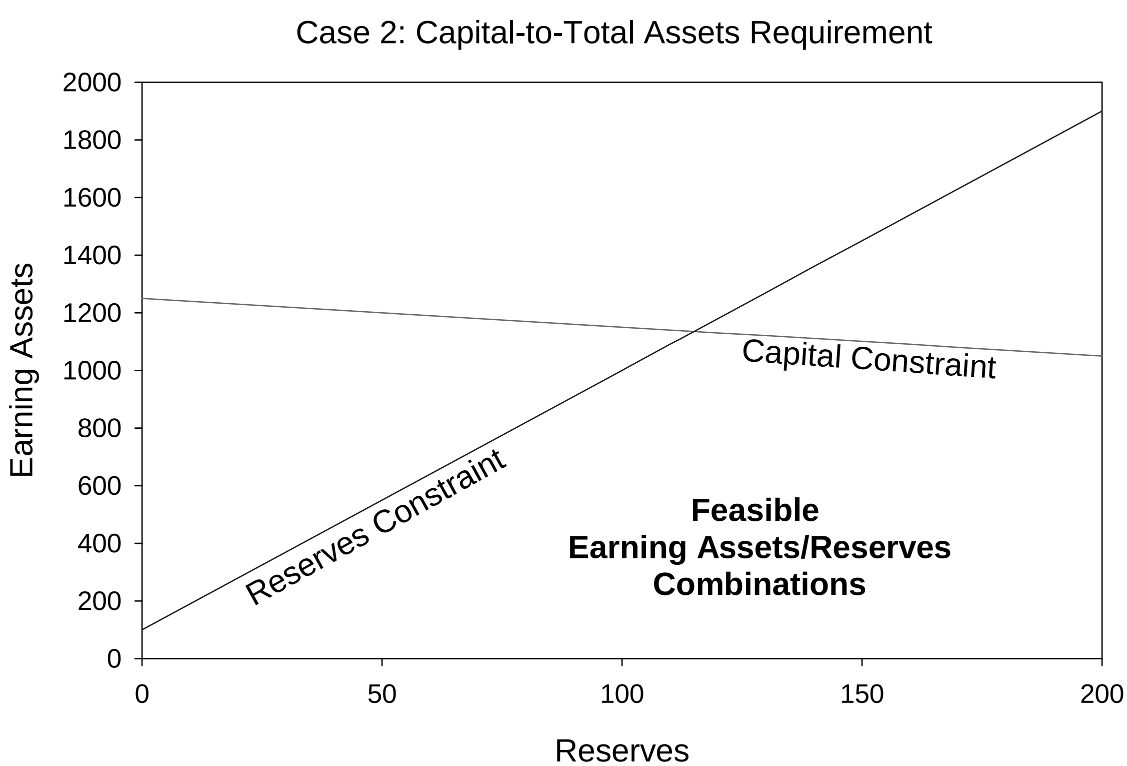
**Panel B: After injection of reserves and raising capital**
**(w/ total assets/capital requirement)**

| | | | |
|---|---|---|---|
| **Reserves** (Total) | 212 | 2120 | **Deposits** |
| Required | 212 | | |
| Excess | 0 | | |
| **Earning Assets** | 2092 | 184 | **Capital** |
| **Totals** | 2304 | 2304 | |

| **Ratios** | **Actual** | **Req'd** |
|---|---|---|
| Reserves/ Deposits | 10.0% | 10.0% |
| Capital/ Earn. Assets | 8.8% | N/A |
| Capital/ Assets | 8.0% | 8.0% |

**Figure 5: The Effects of Capital and Reserve Requirements on Earning Assets**



## Working Paper Series

A series of research studies on regional economic issues relating to the Seventh Federal Reserve District, and on financial and economic topics.

## **Working Paper Series** *(continued)*

## Working Paper Series *(continued)*

## **Working Paper Series** *(continued)*

## Working Paper Series *(continued)*

| | |
|---|---|
| Sub-Debt Yield Spreads as Bank Risk Measures<br>*Douglas D. Evanoff and Larry D. Wall* | **WP-01-03** |
| Productivity Growth in the 1990s: Technology, Utilization, or Adjustment?<br>*Susanto Basu, John G. Fernald and Matthew D. Shapiro* | **WP-01-04** |
| Do Regulators Search for the Quiet Life? The Relationship Between Regulators and The Regulated in Banking<br>*Richard J. Rosen* | **WP-01-05** |
| Learning-by-Doing, Scale Efficiencies, and Financial Performance at Internet-Only Banks<br>*Robert DeYoung* | **WP-01-06** |
| The Role of Real Wages, Productivity, and Fiscal Policy in Germany's Great Depression 1928-37<br>*Jonas D. M. Fisher and Andreas Hornstein* | **WP-01-07** |
| Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy<br>*Lawrence J. Christiano, Martin Eichenbaum and Charles L. Evans* | **WP-01-08** |
| Outsourcing Business Service and the Scope of Local Markets<br>*Yukako Ono* | **WP-01-09** |
| The Effect of Market Size Structure on Competition: The Case of Small Business Lending<br>*Allen N. Berger, Richard J. Rosen and Gregory F. Udell* | **WP-01-10** |
| Deregulation, the Internet, and the Competitive Viability of Large Banks and Community Banks<br>*Robert DeYoung and William C. Hunter* | **WP-01-11** |
| Price Ceilings as Focal Points for Tacit Collusion: Evidence from Credit Cards<br>*Christopher R. Knittel and Victor Stango* | **WP-01-12** |
| Gaps and Triangles<br>*Bernardino Adão, Isabel Correia and Pedro Teles* | **WP-01-13** |
| A Real Explanation for Heterogeneous Investment Dynamics<br>*Jonas D.M. Fisher* | **WP-01-14** |
| Recovering Risk Aversion from Options<br>*Robert R. Bliss and Nikolaos Panigirtzoglou* | **WP-01-15** |
| Economic Determinants of the Nominal Treasury Yield Curve<br>*Charles L. Evans and David Marshall* | **WP-01-16** |
| Price Level Uniformity in a Random Matching Model with Perfectly Patient Traders<br>*Edward J. Green and Ruilin Zhou* | **WP-01-17** |
| Earnings Mobility in the US: A New Look at Intergenerational Inequality<br>*Bhashkar Mazumder* | **WP-01-18** |
| The Effects of Health Insurance and Self-Insurance on Retirement Behavior<br>*Eric French and John Bailey Jones* | **WP-01-19** |

## Working Paper Series *(continued)*

## Working Paper Series *(continued)*