

# Economic Review

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### REMINDER

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and Brian Motley

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- Capital Regulation and Bank Risk-Taking
- A Reexamination of Mean-Variance Analysis of Bank Capital Regulation

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# Nominal Feedback Rules for Monetary Policy

## John P. Judd and Brian Motley

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*We assess empirically how a particular set of monetary policy rules (suggested by Bennett McCallum) would operate in the transition to zero inflation, and in maintaining price stability thereafter. We do this through repeated stochastic simulations of price and nominal income rules within three different models of the economy. The price rule leads to instability in some models. However, the nominal income rule consistently works with high probability to reduce inflation from present levels to zero in five years, without significantly raising the probability of a recession. That rule also would ensure price stability in the long run, but possibly at the expense of slightly more volatility in real GNP.*

It now is widely accepted both outside and inside the Federal Reserve that price stability is the appropriate long-term goal of U.S. monetary policy. This view has been advocated by a substantial part of the economics profession for a long time. The issue recently became the subject of Congressional debate when Representative Stephen Neal proposed that the Congress instruct the Federal Reserve to adopt policies to lower the inflation rate to zero within five years, and to maintain constant prices thereafter.<sup>1</sup> This proposal was endorsed by Federal Reserve Chairman Greenspan and a number of Federal Reserve Bank Presidents (Greenspan 1989, Hoskins 1989, and Parry 1990).

Despite the consensus on price stability as the main long-term goal of monetary policy, the stabilization of real economic activity remains an important short-term goal for most central banks. The desire to achieve both of these goals inevitably raises the issue of which should take precedence at any particular point in time. Most economists would agree that monetary policy tends to have an inflationary bias unless some institutional structure is in place to ensure that the monetary authority achieves its long-term goal of price stability. This consideration raises the long-standing issue of rules versus discretion in the conduct of monetary policy.<sup>2</sup> Proponents of monetary rules argue that unless the monetary authority is required to achieve prescribed values of a nominal variable under its control (such as a monetary aggregate or the monetary base), long-run price stability goals inevitably will be sacrificed for short-run income stabilization objectives. The main argument against rules, and in favor of discretion, however, stems from the belief that following a rule would increase short- to intermediate-term volatility in output, which is considered undesirable.

With the possible exception of three years in the early 1980s, the Federal Reserve has employed a highly discretionary approach in conducting policy. Since the move away from the monetary targeting procedures used from 1979 to 1982, Federal Reserve policy actions have responded to a wide range of economic indicators, including inflation, economic activity, the exchange rate, interest

rates, money, and other financial variables (Heller 1988). Even though the Fed still establishes annual ranges for two monetary aggregates (M2 and M3) and a credit aggregate (total nonfinancial debt), these ranges are not consistently binding on its day-to-day operations. Thus, the process of formulating and executing monetary policy in the U.S. currently lacks an explicit nominal target that ensures that discretionary policy actions taken in response to short-run developments do not take aggregate demand off course in the long-run.

In this paper, we review the theoretical arguments for adopting rules for policy, and assess empirically how a particular set of rules would operate both in the transition to zero inflation and in the longer run after that transition has been completed. The rules we examine are feedback rules of the type proposed by Bennett McCallum (1988a, 1988b), in which the central bank adjusts the growth rate of the monetary base in response to observed deviations of the level of nominal income (or some alternative nominal variable) from established target values. In order to assess

the risks of adopting different rules, we use numerous stochastic simulations to determine the range of outcomes for real GNP and prices that we could expect if these rules were implemented and the economy experienced shocks similar in magnitude to those in the past. Finally, we use simulations of three different economic models to reflect the alternative paradigms that currently have significant followings among macroeconomists (as discussed in Mankiw 1990). Given the intense theoretical debate going on in the macroeconomics profession, a rule should not be given serious consideration unless it is robust across alternative theories.

The remainder of the paper is organized as follows. Section I presents a brief overview of the literature on the theoretical basis for monetary-policy rules, and the advantages and disadvantages of alternative target variables. Section II discusses the nature of, and rationale for, McCallum's nominal feedback rules. Section III presents the empirical results. The conclusions we draw from these simulations are presented in Section IV.

## I. The Role of Monetary Policy Rules

The basic argument in favor of rules in the conduct of monetary policy is that discretion leads to time-inconsistent results. Even if the monetary authority has the same objective function as the general public and acts to maximize that function at every point in time, the results of its actions will be suboptimal in the long-run. The central bank will produce more inflation (but no more real growth) *ex post* than was desired *ex ante* (see Barro 1986, Barro and Gordon 1983, and Kydland and Prescott 1977). This result holds even if the central bank maximizes an objective function that assigns negative weight to inflation while putting positive weight on output above its full-employment level.

The key assumptions underlying this result are that there is a positive relation between monetary policy surprises and deviations of output from its full-employment level, and that the public's expectations eventually are consistent with the policy followed by the central bank. Thus, the public can be "fooled" only temporarily. The assumption that the public cannot be fooled permanently means that output cannot deviate from its full-employment level in the long-run, and therefore, that social welfare is maximized by producing zero inflation. Under these circumstances, therefore, if the monetary authority were to adopt a long-run policy rule, it would choose one that produced zero inflation.

At any point in time, however, the monetary authority takes the public's prevailing inflation expectation as a datum. Thus, if it is not bound by a rule, the monetary authority can add to social welfare in the short-run by generating a policy surprise that raises output above its full-employment level. But in the long-run, the authority is unable to raise utility by producing surprises because on average, real GNP cannot be raised above its full-employment level.<sup>3</sup> Indeed, since the average rate of inflation is raised by the authority's discretionary actions, social welfare is actually reduced by the discretionary approach compared with the situation in which a rule is imposed. The extent of the inflationary bias in discretionary policy is affected by the central bank's rate of time preference. The more weight it places on near-term, relative to more distant, developments, the larger is the inflationary bias.

If it is to solve the time-inconsistency problem, a rule must commit the monetary authority permanently and in advance. This would ensure that the public would believe that the rule would be followed into the indefinite future and would form its expectations accordingly. The rule must be stated in terms that the monetary authority is capable of achieving, since otherwise the policymaker cannot be held accountable. For this reason, proposals have been made to require the central bank to stabilize the growth rate of some easily observed and measured variable that is under its

direct control, such as the monetary base or the narrow money stock. Friedman's (1960) constant-money-growth rule was an early example of a time-consistent policy commitment.

Contingent rules, so long as they can be clearly defined and enforced, also could solve the time-inconsistency problem. For example, in principle, a time-consistent nominal rule that also specifies how the growth of the monetary base temporarily would respond to business cycles might reduce short-run swings in the economy while at the same time ensuring that money growth would be noninflationary over time. However, it may be difficult to enforce contingent rules, since the monetary authority may be tempted to "cheat" on its longer-run price stability condition in the expectation that the public will be unable to distinguish between cheating and allowable responses to changes in cyclical conditions. Thus it is especially important that contingent rules be specified in terms of an easily observable variable that clearly is under the control of the central bank.

### Alternative Nominal Targets

Most analyses of monetary policy rules have begun with the presumption that the target should be money, especially M1. The narrow money supply is appealing because it can be controlled reasonably well by the central bank and because all credible theoretical models view money growth as the unique causal factor in steady-state inflation. However, uncertainties about movements in the velocity of money in the short to intermediate run, related to the deregulation of the financial system, have been a central feature of the U.S. economy and monetary policy since the early 1980s (Simpson 1984). These developments have raised serious doubts about the practical usefulness of money as a target of monetary policy.

These concerns about instability in velocity have motivated proposals that the Fed should target nominal GNP. Thus, this variable has been seen as a second-best solution to the velocity problem (Hall 1983 and Tobin 1980). Targeting nominal GNP would get around the problem of velocity instability, since the money supply automatically would accommodate shifts in velocity under this approach.<sup>4</sup>

The following identity illustrates how nominal income targeting can be used to achieve price level objectives:

$$p_t \equiv x_t - y_t,$$

where  $p$  = log of price level  
 $x$  = log of nominal income  
 $y$  = log of real GNP

As this identity shows, a predictable relationship between nominal income and the price level depends upon the predictability of the level of real GNP. According to some analyses, the level of real GNP has a long-run trend, called potential GNP, which is determined by long-run supply conditions in the economy, including labor force growth and trend productivity (Evans 1989). Under this hypothesis, these factors evolve gradually over time, and thus trend GNP growth should be relatively easy to predict; that is, it is "trend-stationary." To the extent that this is the case, it is straightforward to calculate the path of nominal GNP required to achieve long-run price stability.

However, Haraf (1986) cites evidence that real GNP is a nontrend-stationary time series. If this were the case, and nominal GNP grew at a constant rate, the price level would evolve as a random walk, and thus could drift over time. This problem would arise if real GNP were affected by supply shocks that had permanent effects on the level of real GNP. As can be seen in the above identity, under nominal income targeting, a positive (negative) supply shock, which brings about a permanent increase (decrease) in output, will induce an unnecessary price level decline (increase). Such responses can be detrimental to macroeconomic performance by raising uncertainty about the level of prices in both the short and long run. Unfortunately, statistical tests are not capable of distinguishing accurately between random walks and trend-stationary processes with autoregressive roots close to unity (Mankiw 1989). Thus, there is some inherent uncertainty concerning possible problems caused by the behavior of real GNP for nominal income targeting.

In part because of this concern, a number of authors have argued that the Federal Reserve should target prices directly (Barro 1986 and Meltzer 1984), since under this approach the price level would not be affected by the time-series properties of real GNP. No matter what time-series properties real GNP displays, direct price level targeting obviously could avoid long-term price level drift. The major potential disadvantage of price level targeting is that in sticky price (Keynesian) models, attempts by monetary authorities to achieve a predetermined path for prices involve very sharp movements in real GNP in the short run, which may not be desirable (Hall 1983). Essentially, if prices are sticky, policy actions have their largest effects on output in the short run. Of course, in flexible price (real business cycle) models this would not be a problem because prices would be able to adjust to policy changes in the short run, requiring no adjustment of output.

Concerns about volatility in real GNP motivate the so-called modified nominal income target proposed by Taylor

(1985), which is defined as the inflation rate plus the GNP “gap” (the difference between real GNP and its full employment level). This target differs from the others discussed above in that it uses the inflation *rate* rather than a nominal *level*. Thus it does not prevent the price level from drifting upward or downward in the long run. For example, if the inflation rate were to rise, the modified nominal income target would call for a tightening of policy only until the inflation rate returned to zero, whereas the

nominal income and price targets would require a longer period of tightening until the previous price level was restored. However, modified nominal income may have an advantage over the two other targets discussed above in terms of real GNP volatility. Taylor (1985) shows that, in the context of a rational expectations Phillips curve model, the rule would cause less volatility of real GNP than would a nominal GNP rule.

## II. McCallum-Type Rules

The preceding discussion makes it clear that the choice of a nominal target variable cannot be determined from theory alone. This choice depends on such factors as the time series properties of real GNP and the degree of flexibility of prices. An empirical investigation is needed. McCallum (1988a, 1988b) has examined the empirical properties of *operational versions* of nominal income and price rules. These rules specify a long-run equilibrium growth rate for the monetary base plus a rule for adjusting quarterly growth in the base in response to deviations between the actual and desired values of the target variable. They may be written in the form:

$$(1) \quad \Delta b_t = [\Delta p_t^* + \Delta y_t^f] - \Delta \bar{v}_t + \lambda [z_{t-1}^* - z_{t-1}]$$

where  $b_t$  = log of the monetary base,  $p_t$  = log of price level,  $y$  = log of real GNP,  $z_t$  = log of target variable, \* denotes a value desired by the central bank, and

$$\Delta \bar{v}_t = \left( \frac{1}{16} \right) [(x_{t-1} - b_{t-1}) - (x_{t-17} - b_{t-17})].$$

The left side of (1) represents the growth rate of the monetary base, which serves as the policy instrument. The right side has three components. The first term represents the growth rate of nominal GNP the central bank wishes to accommodate in the long run, which is equal to the sum of the desired inflation rate ( $\Delta p^*$ ) and the steady-state growth rate of real GNP ( $\Delta y_t^f$ ). The second component,  $\Delta \bar{v}_t$ , subtracts the growth rate of base velocity over the previous four years, and is designed to pick up long-run trends in the relation of base growth to nominal GNP growth.<sup>5</sup> The third term specifies the feedback rule determining how base growth is adjusted when there is a target miss in the previous quarter. That miss is defined as  $[z_{t-1}^* - z_{t-1}]$ , while the term  $\lambda$  defines the proportion of the miss the central bank attempts to offset each quarter. As such, values of  $\lambda$  can be chosen by the central bank between 0 and 1. In steady-state, the feedback term drops out (since  $z^* = z$ ), and the rule simply states that  $\Delta b_t = \Delta p_t^* + \Delta y_t^f - \Delta \bar{v}_t$ .

McCallum's rules use the monetary base as the operat-

ing instrument on the grounds that it can be accurately controlled by the central bank on a day-to-day basis, and that this controllability is unlikely to be upset by financial or regulatory innovations. Thus, when the base is used as the policy instrument, the public can easily observe whether the central bank is adhering to its rule and can hold the central bank accountable for its actions. This feature has the advantage that it provides an opportunity for the central bank to develop credibility with the public. Such credibility may substantially lower the costs, in terms of lost economic output, of reducing inflation (see Blackburn and Christensen 1989).

A drawback to using the base as an instrument is that its velocity has tended to be unstable following the deregulation of the financial system in the 1980s. However, two features of the rules under investigation tend to mitigate the adverse effects of instability in velocity. First, the  $\Delta \bar{v}_t$  term accounts for gradual movements in the relationship between base growth and macroeconomic developments. Second, under McCallum-type rules, shifts in the base velocity are automatically offset by policy. For example, if base velocity unexpectedly rises, nominal income will rise relative to the target, which will induce a contraction in the base growth rate under the McCallum rule. This contraction will tend to bring nominal income back to its target.

One of McCallum's main objectives is to test the robustness of the nominal income rule across alternative economic theories, which have different implications for the correlations among  $\Delta b$ ,  $\Delta p$ , and  $\Delta y$  in the presence of shocks. He argues that neither theory nor evidence points convincingly to any one of the competing models of the dynamic interaction between nominal and real variables. Because of this uncertainty about the true structure of the economy, the monetary authority should adopt a rule that is likely to work well in a variety of different economic environments. McCallum tests his proposed rule by conducting counterfactual simulations under several alternative macroeconomic models. The rule is designed to be

model-free: that is, the monetary authority responds to *observed* deviations from the target, and does not need to base its actions on forecasts or judgments that would require knowledge of the structure of the economy. McCallum's empirical results suggest that if the Fed had followed the rule from 1954 to 1985, there would have been less cyclical variability in nominal GNP and essentially zero inflation, and that this conclusion holds true for all of the models tested.

McCallum, of course, recognizes that these results are subject to the Lucas (1973) critique: the estimated parameters in the models he estimates and simulates might have changed significantly if the Federal Reserve actually had followed the rules being tested. McCallum (1988a) attempts to deal with this issue in two ways. First, he cites Taylor's (1984) finding of parameter stability across the Fed's policy regime change in 1979, and argues that the Lucas critique may not be empirically important in the context of monetary policy rules. Second, he substantially alters the coefficients in one of his estimated models, and shows that the simulation results are qualitatively unchanged (McCallum 1988a, pp. 192–194).

### Extensions of McCallum's Exercise

We extend McCallum's results in a number of directions. First, we consider another target variable in addition to nominal GNP and the price level, namely, Taylor's modified nominal income rule. Thus, three alternative short-run target variables for the policy rules are considered: nominal income (equation 2), the price level

(equation 3) and modified nominal income (equation 4). In addition, "no rule" simulations also are computed, in which the monetary base followed the same path as in the historical sample period:

$$(2) \quad \Delta b_t = [\Delta y_t^f + \Delta p_t^*] - \Delta \bar{v}_t + \lambda[x_{t-1}^* - x_{t-1}]$$

$$(3) \quad \Delta b_t = [\Delta y_t^f + \Delta p_t^*] - \Delta \bar{v}_t + \lambda[p_{t-1}^* - p_{t-1}]$$

$$(4) \quad \Delta b_t = [\Delta y_t^f + \Delta p_t^*] - \Delta \bar{v}_t + \lambda[(y_{t-1}^f - y_{t-1}) + (\Delta p_{t-1}^* - \Delta p_{t-1})].$$

Second, we conduct repeated stochastic counterfactual simulations of the alternative models and rules. In McCallum's simulations, the monetary authority is assumed to face the same set of shocks that actually occurred in the historical period. Below, we assume only that the shocks have the same means and variances as the historical shocks. Thus, rather than computing a single simulation of the economy under each rule, we obtain a probability distribution of alternative outcomes based upon numerous sets of shocks. This enables us to compare different rules in terms of the full range of alternative outcomes that each might produce. Third, we examine how adoption of various rules might affect the volatility of real GNP. Since concerns about such effects seem to be a major reason that many central banks hesitate to adopt rules, we focus a good deal of our attention on this issue. Finally, we examine how alternative rules might be used to bring the inflation rate down from its level in recent years to zero over the five-year horizon specified in the Neal Amendment.

## III. Empirical Results

Each of the policy rules was simulated under three alternative sets of assumptions about the structure of the economy: a Keynesian (or Phillips curve) model, a real business cycle model, and an atheoretic vector autoregression (VAR).<sup>6</sup> We closely followed McCallum in specifying and estimating these models, and our estimates are close to those reported by McCallum (1988b). As will become apparent, the models are not attempts to describe the structure of the economy as precisely as possible. Rather, they incorporate the fundamental features of the various macroeconomic paradigms, and are meant to illustrate the basic nature of the responses of the economy to the implementation of the monetary-policy rules tested.

The Keynesian model consists of three equations. First, the real aggregate demand equation embodies the direct effects of monetary (and fiscal) policy on macroeconomic activity. It specifies the growth rate of real GNP as a

function of current and lagged growth rates of the real monetary base, real government spending ( $g$ ), and its own lagged values (our estimates of the parameters of this aggregate demand relation are shown in equation A1 of the Appendix):

$$(5) \quad \Delta y_t = \sum_{i=1}^I \alpha_i \Delta y_{t-i} + \sum_{j=0}^J \beta_j (\Delta b_{t-j} - \Delta p_{t-j}) + \sum_{k=0}^K \gamma_k \Delta g_{t-k}.$$

The supply side of the Keynesian model is a simplified Phillips curve, which embodies the essential "sticky-price" characteristic of the paradigm. It specifies that the current inflation rate depends on past inflation and the gap between actual and full employment real GNP (see equation A2 of the Appendix):



$$(6) \quad \Delta p_t = \sum_{n=0}^N h_n (y_{t-n} - y_{t-n}^f) + \sum_{m=1}^M k_m \Delta p_{t-m},$$

where

$$\sum_{m=1}^M k_m = 1.$$

The coefficients on lagged inflation ( $k_m$ ) are constrained to sum to 1, thus ensuring that, in steady state, real GNP will be equal to its full employment level, and inflation will be constant. Equation (7) defines  $y^f$ , which is the log of full employment real GNP and is measured as the fitted values of a log linear time trend ( $T$ ) of real GNP (see equation A3 in the Appendix):

$$(7) \quad y_t^f = \delta + \zeta T_t.$$

In combination with any one of the policy rules that defines the growth rate of the base, equations (5), (6), and (7) can be simultaneously solved for values of  $\Delta p$ ,  $\Delta y$ ,  $y^f$ , and  $\Delta b$  as functions of the monetary policy target and other variables. For the purpose of evaluating monetary policy rules, the essential feature of this model is that monetary policy affects real GNP with relatively short lags, while inflation is affected with long lags. This means that attempts to exert precise control over inflation in the short run inevitably involve a high degree of volatility of real GNP. As noted above, it is this concern that has motivated the view that nominal GNP or modified nominal GNP might be a better target variable, since neither requires such precise short-run control of the price level.

The real business cycle model consists of two equations. First, the price determination equation is obtained by inverting equation (5) (see equation A4 in the Appendix):

$$(8) \quad \Delta p_t = \left( \frac{-1}{\beta_0} \right) \Delta y_t + \sum_{i=1}^I \left( \frac{\alpha_i}{\beta_0} \right) \Delta y_{t-i} + \Delta b_t + \sum_{j=1}^J \left( \frac{\beta_j}{\beta_0} \right) (\Delta b_{t-j} - \Delta p_{t-j}) + \sum_{k=0}^K \left( \frac{\gamma_k}{\beta_0} \right) \Delta g_{t-k}.$$

This specification of the price equation follows from the assumption that prices are flexible and that real GNP is independent of aggregate demand. Thus inflation is directly determined by current and lagged values of monetary base growth, real GNP growth, and other variables.

Real GNP is determined by a simple time series model, which is consistent with movements in real GNP being determined by *permanent* technology and labor supply shocks. Thus equation (9) specifies that real GNP has a unit root (that is, shocks have a permanent effect on the

level of real GNP; see equation A5 in the Appendix for econometric estimates):

$$(9) \quad \Delta y_t = \theta + \sum_{l=1}^L \mu_l \Delta y_{t-l}.$$

Any of the monetary policy rule equations and equations (8) and (9) can be solved for values of  $\Delta p$ ,  $\Delta y$ , and  $\Delta b$  as functions of values of the monetary policy target and other variables. For present purposes, the key features of this model are that prices respond immediately to changes in the base and real GNP is unaffected by monetary policy. Thus, short-run control of prices is much more appealing than in the Keynesian model. Furthermore, the distinction between controlling prices and nominal income is nonexistent, since real GNP does not respond to monetary policy.

Thus the Keynesian and real business cycle models make opposite assumptions about the responsiveness of prices and real GNP to monetary policy actions. The Keynesian model assumes that real GNP responds relatively quickly but that prices lag; the real business cycle model, however, assumes that prices respond quickly but that real GNP does not respond at all. By testing the various rules in both models, we have encompassed the broad range of assumptions that potentially could be made in this regard.

In addition to the two models just discussed, we also conducted simulations using a four-variable VAR that included growth rates of nominal GNP, the price level, and the base, as well as the level of the Treasury bill rate (see Appendix A for estimation results). In simulating this model under a policy rule, the estimated equation for the base was replaced by the equation defining the policy rule. The VAR embodies no theoretical restrictions, and therefore is agnostic about the structure of the economy.

### Simulating the Models

Two basic questions were addressed with dynamic simulations of the estimated models. First, how would the principal macroeconomic variables (real and nominal GNP, prices and the inflation rate) have evolved over the historical sample period (1954 to 1989) if the monetary authority had followed each of the three policy rules throughout that period? We label these simulations as "counterfactual experiments." The policy rules in these simulations were specified to attempt to hold the price level constant at its level in 1954. For each rule, within the context of each model, we calculated 500 simulations in which the shocks had the same variances as the error terms

in the respective model equations.<sup>7</sup> Each set of 500 simulations is called an experiment. We calculated a 95 percent confidence interval for each of these experiments.

Second, how might the economy evolve in the future if the monetary authority adopted a policy rule beginning in 1990 with the objective of lowering inflation gradually to zero by 1995 and holding the price level constant thereafter? For these disinflation experiments, we assumed that the shocks to aggregate demand and aggregate supply in the future would have the same variances as in the estimation sample period. Again, we calculated confidence intervals based upon 500 simulations for each experiment.

### Counterfactual Experiments

In presenting the results from simulating the alternative rules, we focus on three measures of economic performance that should reflect the concerns of policymakers—the price level, the rate of inflation and the short-run growth rate of real GNP. Ideally, a policy rule should deliver low inflation, in both the short run and long run, without causing unacceptable volatility in real GNP growth. Given the conventional definition of a recession as two quarters of declining GNP, we focus on the (annualized) two-quarter growth rate of real GNP.

Table 1 shows the performance of the various rules in stabilizing the price level by reporting the 95 percent confidence intervals for average annual inflation over 1954:Q1 to 1989:Q4. With some notable exceptions discussed below, adoption of the rules could have stabilized prices in the long run. In most cases, the confidence bands center around an average inflation rate near zero.<sup>8</sup> Moreover, these confidence bands are in most cases much narrower under the rules than under the policy actually followed over the period (the “no rule” case). For example, in the Keynesian model with  $\lambda = 0.25$ , average inflation would have been between  $-0.67$  and  $+0.48$  percent (with 95 percent probability) under a nominal income rule, but between  $2.60$  and  $5.89$  percent with no rule. Only the modified nominal income rule under the real business cycle model produced confidence bands wider than the no rule case. This result confirms our speculation that this rule would allow the price level to drift in the long run because it targets the short-run inflation rate rather than the price level. Price level drift is especially acute in the real business cycle model because of its unit root in real GNP.

Several of the experiments summarized in Table 1 produced explosive cycles in the economy. In particular, although the price rule works well in the real business cycle

**Table 1**  
**Simulated Inflation Rate Under Alternative Rules<sup>a</sup>**  
1954-1989

Policy Rules		95% Confidence Limits <sup>b</sup>		
		Keynesian	Real Business Cycle	Vector Autoregression
Nominal GNP	$\lambda = 0.25$	-0.67 to 0.48	-0.58 to 0.75	-2.26 to -0.31
	$\lambda = 0.50$	-0.47 to 0.33	-0.61 to 0.78	-2.23 to -0.38
	$\lambda = 0.75$	-0.40 to 0.28	-0.64 to 0.80	Explosive
Price Level	$\lambda = 0.25$	Explosive	0.002 to 0.14	-0.31 to 0.27
	$\lambda = 0.75$	Explosive	0.02 to 0.18	-0.32 to 0.45
Modified Nominal GNP	$\lambda = 0.25$	-1.43 to 1.75	-15.2 to 17.0	Explosive
	$\lambda = 0.75$	-0.96 to 1.13	-30.7 to 33.4	Explosive
No Rule (Actual Base)		2.60 to 5.89	2.78 to 6.31	3.16 to 5.77
Actual Inflation			4.43	

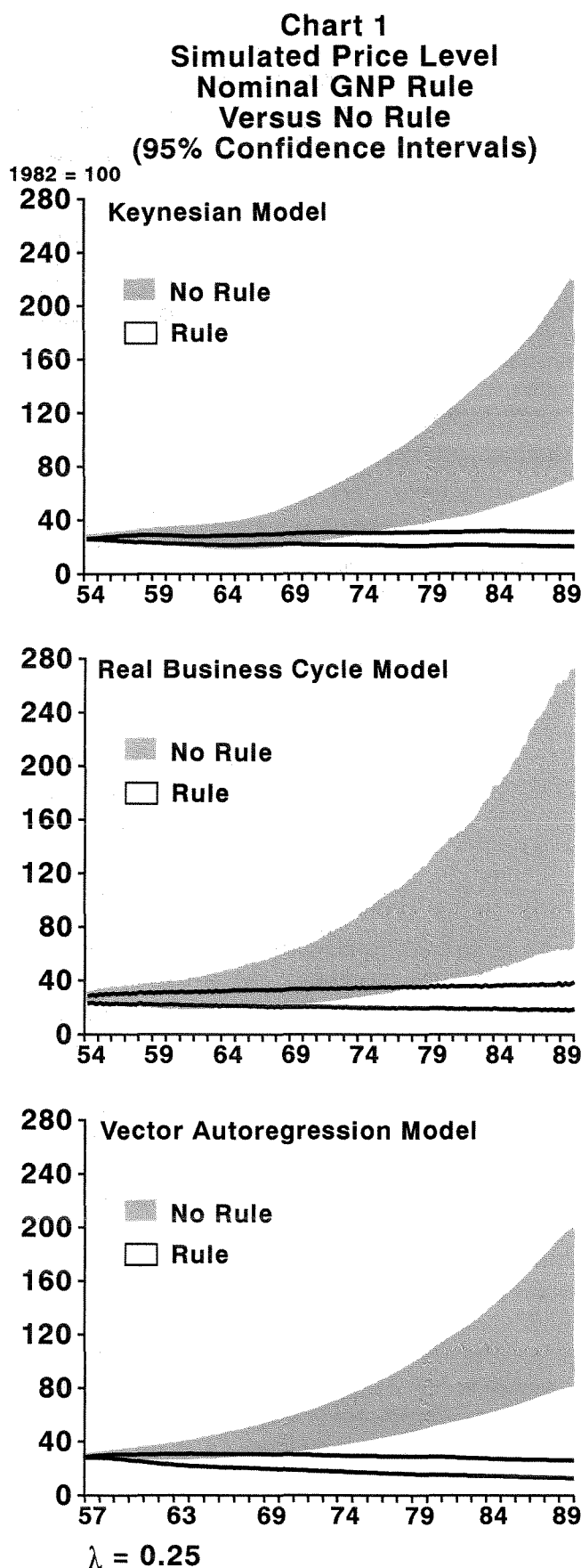
<sup>a</sup>These results are referred to as counterfactual experiments in the text.

<sup>b</sup>Annual rates of change.

model with its flexible prices, it produces instability in the “sticky price” Keynesian model. The modified nominal income rule works well in the Keynesian (Phillips curve) context, for which it was designed, but causes instability in the VAR.<sup>9</sup> In fact, only the nominal income rule with cautious policy responses ( $\lambda = 0.25$  and  $0.50$ ) was stable in all three models.

Thus the results of these simulations show that the nominal income rule is more robust across alternative models than are the price and modified nominal income rules. Within the context of uncertainty about the true structure of the economy, the nominal income rule is the only one tested that is not explosive in any of the macro models (for suitably small values of  $\lambda$ ) and so could be considered a viable approach for policy. To illustrate the effects of this rule (with  $\lambda = 0.25$ ), in Chart 1 we have plotted the 95 percent confidence intervals for the price level. In all of the models, the confidence intervals center throughout the simulation period on a price level near its level at the beginning of the period, and the confidence bands are relatively narrow. For comparison, the 95 percent confidence interval for the no-rule simulations, with the monetary base taking on its actual historical values, also are plotted. These results suggest that by following the nominal income rule, monetary policy could have avoided the inflation that occurred over this period with high probability.

As noted in the introduction, one reason often given by central banks for not taking advantage of rules to control inflation is that nondiscretionary approaches tend to create volatility in real GNP. To address this issue, Table 2 reports the 95 percent confidence intervals for the two-quarter growth rate of real GNP *for the year 1989*, under the rules in the three models and for the no rule case. Since the width of the confidence intervals varies somewhat over the simulation period, we show the results for 1989 as a representative year. In evaluating these results, we use the no rule case as a basis for comparison, since it is an estimate of the confidence band that actually obtained over the sample period under the policies followed by the Fed. Of course, the rules have no effect on real GNP in the real business cycle model. In most other cases, the bands are wider under the rules than in the no rule case, implying that rules-based regimes may increase the short-run volatility of real



**Table 2**  
**Simulated Two-Quarter Real GNP Growth in 1989<sup>a</sup>**

Policy Rules		95% Confidence Limits <sup>b</sup>		
		Keynesian	Real Business Cycle	Vector Autoregression
Nominal GNP	$\lambda = 0.25$	-10.8 to 17.5	-3.5 to 9.6	-3.2 to 11.9
	$\lambda = 0.50$	-7.3 to 13.6	-3.4 to 9.3	-7.6 to 15.7
	$\lambda = 0.75$	-6.3 to 12.7	-3.8 to 9.5	Explosive
Price Level	$\lambda = 0.25$	Explosive	-3.6 to 9.6	-3.2 to 11.4
	$\lambda = 0.75$	Explosive	-3.6 to 9.4	-13.0 to 19.5
Modified Nominal GNP	$\lambda = 0.25$	-4.4 to 9.9	-3.7 to 9.2	Explosive
	$\lambda = 0.75$	-4.8 to 10.1	-3.3 to 9.3	Explosive
No Rule (Actual Base)		-7.3 to 8.3	-3.8 to 9.6	-4.0 to 8.7
Actual Real GNP Growth			2.74	

<sup>a</sup>These results are referred to as counterfactual experiments in the text.

<sup>b</sup>Annual rates of change.

GNP. An exception to this conclusion is the modified nominal income rule in the Keynesian model. However, as noted above, this rule produces unstable results in the VAR and very wide confidence intervals for inflation under the real business cycle model.

### Rules that Explicitly Attempt to Smooth Real GNP

In an attempt to find a rule that might reduce short-run real income volatility in the Keynesian model and the VAR, we experimented with a rule in which the monetary authority responded both to the level of nominal GNP (as in the nominal income rule) and to the growth rate of real GNP relative to its growth rate in the recent past.<sup>10</sup> In steady state, this rule would yield the same results as the nominal income rule, but it would induce a stronger response to temporary fluctuations in real GNP growth:

$$(10) \quad \Delta b_t = [\Delta y_t^f + \Delta p_t^*] - \Delta \bar{v}_t + \lambda[x_{t-1}^* - x_{t-1}] \\ - \lambda[\Delta y_{t-1} - \left(\frac{1}{Q}\right) \sum_{q=1}^Q \Delta y_{t-q}],$$

with  $Q$  equal to 20 quarters.

We also tried a rule that replaced the growth rates of real GNP in equation (10) with levels, so that the final term in the equation was:  $-\lambda[y_{t-1} - y_{t-1}^f]$ . However, we found that both rules produced somewhat *wider* fluctuations in real GNP than the simple nominal income rule in the various models. These attempts obviously do not eliminate the possibility that some other specification would reduce real GNP volatility, but at least these simple, straightforward approaches do not seem to do the job.

### Disinflation Experiments

In this section, we report the results of simulating a policy rule specified so as to lower the inflation rate to zero within five years. We chose this time interval because the Neal Resolution proposes this objective for the Federal Reserve. In view of the results of the counterfactual experiments, these disinflation simulations were computed only for a nominal income rule with  $\lambda$  equal to 0.25.

In these simulations, the policy rule (equation (2)) was specified so that both the equilibrium growth rate of the base ( $\Delta b^* = \Delta p^* + \Delta y^f$ ) and the targeted level of nominal income ( $x_{t-1}^*$ ) allow for a gradual decline in

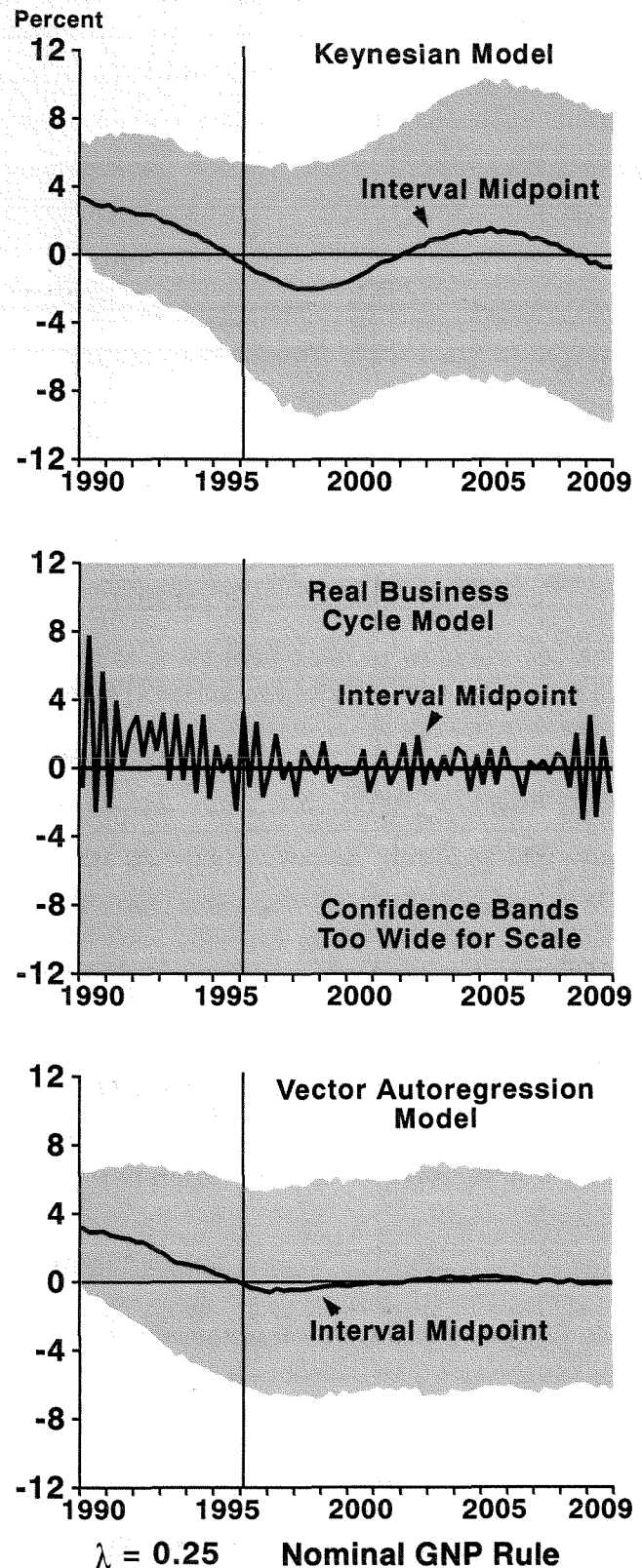


inflation over a period of five years. This requires that  $\Delta p^*$  decline gradually from the actual inflation rate in 1989 to zero in 1994.Q4. From 1994.Q4 onward  $\Delta p^* = 0$ , and thus  $\Delta b^* = \Delta y^f$ . At the same time, the target level of nominal GNP ( $x_{t-1}^*$ ) is set equal to the actual lagged value of nominal GNP in 1990.Q1, after which it grows at a rate that declines steadily until, after twenty quarters, it grows at  $\Delta y^f$ .

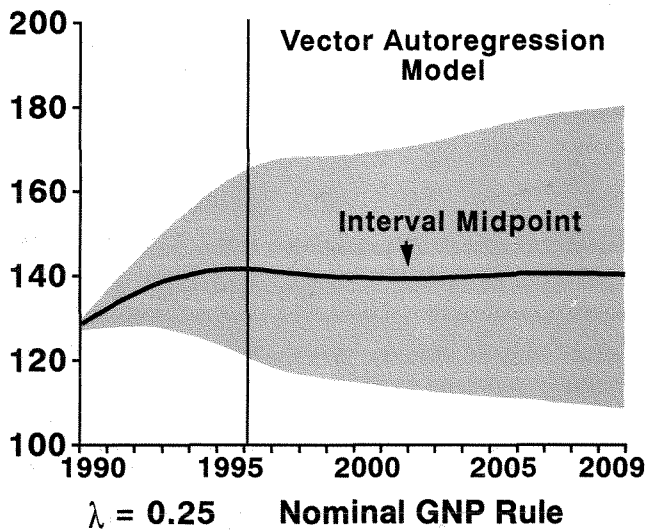
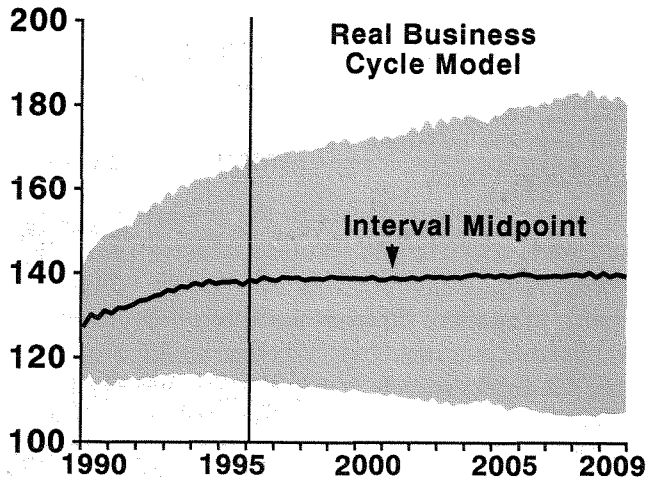
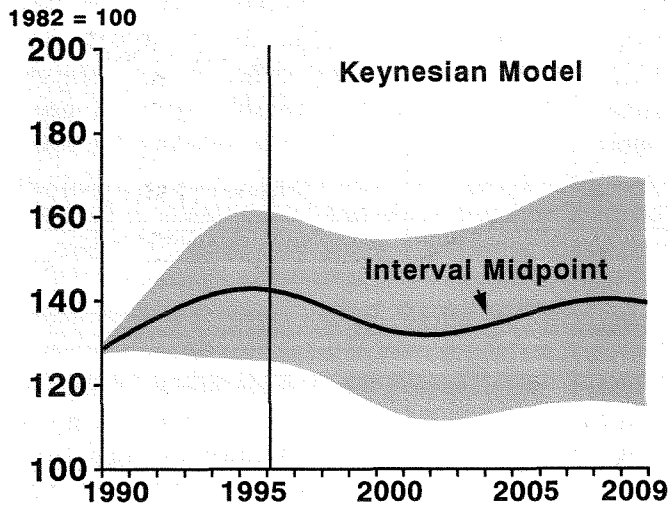
The results of this simulation are shown in Charts 2 through 4. Chart 2 shows the path of the inflation rate under the rule in the three alternative models, while Chart 3 shows the results for the price level. These charts suggest that in all three models, adoption of the rule would have a good chance of reducing inflation to zero within five years and of maintaining generally stable prices thereafter. The confidence bands for inflation are wide because they apply to inflation rates in individual quarters. However, the relatively narrow bands in the price level charts make it clear that average inflation over an extended period of time would be held close to zero with a high degree of confidence.<sup>11</sup>

Chart 4 shows the simulated two-quarter GNP growth rate in the three models. Even during the period in which the inflation rate is being brought down, there is a better than even chance that a recession can be avoided. Although the mean simulated GNP growth rate declines below the trend growth rate in the early years of the simulations, it does not become negative. Perhaps more significant is the observation that the confidence intervals on real GNP growth are no wider during the period in which inflation is coming down than they were during the historical sample period. Thus a policy of aiming for zero inflation by following a nominal income targeting policy rule would not significantly worsen the probability of the economy falling into a recession.

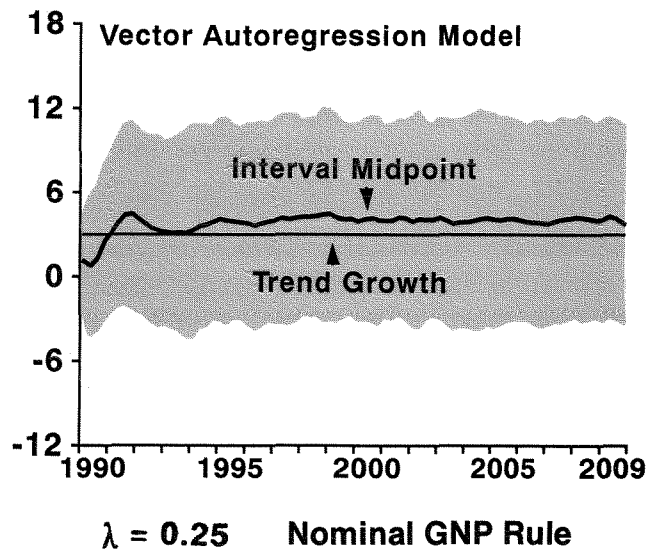
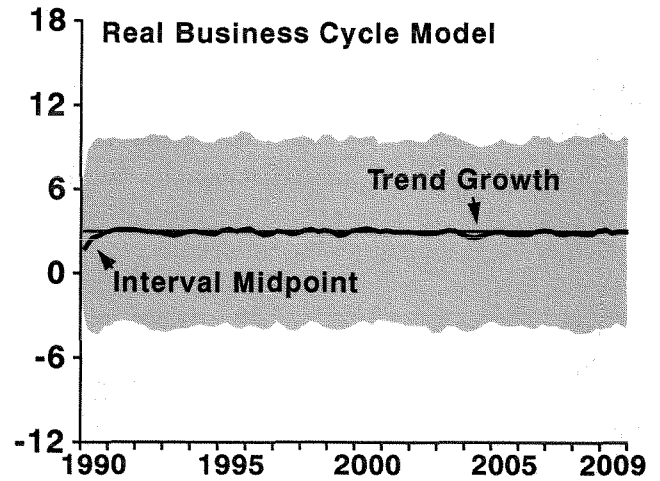
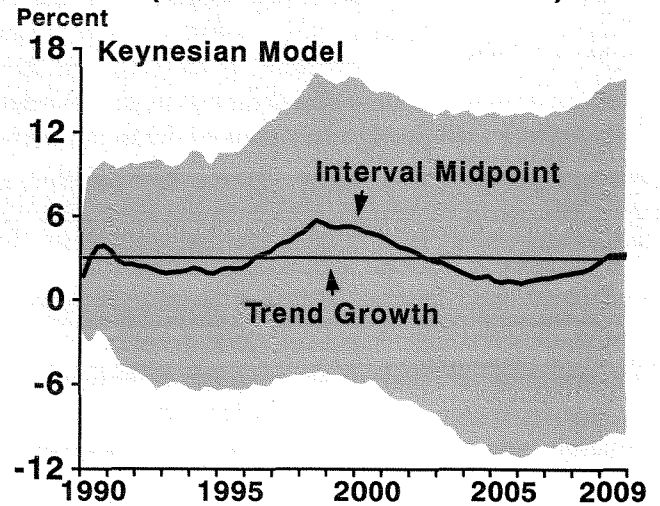
**Chart 2**  
**Simulated Inflation Rate**  
**(95% Confidence Intervals)**



**Chart 3**  
**Simulated Price Level**  
**(95% Confidence Intervals)**



**Chart 4**  
**Simulated Two-Quarter**  
**Growth of Real GNP**  
**(95% Confidence Intervals)**



### III. Conclusions

In this paper, we have extended the work of Bennett McCallum on the usefulness of nominal feedback rules for linking short-run monetary policy actions to the goal of achieving and maintaining price stability. Given present uncertainties about the structure of the economy, these rules are designed to be model-free; that is, the monetary authority does not need to rely on a model to implement them, and they perform well in several possible models. In addition, the rules are operational in the sense that they define movements in a variable (the monetary base) that can be controlled by the central bank.

We have examined the properties of three such rules—with short-run targets of nominal GNP, the price level, and inflation plus the GNP “gap”—in the context of three alternative views of the structure of the economy. Our tests involved numerous stochastic simulations of these models and rules. We examined the behavior of prices and real GNP during a transition from the current prevailing inflation rate to price stability, and during an extended period in which price stability is maintained.

This analysis leads us to a number of conclusions. We find that the nominal income rule is successful at maintaining price stability, in the sense that at the end of the simulations, 95 percent confidence intervals for the simulated price level are centered on the level of prices that existed at the beginning of the simulation period. Moreover, the nominal income rule provides tight confidence intervals, suggesting a high level of certainty about where prices will end up under the rule.

The price level and modified nominal income rules produce dynamic instability in some of the models tested. Only the nominal GNP rule, with relatively cautious adjustment parameters of 0.25 and 0.50, was nonexplosive in all the models. Given the uncertainty about which model is most appropriate, this would appear to be the only rule

tested with sufficient robustness to be considered seriously as a target. This rule, however, does present the problem that it appears to increase real income volatility in some models. In interpreting the results for real income variability, however, it is important to bear in mind that the estimates we have obtained probably represent upper bounds on the detrimental effects of following the rules. These rules most likely would have beneficial effects on Fed credibility and would reduce uncertainty in the economy, which most likely would have beneficial effects on real income volatility (Blackburn and Christensen 1989). These beneficial effects are not captured in our simulations, and we have no way of measuring their significance.

Finally, we simulated the possible effects of moving from the present inflation rate to zero inflation in five years. We limited these experiments to the nominal income rule for reasons given above. Under all three models, this rule achieved zero inflation in five years in the sense that the confidence intervals for inflation were centered on zero. Moreover, even without beneficial credibility effects, none of the models suggested that the disinflationary process would noticeably increase the chances of a recession compared with the experience over the past 35 years under actual policy.

Thus, our results suggest that the nominal income rule could work effectively in reducing inflation from current rates to zero. Moreover, this rule would ensure price stability thereafter, although possibly at the expense of more volatility in real GNP. Whether a rule seems worth trying (*ex ante*) depends on how important achieving and maintaining zero inflation is to the policymaker, compared with the possible benefits of attempting to smooth real GNP. This paper has attempted to put some parameters on the nature of the tradeoff the policymaker would face in making this choice.

## ENDNOTES

1. This legislation was called the "Zero-inflation" Amendment, H.R. 2795, 101st Congress, 1st session.
2. See Englander (1990) for a review of these issues and an extensive bibliography.
3. This argument assumes away the possibility that the central bank may be able to use discretion to reduce the size of fluctuations of real GNP around its full-employment level. If this were possible, and if stability had utility for the public, then there could be some positive utility from discretion in the long-run, which could offset the loss of utility from higher inflation.
4. Hence, Tobin's observation that nominal income targeting is nothing but "velocity-adjusted money targeting."
5. McCallum selected the 16-quarter average to be long enough to avoid dependence on cyclical conditions. As a consequence, the term can take account of possible changes in velocity resulting from regulatory and technological sources.
6. McCallum also examines the properties of a rational expectations inflation surprise model (Lucas 1973). We decided not to pursue this approach because it no longer receives much support from macroeconomists.
7. In the Appendix, we reproduce some of McCallum's simulation results. Following his approach, in this table we used only one set of shocks, equal to the actual historical errors in the estimated equations. Our results are similar to his.
8. The simulation of the VAR under the nominal income rule produced a gradual decline in the price level. At the same time, the model predicts that real GNP would have risen more rapidly than actually occurred historically. This result implies that to produce zero inflation, the rule should have specified a faster steady-state growth rate of the base. It appears that the VAR model embodies an inverse correlation between the inflation rate and the real GNP growth rate. This correlation also is found in Lebow, Roberts, and Stockton (1990) and Selody (1990). Thus if the growth rate of the base is reduced to hold down inflation, the trend growth rate of real GNP is higher. One of the main arguments in favor of price stability is that it would boost real growth by facilitating long-range planning and eliminating the need for economic agents to waste resources in efforts to avoid the effects of inflation. The VAR appears to be consistent with this view. By experimentation, we found that if the base growth rate was set to produce zero inflation, the trend GNP growth rate was 4 percent, rather than the actual trend rate of 2¾ percent over the historical sample.
9. Simulations also were computed with an inflation rule, but this procedure produced instability in all models and so was abandoned.
10. Recall that policy does not affect real GNP in the real business cycle model.
11. Prices are more volatile in the real business cycle model than in the other models, because holding nominal income stable implies that independent fluctuations in real GNP are mirrored in opposite fluctuations in prices.



# APPENDIX

## Regression Results

1954.1—1989.4

The variables in the regressions below are defined as follows:

- $b$  = log of monetary base  
(adjusted for reserve requirement changes)
- $g$  = log of high-employment government expenditures
- $p$  = log of GNP deflator
- $i$  = log of 3-month Treasury bill rate
- $y$  = log of real GNP
- $y^f$  = log of real GNP trend
- $T$  = time trend

### Keynesian Model

#### Aggregate Demand:

$$(A1) \Delta y_t = 0.0044 + 0.26 \Delta y_{t-1} + 0.25 (\Delta b_t - \Delta p_t) + 0.18 (\Delta b_{t-1} - \Delta p_{t-1}) + 0.091 \Delta g_t - 0.091 \Delta g_{t-1}$$

(4.64)      (3.29)      (2.17)      (1.51)      (2.20)      (-2.20)

$$\begin{aligned} \bar{R}^2 &= 0.19 \\ SEE &= 0.0091 \\ Q &= 26.08 \\ D.F. &= 139 \end{aligned}$$

#### Aggregate Supply:

$$(A2) \Delta p_t = 0.026 (y_t - y_t^f) + 0.35 \Delta p_{t-1} + 0.23 \Delta p_{t-2} + 0.23 \Delta p_{t-3} + 0.20 \Delta p_{t-4}$$

(2.71)      (4.22)      (2.66)      (2.46)      (2.38)

$$\begin{aligned} \bar{R}^2 &= 0.62 \\ SEE &= 0.0041 \\ Q &= 26.97 \\ D.F. &= 140 \end{aligned}$$

$$(A3) y_t^f = 7.05 + 0.007557 T_t$$

(855.16)      +      (99.71)

$$\begin{aligned} \bar{R}^2 &= 0.99 \\ SEE &= 0.038 \\ Q &= 982.64 \\ D.F. &= 142 \end{aligned}$$

### Real Business Cycle Model

#### Aggregate Demand

$$(A4) \Delta p_t = 0.017 - 3.94 \Delta y_t + 1.01 \Delta y_{t-1} + \Delta b_t + 0.72 \Delta b_{t-1} - 0.72 \Delta p_{t-1} + 0.36 \Delta g_t - 0.36 \Delta g_{t-1}$$

### Aggregate Supply:

$$(A5) \Delta y_t = 0.0051 + 0.30 \Delta y_{t-1} + 0.14 \Delta y_{t-2} - 0.13 \Delta y_{t-3}$$

(4.59)      (3.60)      (1.65)      (-1.54)

$$\begin{aligned} \bar{R}^2 &= 0.11 \\ SEE &= 0.0093 \\ Q &= 25.23 \\ D.F. &= 140 \end{aligned}$$

### Vector Autoregression

#### Marginal Significance Levels

	Dependent Variables <sup>a</sup>			
	$\Delta y$	$\Delta p$	$R$	$\Delta b$
$\Delta y$	0.300000	0.700000	0.005000	0.018000
$\Delta p$	0.300000	0.000015	0.091000	0.180000
$R$	0.000016	0.035000	0.000000	0.000000
$\Delta b$	0.007800	0.008000	0.051000	0.000000
$\bar{R}^2$	0.300000	0.673000	0.930000	0.710000
SEE	0.008400	0.003900	0.950000	0.003700
Q	23.920000	38.910000	34.990000	29.880000
D.F.	120	124	119	121

<sup>a</sup>Lags chosen by Final Prediction Error procedure (Judge, et al. 1985).

## Simulations of Alternative Target Variables<sup>a</sup>

1954.1—1989.4

Targets	RMSE Values			
	Real Business Cycle			Vector
	Keynesian			Autoregression
Nominal GNP	$\lambda = 0.25^b$	0.0268	0.0167	0.0237
	$\lambda = 0.75$	0.0171	0.0115	Explosive
Price Level	$\lambda = 0.25^b$	Explosive	0.0161	0.0293
	$\lambda = 0.75$	Explosive	0.0080	0.0490
Modified	$\lambda = 0.25$	0.0279	0.0317	Explosive
Nominal GNP	$\lambda = 0.75$	0.0196	0.0240	Explosive

<sup>a</sup>Shocks equal residuals in estimated model equations.

<sup>b</sup>See Tables 1 and 2 in McCallum (1988b).

## REFERENCES

- Barro, Robert J. 1986. "Recent Developments in the Theory of Rules Versus Discretion." *The Economic Journal Supplement*, pp. 23-37.
- \_\_\_\_\_, and David B. Gordon. 1983. "A Positive Theory of Monetary Policy in a Natural Rate Model." *Journal of Political Economy* pp. 589-610.
- Blackburn, Keith, and Michael Christensen. 1989. "Monetary Policy and Policy Credibility: Theories and Evidence." *Journal of Economic Literature* (March) pp. 1-45.
- Englander, A. Steven. 1990. "Optimal Monetary Policy Design: Rules versus Discretion Again." In *Intermediate Targets and Indicators of Monetary Policy*. Federal Reserve Bank of New York.
- Evans, George W. 1989. "Output and Unemployment Dynamics in the United States: 1950-1985." *Journal of Applied Econometrics* 4, pp. 213-238.
- Friedman, Milton. 1960. *A Program for Monetary Stability*. New York: Fordham University Press.
- Greenspan, Alan. 1989. "A Statement before the Subcommittee on Domestic Monetary Policy of the Committee on Banking, Finance and Urban Affairs, U.S. House of Representatives, October 25, 1989." *Federal Reserve Bulletin* (December) pp. 795-803.
- Hall, Robert E. 1983. "Macroeconomic Policy Under Structural Change." In *Industrial Change and Public Policy*, pp. 85-111. Federal Reserve Bank of Kansas City.
- Haraf, William S. 1986. "Monetary Velocity and Monetary Rules." *Cato Journal* (Fall) pp. 641-662.
- Heller, Robert H. 1988. "The Making of U.S. Monetary Policy." Paper presented at Seminar for Economic Policy, April 27. The University of Cologne, West Germany.
- Hoskins, W. Lee. 1989. "Monetary Policy, Information, and Price Stability." Federal Reserve Bank of Cleveland *Economic Commentary* (February).
- Judge, C.G., W.E. Griffiths, R.C. Hill, H. Lutkepohl, and T.C. Lee. 1985. *The Theory and Practice of Econometrics*. New York: John Wiley.
- Kydland, Finn E., and Edward C. Prescott. 1977. "Rules Rather Than Discretion: Time Inconsistency of Optimal Plans." *Journal of Political Economy* pp. 473-491.
- Lebow, David E., John M. Roberts and David J. Stockton. 1990. "Economic Performance under Price Stability." Unpublished paper, Board of Governors of the Federal Reserve System (December).
- Lucas, Robert E. 1973. "Some International Evidence on Output-Inflation Trade-offs." *American Economic Review* pp. 326-334.
- Mankiw, N. Gregory. 1989. "Real Business Cycles: A New Keynesian Perspective." *The Journal of Economic Perspectives* (Spring) pp. 79-90.
- \_\_\_\_\_. 1990. "A Quick Refresher Course in Macroeconomics." *Journal of Economic Literature* (December) pp. 1645-1660.
- McCallum, Bennett T. 1988a. "Robustness Properties of a Rule for Monetary Policy." *Carnegie-Rochester Conference Series on Public Policy* 29, pp. 173-204.
- \_\_\_\_\_. 1988b. "Targets, Indicators, and Instruments of Monetary Policy." In *Monetary Policy in an Era of Change*. Washington, D.C.: American Enterprise Institute.
- Meltzer, Allan. 1984. "Credibility and Monetary Policy." In *Price Stability and Public Policy*, pp. 105-128. Federal Reserve Bank of Kansas City.
- Parry, Robert T. 1990. "Price Level Stability." Federal Reserve Bank of San Francisco *Weekly Letter* (March 2).
- Selody, Jack C. 1990. "The Benefits and Costs of Price Stability: An Empirical Assessment." Unpublished paper, Bank of Canada (December).
- Simpson, Thomas C. 1984. "Changes in the Financial System: Implications for Monetary Policy." *Brookings Papers on Economic Activity* 1, pp. 249-272.
- Taylor, John B. 1984. "Recent Changes in Macro Policy and Its Effects: Some Time Series Evidence." *American Economic Review Papers and Proceedings*, pp. 206-210.
- \_\_\_\_\_. 1985. "What Would Nominal GNP Targeting Do to the Business Cycle?" *Carnegie-Rochester Conference Series on Public Policy* 22, pp. 61-84.
- Tobin, James 1980. "Stabilization Policy Ten Years After." *Brookings Papers on Economic Activity* 1, pp. 19-49.

# Why Banks Need Commerce Powers

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*Commercial banks are important intermediaries of credit for the commercial and industrial sector. Their power to finance commercial and industrial activity, however, is limited sharply by the restrictions imposed by law and regulation. In particular, banks are limited in their ability to hold corporate equity in commercial firms. The author argues that these restrictions on banks' commerce powers likely impair the ability of banks to effectively intermediate credit, particularly to risky firms. In addition to a theoretical presentation, the paper provides empirical evidence consistent with the importance of lender equity powers.*

The powers of commercial banks in the United States are circumscribed sharply by law and regulation. The main source of these restrictions is the Banking Act of 1933 ("Glass-Steagall Act"). The act's restrictions on bank underwriting powers are its best known features. These restrictions effectively separate investment banking from commercial banking and limit the ability of banks to operate mutual funds or issue other asset-backed liabilities.

In addition to the underwriting limitations, however, the act restricts a bank's ownership of securities for its own account. Specifically, most banks in the United States generally may hold only debt securities of other companies, unless otherwise authorized. This has come to mean that banks may hold only small amounts of nonfinancial firm equity, and in no case may banks exercise control over commercial companies.<sup>1</sup> Banks also generally may not hold the debt and equity simultaneously of a client commercial firm because of this restriction.<sup>2</sup> In general, therefore, the Banking Act of 1933 confines banks to the role of portfolio lender, and the ownership of shares in commercial enterprises by banks is limited severely.

The separation of banking and commerce is a seldom debated restriction on bank powers. While there has been much debate in recent years over the investment banking powers restrictions, removal of the commerce restrictions is considered to be much more difficult politically. The ownership and control of commercial enterprises by banks raises questions of concentration of economic power. In addition, in an environment of underpriced deposit insurance, it raises important questions about propagation of the safety net.

This paper argues that there are important arguments in favor of the removal of the commerce restrictions. In particular, it is argued that the ability to simultaneously hold the equity of and lend to commercial firms is important to successful intermediation of risky credits. To the extent that banks are special intermediaries whose function is not costlessly replaced by other types of firms, the commerce restrictions may have significant macroeconomic consequences.<sup>3</sup> In particular, costs of capital may

be higher and total investment lower than would be the case if banks were permitted to hold corporate equity.

In subsequent sections of the paper, the theoretical analysis is developed using a simple theoretical representation of the firm in the context of information asymmetry. (For exposition purposes, the analysis abstracts from problems caused by underpriced deposit insurance.) The paper goes on to look for data verifying the theoretical notions.

## I. The Theoretical Advantages of Mixed Finance

In recent years, the finance literature has come to recognize the importance of information asymmetries in financial relationships. If one party is better informed than another about events affecting the relationship, a financial relationship may be infeasible or handicapped unless the contractual agreement controls the ability of one party to exploit the other.

A primary instance of such a problem can arise in the context of a firm and its external financiers. It is probably reasonable to assume that the insider/management of the firm knows more than outside financiers about the firm's projects and prospects. This is likely because it is costly to make the firm transparent to outside investors, and because information is fungible, so that its general release would dissipate rents enjoyed by the firm in its markets. In such an atmosphere of information asymmetry, there is no assurance that the self-interested behavior of the firm will conform to that expected by its outside financiers. The result may be failure to fund socially desirable activities, or financial contracts that do not allocate resources optimally.

In the following discussion, we demonstrate formally that pure debt is not the socially desirable form of finance under many conditions. Rather, outside financiers may need to hold some form of equity claim on the firm simultaneously with the debt claim if the firm's value is to be maximized. We will call this type of financing "mixed" financing.

### A Model of the Financing and Strategy Choices of the Firm

We examine the financing arrangements for a firm that faces uncertainty about its future payoffs.<sup>4</sup> Let  $P$  be the nonnegative payoffs ranging from 0 to  $m$  and  $x$  be a parameter representing different "strategies" that indexes various payoff distributions. Using Lucas/Breeden-type capital asset pricing, the market value (in a competitive market) of the firm can be derived from information on the distribution of payoffs.<sup>5</sup> As Ross (1987) has shown, a distribution function  $f(P, x)$  can be derived that has the property

Direct empirical verification of the effects of expanded powers hypothesized is difficult because U.S. banking exists in the context of restricted powers. However, international comparisons, and scrutiny of the contracting processes of nonbank U.S. financial intermediaries provide anecdotal evidence that is generally consistent with the hypothesized effects. The paper concludes with some broad policy observations.

$$\int_0^m f(P, x) dP = 1.^6$$

Thus the discounted expected value of the firm,  $MV(x)$  can be written as

$$MV(P, x) = r^{-1} \int_0^m P f(P, x) dP$$

or

$$MV(x) = \frac{1}{r} \int_0^m [1 - F(P, x)] dP,$$

where  $r$  is the return on a certain payoff (the "risk-free" return) and  $F(P, x)$  is the cumulative distribution associated with  $f(P, x)$ .<sup>7</sup> We assume that the firm has a maximum discounted expected value at some strategy  $x^*$ , and that its value function is strictly concave in  $x$ . In addition, we assume that the firm borrows in external debt markets an amount equal to  $D$ .

The value of the firm can be partitioned into those payoffs that accrue to debt holders,  $B(x)$ , and those that accrue to equity holders,  $V(x)$ . Specifically, if the coupon payment on the debt is  $R$ , the market value of the firm can be partitioned as

$$MV(x) = B(x) + V(x) = \frac{1}{r} \int_0^R [1 - F(P, x)] dP + \frac{1}{r} \int_R^m [1 - F(P, x)] dP.$$

That is, the discounted expected value of the payoffs between 0 and  $R$  accrues to bondholders, while the portion in excess of this accrues to equity holders.

Note that  $x$  indexes not only the firm's value, but also the "risk" of the strategy. Bankruptcy occurs if  $P < R$ . The strategy  $x'$  will be considered riskier than  $x$  if the probability of bankruptcy is greater. That is, if  $F(R, x') > F(R, x)$ . If the distribution function has a single-crossing property, then this also suggests that when  $x'$  is greater than  $x$ ,  $x'$  is a riskier strategy than  $x$ .<sup>8</sup>

## The Moral Hazard Problem

Having structured the basic valuation model, we can now model how information asymmetry can influence the viability of external finance for this firm. It is assumed that only outside financiers hold the debt of the firm, and that outside financiers are informationally handicapped relative to the insider/equity holders of the firm. This information asymmetry takes the form of uncertainty about the strategy,  $x$ , that will be chosen by the insiders.

We look first at the case when outside financiers can only hold the debt the firm (and thus the insiders hold all the equity). For a given coupon,  $R$ , on the debt, insiders have an incentive to choose a riskier strategy than the one incorporated in  $R$ . This is because for  $x' > x$ , for a given coupon

$$\begin{aligned} V(x') &= \frac{1}{r} \int_R^m [1 - F(P, x')] dP > V(x) \\ &= \frac{1}{r} \int_R^m [1 - F(P, x)] dP \end{aligned}$$

and

$$\begin{aligned} B(x') &= \frac{1}{r} \int_0^R [1 - F(P, x')] dP < B(x) \\ &= \frac{1}{r} \int_0^R [1 - F(P, x)] dP, \end{aligned}$$

by the earlier definition of a riskier strategy. In essence, riskier strategies add to the "upside" value captured by equity holders while decreasing the value of the position of the bondholders (for a given amount of outstanding debt). This implies that  $\partial B(x)/\partial x < 0$ .

## The Effect on Risk-Taking

The equilibrium effect of the moral hazard problem on risk-taking and the value of the firm requires consideration of how the parties to the transaction will respond to these incentives. Since the value of the firm is assumed to be a concave function of the strategy  $x$ , by definition it is maximized when  $\partial MV(x)/\partial x = 0$ , which will occur by definition at  $x^*$ . The insider/borrower, however, will have his equity stake maximized when the first order condition for a maximum value of  $V(x)$  is met. This is when

$$\frac{\partial V(x)}{\partial x} = \frac{\partial MV(x)}{\partial x} - \frac{\partial B(x)}{\partial x} = 0,$$

at a given coupon rate,  $R$ . But since  $\partial B(x)/\partial x < 0$ , the value of the first-order condition will be zero only for strategies for which  $\partial MV(x)/\partial x < 0$ . By the assumed

concave nature of the firm value relationship, this requires selection of a strategy,  $x^+$ , that is greater than the value-maximizing strategy,  $x^*$ . Thus, the strategy,  $x^+$ , that would be chosen by the insider would result in a less than maximum firm value, and strategies riskier than the value-maximizing strategy.

A rational lender, of course, will anticipate the tendency for the insider to take on riskier projects, and will charge a risk-adjusted bond coupon rate that accommodates this expectation. Thus, he will charge a risk-adjusted rate  $R(x^+)$  so that the value of the debt is equal to  $D$ , the given amount of outside debt financing obtained by the firm. That is, in equilibrium  $R(x^+)$  will be chosen so that

$$B(x^+) = \frac{1}{r} \int_0^{R(x^+)} [1 - F(P, x^+)] dP = D.$$

This will be a higher coupon than at the value-maximizing strategy, since for  $x^+ > x^*$ ,  $R(x^+)$  must be greater than  $R(x^*)$  in order to make

$$\begin{aligned} &\frac{1}{r} \int_0^{R(x^+)} [1 - F(P, x^+)] dP \\ &= \frac{1}{r} \int_0^{R(x^*)} [1 - F(P, x^*)] dP = D. \end{aligned}$$

In equilibrium, therefore, lenders price debt in the above manner so that its discounted value is always equal to the amount borrowed,  $D$ . As a result, if a strategy,  $x$ , is pursued where  $x^* \leq x < x^+$ , it is immediately implied that

$$\begin{aligned} V(x^*) &= MV(x^*) - D \geq V(x) = MV(x) - D > V(x^+) \\ &= MV(x^+) - D. \end{aligned}$$

That is, the value of the insider's equity would be greater if the strategy,  $x$ , which is less risky than the strategy  $x^+$ , were employed.

## Mechanisms to Control Risk-Taking

Thus, the insider has an incentive to find some way to persuade outside financiers that the riskiest strategies will not be pursued. The mechanism could involve, for example, covenants in the financial agreement to bind the insiders' behavior. Covenants that restrict additional borrowing by the firm, or give borrowers seats on boards of directors (thereby giving them access to inside information) may be thought of in this light.

Alternatively, the outside financiers could be given a share of the equity of the firm in return for their lending the funds,  $D$ . Let us say, for example, that the insiders give

away a portion,  $t$ , of  $V(x)$  so that the insider's share is now

$$(1-t)[MV(x) - B(x)]; 0 \leq t \leq 1.$$

The insider will now have to find a strategy,  $x^{++}$ , to maximize

$$(1-t) \frac{\partial MV(x^{++})}{\partial x} - (1-t) \frac{\partial B(x^{++})}{\partial x} = 0,$$

which will have the same optimum for a given  $R$  as before since it is just a scalar of the first order condition in the all-debt finance case. However, the reaction of the bondholders will change. Since they now hold a share of the equity of the firm, everything else being equal, they will require a lower coupon on competitively priced debt,  $D$ .<sup>9</sup>

It can be shown that the optimal strategy,  $x^{++}$ , in this situation will be less risky than the strategy pursued when only all-debt positions were permitted. That is,  $x^{++}$  will be less than  $x^+$ . This can be demonstrated by recognizing that if the new strategy,  $x^{++}$ , is in fact better for equity holders than  $x^+$ , then  $V(x^{++}, R^{++}) > V(x^+, R^{++})$ . It also must be the case that it was not the preferred strategy when all-debt finance was used. That is, it must be the case that  $V(x^+, R^+) > V(x^{++}, R^+)$ . With the knowledge that  $R^{++}$  is less than  $R^+$ , these two relationships together imply that

$$\int_{R^{++}}^{R^+} [F(P, x^+) - F(P, x^{++})] dP > 0.$$

This will be the case only if  $x^{++}$  is a lower risk strategy than  $x^+$ .<sup>10</sup> Thus, if outside financiers are offered the opportunity to simultaneously hold the debt and equity of a firm, the firm will adopt less risky strategies. These strategies more nearly maximize the value of the firm.

The same result, it should be emphasized, can be obtained by directly monitoring and controlling the firm's risk-taking via restrictive covenants, participation inside the firm, and other techniques. Monitoring efforts are costly, however, because they involve expenditure of resources by the outside financier, and because they require the firm to reveal information that it might otherwise prefer not to circulate outside the firm. If the outside financiers are given some control over the firm (through seats on boards of directors, for example), there also may be a cost burden in the form of less efficient management (because the outsiders, by definition, may be less expert in the business of the firm than the firm itself). Whether monitoring and control approaches will be used with (or instead of) mixed financing depends upon the balance of the costs and benefits of each approach.

In summary, however, we have found that, for a firm with

a given face value of debt,  $D$ , and a given distribution of payoffs, allowing outsiders to simultaneously hold debt and equity increases net firm value over all-debt finance. Thus, if an artificial restriction limits outside financiers to all-debt claims, net social value of the firm's activities will be enhanced if nonzero equity shares are permitted. Since the moral hazard problem is greatest in the case of a borrower who has little equity at stake, or whose risk-taking cannot be controlled or monitored accurately, the remedy of mixed financial contracts likely is of particular value in these cases.<sup>11</sup>

Needless to say, various forms of mixed financing besides the simple mixed finance form used here can produce this result. Convertible debt, debt plus warrants or rights, collateralized lending, and other forms of mixed debt and equity financial structures are essentially ways of sharing equity claims with lenders.

### The Role of Banks in Mixed Finance

Thus far, the discussion has emphasized the importance of mixed financing generally in the relationship between a firm and its outside financiers. An obvious question, however, is whether mixed financing needs to be done by financial institutions that accept deposits. There would appear to be a simple answer to this question, one that relies again on the notion of asymmetric information.

A bank is distinguished from other intermediaries because it issues debt, redeemable on demand, that may be used in lieu of currency to effect household transactions. The depositors of a bank thus are holders of par-value, demand debt. Because depositors consist of ordinary households, they may be assumed to be informationally deprived relative to the managers of the bank. Thus they, like the outside financiers of our previous discussion, need to be able to observe behavior on the part of the bank that is consistent with control of risk-taking. In essence, this is an extension of the argument made by Diamond (1984) and Gorton and Haubrich (1987) that a bank has an incentive to structure the portfolio so as to simplify the depositors' own monitoring problem.

From our earlier analysis, a bank that holds a pure-debt position in firms has a claim that will be used to finance a riskier strategy than it would be if it employed mixed debt and equity finance. To the extent that such mixed financing improves the lender's control over the moral hazard problem, it is a superior claim to the pure-debt position. It is likely that depositors, everything else being equal, would prefer their deposits be invested in such superior claims. Thus, depositors desiring a risk-free rate of return would prefer banks with investments structured as mixed finance

for the same reason that a lender would prefer such an investment itself.

### The Specialness of Banking

This line of reasoning suggests that banks with commerce powers would dominate banks restricted to all-debt financial contracting with loan clients. It does not say, however, that fully empowered banks necessarily dominate other types of financial institutions with the ability to hold the equity and debt of a firm. For this to be the case, there must be something "special" about the banking firm in the first place.

The "specialness" of a bank can be either on the assets or liabilities side of its activities. That is, depository institutions may be special because the provision of deposit services lowers the cost of accessing the savings of certain types of individuals in the economy. Households, for example, may have little in the way of resources to devote to financial management. Hence, they may seek demand debt as an investment because it offers a bankruptcy covenant

that is inexpensive to exercise (they can just demand repayment of their debt, without any legal costs), and demand debt simultaneously provides liquidity and investment services.

Alternatively, banks may be special because they are superior monitors of loan credits. This is an argument that has been made by James (1987) and others. For this to be an advantage of *depository* loan monitors, however, this technological advantage must flow from some advantage of jointly providing this service and deposit services. Conceptually, this could be because holding deposit accounts provides monitoring information about loan clients, or because banks enjoy scale economies because deposit liabilities provide a large liability base.

Although economists continue to debate the issue, the empirical importance of banking in virtually all financial landscapes strongly suggests that banks play special roles.<sup>12</sup> By extension, therefore, restricting the equity powers of commercial banks will have important consequences to the extent the powers restrictions have the adverse effects modeled above.

## II. Empirical Support

The arguments made in this paper suggest a number of testable hypotheses about the use of mixed financing and the role of banks:

1. Mixed debt-equity financing will be used when the riskiness of projects is difficult for outsiders to monitor or control.
2. Preference for such financing also will be higher where the equity stake of the firm is small or collateral is not available.
3. Banks that must hold only debt will be dominated by intermediaries without such restrictions. As a corollary of this, banks will be more prominent intermediaries in financial systems that grant banks equity powers.
4. In economies where external finance is handicapped by instrumentation powers, there will be greater reliance on financing generated internally by the firm, despite the inefficiency of such finance.

Because mixed debt-equity financing by banks is not permitted in the U.S., however, it is necessary to look to other financial sectors and other financial systems to see if these hypothesized effects are observed.

### Evidence from Venture Financing

Hypotheses 1 and 2 above can be tested by examining financings that clearly involve risky projects and asym-

metric information. Mixed debt-equity financing should be prevalent in these types of circumstances.

**The Nature of Venture Activity.** An examination of U.S. venture capital activity helps test these hypotheses. The venture capital business in the United States provides financing in an environment of particularly severe information asymmetry on project risk. Venture projects, because of their novelty, are risky and difficult to evaluate externally. In addition, venture firms, by definition, are firms with low collateral and market value net worth. Thus, start-up firms offer little in the way of receivables or other sources of collateral to protect the financier's position; and the entrepreneur typically has little equity in the enterprise to moderate the moral hazard problem faced by the lender. As Table 1 demonstrates, the result is a class of investments with very high risk, relative to other types of assets in the economy.

**The Type of Instrumentation.** The type of financial instrumentation typically employed in the high-risk setting of venture finance as displayed in Table 2 supports the theoretical notions offered earlier.<sup>13</sup> As is apparent from this table, simple coupon debt instruments ("notes" in Table 2) are very uncommon in venture financing.<sup>14</sup> When pure debt is used, it is typically very short term, usually to provide a new firm with interim working capital or other temporary needs. Consistent with the model above, both



**Table 1**  
**Comparative Returns and Risks**  
**(1978–87)**

Asset Class	Average Annual Returns (%)	Standard Deviation of Returns (%)
Venture Capital Funds > 6 years	24.4	51.2
S&P 500 stocks	15.9	12.3
Small stocks	20.4	18.9
Real estate	12.8	n.a.
Treasury bills	9.2	2.7
Long-term government bonds	10.5	16.2
Long-term corporate bonds	10.7	16.4

Source: Chiampou and Kallett (1989).

the monitoring problems and the high risk of the projects predispose against the use of pure debt.

The most common form of venture finance instrument appears to be convertible preferred stock, which is essentially a mixed debt-equity position similar to the simpler equity share modeled above. The preferred stock dimension gives the venture capitalist some debt-like returns, while the convertibility feature provides opportunities to enjoy the greater upside potential of common stock. Less commonly, straight debt with equity conversion or detachable stock warrant features are employed. These, too, have elements of a mixed financial structure.

The venture finance positions are augmented by other covenants that serve the role of direct risk-capping, that is,

**Table 2**  
**Venture Capital Financing**  
**Instruments 1990**

Type of Instrument	Average Use by Venture Funds (% of fund assets)	Standard Deviation in Average Use (%)
Common Stock	26.1	25.5
Convertible Preferred Stock	62.0	37.1
Notes	2.9	3.5
Convertible Debt	2.3	4.7

Source: Sample of venture fund reports, 1990.

**Table 3**  
**Features of**  
**Venture Capital Instruments**

Feature	Mean Proportion of Financings
Convertible preferred with liquidation priority	64
Convertible preferred with mandatory redemption	41
Warrants	25
Antidilution "ratchets"	71
Restrictions on sale of founder stock	66

Source: QED Survey of Venture Partnerships. Note that individual financings may employ more than one of these features, so that the total of the proportion of financings may exceed 100 percent.

permitting the financier to control his losses should he perceive a deterioration in his position. The convertible preferred positions, for example, often include liquidation priority and redemption rights. Liquidation priority, provides the venture capitalist with a worst-case downside protection; redemption rights require that the firm cash out the venture capitalist at a premium over the value of the initial investment if, by a certain time, performance has been less than anticipated. In addition, various antidilution and stock sale restrictions are frequently imposed to prevent the firm from increasing its leverage or diluting the claims of the venture capitalist. Table 3 presents the frequency of such features from a survey of venture partnerships.

In addition to embedding these control features in their outside positions, venture capitalists often obtain inside (management) rights in return for their significant outside funding. These rights may include the opportunity to appoint one or more directors or to serve as an officer of the company. In addition, financing to venture firms usually is provided in stages, to give the venture financier additional control.

### **Evidence from Recent Changes in Tax Law and Venture Activity**

All of these contracting conventions observed in the venture capital industry lend further support to the notion that mixed debt-equity positions are useful in intermediating these types of risky credits. This observation is further supported by the effect of recent changes in tax law on the



level of venture finance activity. Recent changes in tax law have increased effective capital gains tax rates and increase the benefits of tax-deductible debt finance. Specifically, with the passage of the Tax Act of 1986, personal income tax rates were made lower than the corporate income tax rate, and the rates at which capital gains and ordinary income are taxed were equalized. Both have the effect of favoring debt over equity finance.

In the venture capital industry, this appears to have resulted in a reduction of venture commitment flows by about 60 percent, and to have skewed venture finance activity toward lower-risk, more conventional intermediation.<sup>15</sup> This recent experience underscores the selective importance of equity and mixed finance positions in financing risky ventures.

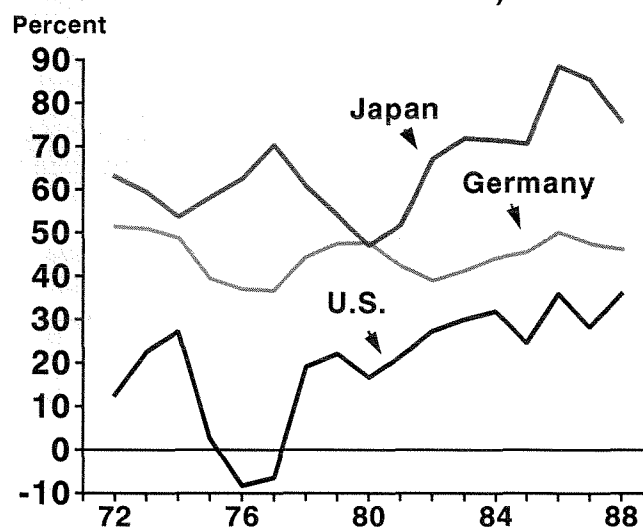
### Evidence from Other Banking Systems

Hypotheses 3 and 4 state, respectively, that in economies that do not restrict bank commerce powers, banks will be the dominant form of intermediation and, by extension, that external finance thus will be facilitated. Although the commerce powers of commercial banks are limited today in the United States, banks in some other countries enjoy greater flexibility in this regard. This permits us to see whether mixed financing emerges as a common financing technique in such systems, and how banks fare versus other intermediaries when these powers are available.

**German and Japanese Banking.** Commerce powers are generally less restricted in most European countries and in Japan as well. Of the major European countries, Germany has the most liberal policies regarding combinations of banking and commerce. So-called universal banking is practiced, and banks enjoy virtually complete flexibility in the relationships that they may have with commercial firms.<sup>16</sup> These powers are of long standing in Germany, having been acquired with the introduction of joint-stock banking that occurred in 1848. These so-called Kreditbanken enjoyed both investment and commercial banking powers. In addition, historically there have been no antitrust laws or restrictions against interlocking directorates in Germany, and banks were permitted, as needed, to require representation on supervisory boards of the firms to which they lent funds.

Japanese financial regulation is nominally similar to the U.S., since restrictions similar to Glass-Steagall were imposed in the postwar period. In practice, however, as Kim (1988) has pointed out, the keiretsu industrial relationships and mochiai cross-shareholding relationships function to permit considerable exercise of mixed financing. Thus, both Germany and Japan offer interesting

**Chart 1**  
**Use of Bank Debt**  
**by Commercial Firms**  
(Share of Outside Financing  
Obtained from Banks)



opportunities to examine the effects of liberal commerce powers.

*Dominance of Bank Intermediaries.* In both countries, commercial banks are the dominant intermediaries. In sharp contrast to the U.S., the major share of external finance is obtained in the form of bank loans, rather than the direct placement of debt or equity securities. Chart 1 depicts the level and trend of bank loan share in the U.S., Japan and Germany.

The pattern of finance in both Germany and Japan appears to emphasize mixed debt and equity finance. Unlike banks in the U.S., banks in both Germany and Japan hold major equity positions in their corporate credit clients. In Germany, it is estimated that banks hold between 5 and 10 percent of total banking assets in the form of corporate equity, or about 10 to 20 percent of total corporate equity in Germany. Complete data are not available on the equity positions of German banks. Special antitrust studies conducted in the 1970s, however, reveal the role of German banks in large corporations. As Table 4 shows, German banks have very significant positions in these companies, with 28 percent of the largest companies having 10 percent or more of their equity capital held by financial institutions. Commercial banks appear to use this practice the most, but a wide variety of universally empowered financial institutions hold corporate equity.

In addition to significant equity positions, German banks obtain additional corporate control capability because of stock voting practices permitted in Germany. In

**Table 4**  
**German Bank Equity Positions in 74 Large Commercial Firms**

Bank Class	Percent of Firms Affected 1974-1975							
	Control Share: Equity Plus Proxy Votes				Control Share: Equity Only			
	>50%	25-50%	10-25%	<10%	>50%	25-50%	10-25%	<10%
"Big Three"	0	10	17	73	0	7	3	2
Big Regional Banks	2	7	9	82	0	6	0	2
Large Commercial Banks	16	30	22	32	4	11	4	2
Savings and Giro Banks	1	1	6	92	0	3	0	4
Cooperative Banks	0	0	0	99	0	0	0	0
Other Banks	0	7	9	84	2	2	2	15
All Financial Institutions	55	22	14	10	11	12	5	10

Source: Bericht der Studienkommission, "Grundsatzfragen der Kreditwirtschaft" Table 10, p. 436.

particular, German banks also are the major provider of stock brokerage and dealing services. As a result, most shares are held on deposit by banks. German law and regulation permits the shareholder to delegate voting authority to the bank of deposit.

These delegated voting rights add to the ability of German banks to control risk in the corporations to which they have lent; in the parlance of our earlier model, they are able to directly limit selection of risky projects through their corporate affiliations. Referring again to Table 4, 90 percent of the large-company sample had 10 percent or more of their equity voted by banks in 1974/75. These control channels are further implemented through bank memberships on boards of directors and management committees of commercial firms. A 1979 report by the German Monopolies Commission, (Bericht der Studiet Kommission 1979) for example, found that banks had representatives on the boards of two-thirds of the top 100 corporations.

For reasons given earlier, we would expect the use of mixed financing to be less common in the financing of well-established firms with substantial net worth since they pose more modest monitoring and control challenges than new, low-net worth firms. Indeed, over time the amount of equity held by German banks in large corporations has declined (Bericht der Studiet Kommission 1979).

Similar patterns of significant stock ownership and control have been found in Japan in recent decades. As Table 5 indicates, for example, the six major industrial *keiretsu* all have had significant ownership by financial

institutions. Although banks are nominally limited to 5 percent equity positions in nonbank corporations, through cross-shareholdings with insurance companies and securities firms, the effective position of the main banks of *keiretsu* is enlarged considerably.

*Alternative Explanations.* It could be argued that the dominance of banks in these two countries results not from more efficient bank intermediation, but from less efficient direct placement markets. Indeed, German stock and bond markets in particular are notoriously undeveloped. (The German stock exchange, for example, is open only 2 hours

**Table 5**  
**Ownership of Japanese Commercial Firms by Financial Institutions**  
(1974-1982 average)

Industrial Group	Percent of Shares Held by Financial Institutions
Mitsui	37.0
Mitsubishi	39.6
Sumitomo	34.8
Fuji	37.1
DKB	41.2
Sanwa	40.2

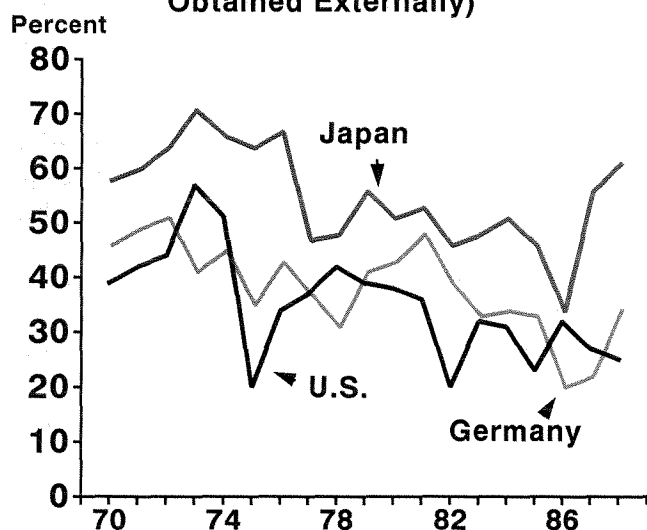
Source: Nakatani (1984)

a day for public trading.) Similarly, corporate debt markets in Japan are said to be poorly developed.

Poorly developed external financial markets however, would lead us to expect to see relatively greater reliance on internal financing. (As Myers and Majluf 1984 have suggested, firms rely on internal finance when information asymmetries cannot be managed by outside intermediation processes.) Yet in both Germany and Japan, there is less reliance on internal financing than in the United States, as illustrated by Chart 2. The comparative reliance of U.S. firms on internal finance is consistent with the notion that bank intermediaries are handicapped in their ability to manage risk in an information-asymmetric environment.

The relatively heavy reliance in the U.S. on a distinct venture capital industry also suggests that banks may be handicapped in financing certain types of credits. In essence, in the United States, the venture capital industry or some institution like it is necessary because of constraints on mixed financing by banks. With no such constraints, we would hypothesize greater bank involvement in venture capital. Indeed, this appears to be the case in Germany, where banks provide between 45 and 55 percent of all venture capital. In fact, similar high percentages are observed by Oohge, et al. (1989) in all other European nations with liberal bank equity powers, such as France (35 percent) and Italy (70 percent). The fact that U.S.-style venture capitalism has had difficulty operating in Japan also may be consistent with this view.

**Chart 2**  
**The Use of External**  
**Financing by Commercial Firms**  
(Percent of Financing  
Obtained Externally)



## Evidence from U.S. Bank Portfolio Behavior

The evidence above suggests that the presence or lack of bank equity powers can have a significant effect on the structure of financial intermediation. In particular, banks' role in financial intermediation of risky credits is likely to be less without equity powers. At issue, however, is not just the specific institutional form of financial intermediation, but rather the efficiency of its provision in the economy.

**Portfolio Effects.** To the extent that strip finance by deposit-taking intermediaries is the most efficient form of intermediation, of course, the market share implications of powers restrictions have direct efficiency effects. Moreover, restricting the type of financial contracting that a bank may use will result in a self-selection of the types of credits able to be served by a bank. This reduces the diversification opportunities that banks may enjoy, and with it, the ability to attract (uninsured) depositors.

In the U.S. context, it seems clear that firms with significant equity and relatively transparent portfolios are increasingly able to go to investors directly to raise new funds. Underwriting and information systems clearly have improved in the computer age. Yet these are precisely the types of credits that banks, under their current restrictions, are best suited to serve. Without the ability to hold corporate equity, banks cannot reasonably expect to serve efficiently firms with low net worth, low collateral, or novel and risky projects. There seems no doubt that, in the United States, the portfolios of commercial banks have become less diversified, and more dependent upon "middle market" credits and remaining high collateral credits.

Having lost the short-term corporate debt market to the commercial paper market in the 1970s, U.S. commercial banks began losing other lines of industrial finance in the 1980s. Call report data reveal that the result has been a decline in the share of commercial and industrial loans relative to total assets. In 1984, for example, C&I loans were 17.5 percent of total assets; as of the first half of 1990, this had declined to less than 15 percent. In absolute, inflation-adjusted terms, lending by U.S. banks to nonfinancial corporations has declined by two-thirds since 1978.

In place of C&I lending, banks have increased substantially their holding of real estate credits. The share of real estate-collateralized loans in U.S. bank portfolios has increased from 14 percent in 1984 to about 23 percent today. In contrast, U.S. Flow of Funds data show that the flow of directly placed corporate debt has increased 500 percent since 1978, and the real value of venture capital commitments by a similar amount since 1980. In sharp contrast to this experience of U.S. banks, real bank lending

to business, in absolute terms has increased in the same period in both Germany and Japan, according to flow of funds data from those countries.

### **Mixed Financing and Corporate Discipline**

An additional source of efficiency effects is the possibility that mixed financing provides a superior mechanism for resolving intracorporate conflicts. In a financial structure composed of separate debt or equity positions, conflicts arise during times of financial stress between equity holders and debt holders. No such conflicts arise, by definition, in a mixed finance position. Workouts thus may not need to result in bankruptcy, takeover, or other costly external control mechanisms.

### **III. Concluding Observations**

This paper has argued that restrictions on the instrumentation powers of commercial banks is a potential handicap to both the U.S. banking industry and to financial intermediation processes in our economy generally. The theory presented in the paper argues that mixed debt-equity finance is a potentially important means of resolving the moral hazard problem that all outside financiers face. Only casual data were presented in this paper, but the pattern of instrumentation is consistent with that implied by the model presented.

The more difficult issue is whether the lack of instrumentation powers of U.S. banks has any important macroeconomic consequences. For this to be so, one must first accept the notion that the handicap of limited commerce powers is significant and, second, that banks have special capabilities not easily provided by other intermediaries. If both of these observations are true, then the lack of universal bank-like powers may result in a handicap to the overall economy.

In concluding this paper, therefore, it is interesting to offer additional, casual observations. The banking systems in at least two major economies, Germany and Japan, follow some variant of mixed finance. In both of these economies, the introduction of bank equity powers is associated with their rapid subsequent development.

In the case of Germany, the introduction of universal banking in 1848 was followed by rapid growth through the turn of the century and the advent of the First World War. Historians and economists such as Riesser, Gerschenkron,

The data on the incidence of corporate takeovers in Germany and Japan are consistent with the view that mixed financing affords an opportunity to effect significant corporate change without formal bankruptcy or takeover and the deadweight costs associated with such processes. In Germany, for example, where this phenomenon has been studied in detail, there has been only one hostile takeover (the takeover of Feldmuehle Nobel in 1989 by Flick), and other types of takeovers have been similarly rare, when compared to the U.S. and the U.K. Rather, the banks have used their strip financier position to press for management changes in advance of serious deterioration of the firm's condition. Similar practices are reported for Japan by Kim (1988).

and Schumpeter have attributed the rapidity of German growth in this period in large part to the intermediation services provided by the Kreditbanken universal banking system. (See Pozdena and Alexander 1991.) The universal banking system appears to have served modern Germany equally well. The German economy has enjoyed higher average real growth rates than the U.S. in the last three postwar decades. In addition, spending on plant and equipment in Germany is roughly twice as great (as a percentage of GNP) in Germany as in the U.S. Nonmilitary research and development expenditures in Germany also exceed those in the U.S. by only a slightly smaller fraction.

In Japan, as Hodder, et al. (1985) point out, the prewar zaibatsu and direct placement markets had managed to provide a volume of external financing of only 2 to 4 percent of GNP. In contrast, the World War II and postwar intermediation by banks is associated with a rate of external finance of as much as 20 percent of GNP. Today, investment in plant and equipment in Japan exceeds that of the U.S. in absolute terms, and at 23.5 percent of GNP is approximately twice the U.S. rate. Research and development spending, at 3.1 percent in Japan, is 50 percent higher than in the U.S.<sup>17</sup>

Obviously, considerable additional research is needed to demonstrate more robustly the effects of restricted banking commerce powers. In addition, before banks receive additional powers of any kind, powers reform must be coordinated with the reform of the deposit insurance system.<sup>18</sup>

## ENDNOTES

1. Section 16 of the Banking Act of 1933 prohibits national banks from purchasing corporate stock [12 USC 24], a prohibition that has been extended to state-chartered banks that are members of the Federal Reserve System [12 USC 335]. Section 4 of the Bank Holding Company Act prohibits a bank holding company (BHC) from owning or controlling, directly or indirectly, the shares of any company that is not a bank [12 USC 1843]. The act exempts investments by BHCs that involve less than 5 percent of the voting shares of another company [12 USC 1843 (c) (6)]. In addition, Congress at various times has made exceptions that permit share ownership in selected organizations, such as Small Business Investment Corporations, which provide a limited form of debt financing to new business ventures [15 USC 682(b)] and state housing corporations [87 Stat. 269].

2. The Banking Act does not generate this restriction specifically. It restricts equity ownership, but generally allows incidental banking powers related to lending. The Office of the Comptroller of the Currency has interpreted this to mean that a bank may take as consideration for a loan a portion of the company's profits or earnings, but not shares of its stock [12 CFR 7.7312]. The Board of Governors of the Federal Reserve System typically has interpreted this restriction conservatively as well, and does not permit a bank to be the lead lender to a commercial firm in which it or other BHC subsidiaries hold shares, even if those shares are nonvoting and thus do not constitute controlling positions. See Taylor (1987) and Bostrom (1989) for a further discussion of these issues.

3. The macroeconomic importance of banks as intermediaries is emphasized by a number of authors studying the relationship between banking activity and business activity. See, for example, Bernanke and Gertler (1989) and Greenwald, Stiglitz, and Weiss (1989).

4. This section draws very heavily on an approach suggested by Roger Craine, and applied by Craine and Steigerwald (1989). Craine and Steigerwald's approach makes very compact a demonstration that otherwise is quite cumbersome.

5. See, for example, Lucas (1978).

6. This need not be the underlying payoff distribution; that will be the case only if agents are risk-neutral.

7. The discounted expected value of the firm is  $MV(P, x) = r^{-1} \int_0^m Pf(P, x) dP$ . However, this can be shown to be equal to  $r^{-1} \int_0^b [1 - F(P, x)] dP$  by application of the rule of integration by parts. Specifically, suppressing the  $x$  index for simplicity, let  $u = [1 - F(P)]$  and  $v = P$ . Then

$$\begin{aligned} r^{-1} \int_0^b [1 - F(P, x)] dP &= r^{-1} \int_0^b u dv \\ &= r^{-1} uv \Big|_{P=0}^{P=m} - r^{-1} \int_0^b v du \end{aligned}$$

This can be written as

$$\begin{aligned} r^{-1} \{ [1 - F(P)]P \} \Big|_{P=0}^{P=m} - r^{-1} \int_0^m P d[1 - F(P)] \\ = -r^{-1} \int_0^m -P dF(P) = r^{-1} \int_0^m Pf(P) dP \end{aligned}$$

since

$$r^{-1} \{ [1 - F(P)]P \} \Big|_{P=0}^{P=m} = 0.$$

8. The single crossing property is that  $F(P, x^1) > F(P, x)$  for  $x^1 > x$ . This ensures that a shift in the distribution has an unambiguous effect on the weight in the tails of the distribution.

9. That is, the  $R(x^{++})$  needed to solve

$$\begin{aligned} \frac{1}{r} \int_0^{R(x^{++})} [1 - F(P, x^{++})] dP \\ + \frac{t}{r} \int_{R(x^{++})}^m [1 - F(P, x^{++})] dP \\ = \frac{1}{r} \int_0^{R(x^+)} [1 - F(P, x^+)] dP = D \end{aligned}$$

is less than  $R(x^+)$ , if the expected value of the equity share is positive.

10. And the two distributions behave so that  $F(P, x^+) > F(P, x^{++})$  for all  $P$ , the so-called "single crossing property" of simple cumulative distributions.

11. The model presented above can be used to show that bigger coupons (such as might arise as the firm enlarges the amount of debt,  $D$ , it wishes to borrow) induce greater risk-taking. Thus, the more leveraged a firm becomes, the greater the moral hazard problem and the potential for a significant effect of a mixed financing mechanism.

12. See, for example, Black (1985).

13. Venture firms may have other sources of finance as well, such as funds raised from family or other direct investor sources. Typically, however, the venture capitalist is the major source of the funding of start-up industrial firms. Because such firms usually are closely held, data are not publicly available to characterize accurately the liabilities of the typical venture firm.

14. For a more complete description of venture financing mechanisms, see Testa and King (1989).

15. See Pozdena and Martin (1990).

16. See Pozdena and Alexander (1991), for a more complete description of the institutional features of the German banking system. This section draws heavily on that source.

17. Restricted equity powers thus may be at the root of the often lamented high cost of capital in the U.S. Indeed, in their recent study of Japanese and U.S. costs of capital, Ando and Auerbach (1990) conclude that the measured Japanese cost-of-capital advantage may be due to the "lower risk" of comparable investments in Japan. This is, of course, simply another way of saying that Japanese financial intermediation methods better accommodate risk.

18. It is not clear, however, that expanded commercial powers necessarily translates into expanded opportuni-

ties to exploit the bank safety net. Giving banks additional tools to manage asset risk should offer them the opportunity to enhance bank profitability and net worth, which in turn quells the desire for risk-taking at the expense of the deposit insurance fund. Even for banks with very low market value net worth (and, hence, a strong preference for risk taking at the expense of the deposit insurer), a method of controlling the cost of risky credits would be used positively to enhance net worth.



## REFERENCES

- Ando, A., and A. J. Auerbach. 1990. "The Cost of Capital in the United States and Japan: A Comparison." *The Journal of Japanese and International Economies* 2, pp. 22, 134-158.
- Bank of Japan. *Economic Statistics Annual*. Various issues.
- Benston, G. 1976. "A Transactions Cost Approach to the Theory of Financial Intermediation." *Journal of Finance* 31, pp. 215-231.
- Bernanke, B. and M. Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *American Economic Review* 79, pp. 14-31.
- Bericht der Studienkommission, Frankfurt. 1979.
- Black, F. 1985. "The Future for Financial Services." In *Managing the Service Economy*, ed. R.P. Inman, pp. 223-233. Cambridge University Press.
- Bostrum, R. E. 1989. "Non-voting Equity Investments by Bank Holding Companies." *The Review of Banking and Financial Services* (March 1) pp. 43-52.
- Campbell, T. S., and W. Kracaw. 1980. "Information Production, Market Signalling, and the Theory of Financial Intermediation." *Journal of Finance* 35, pp. 863-882.
- Chiampou, G. and J. Kallet. 1989. "Risk/Return Profile of Venture Capital." *Journal of Business Venturing* (January).
- Commerzbank. 1985. *Wer Gehort Zu Wem*. Hamburg, West Germany.
- Craine, R., and D. Steigerwald. 1989. "Raiders, Junk Bonds, and Risk." Mimeo.
- Diamond, D. W. 1984. "Financial Intermediation and Delegated Monitoring." *Review of Economic Studies*, pp. 393-414.
- Franks, Julian, and Colin Mayer. 1990. "Capital Markets and Corporate Control: A Study of France, Germany, and the U.K." *Economic Policy* (April) pp. 191-231.
- French, K. R., and J. M. Poterba. 1990. "Are Japanese Stock Prices Too High?" Mimeo.
- Gorton, G., and J. Haubrich. 1987. "Bank Deregulation, Credit Markets, and the Control of Capital." *Carnegie-Rochester Conference Series on Public Policy* 26, pp. 290-348.
- Greenwald, B., J. Stiglitz, and A. Weiss. 1984. "Informational Imperfection in the Capital Market and Macroeconomic Fluctuations." *American Economic Review* 74 (May) pp. 194-200.
- Hodder, J., and A. E. Tschoegl. 1985. "Some Aspects of Japanese Corporate Finance." *Journal of Financial and Quantitative Analysis* 20, pp. 173-191.
- James, C. 1987. "Some Evidence on the Uniqueness of Bank Loans." *Journal of Financial Economics* 26, pp. 217-236.
- Jensen, M. C. 1987. "Corporate Takeovers: A Financial Perspective on Mergers and Acquisitions and the Economy." In *The Merger Boom: Proceedings of a Conference at Melvin Village*. Federal Reserve Bank of Boston.
- \_\_\_\_\_. 1989. "Eclipse of the Public Corporation." *Harvard Business Review* (November).
- \_\_\_\_\_, and W. H. Meckling. 1976. "Theory of the Firm: Managerial Behavior, Agency Costs and Capital Structure." *Journal of Financial Economics* 12, pp. 541-552.
- Kim, Sun Bae. 1988. "Industrial Financing in Postwar Japan." Mimeo. University of Toronto (November).
- \_\_\_\_\_. 1989. "Modus Operandi of Lender-cum-Shareholders Banks." Mimeo. University of Toronto (November).
- Leland, J., and D. Pyle. 1977. "Information Asymmetries, Financial Structure, and Financial Intermediation." *Journal of Finance* 32, pp. 371-387.
- Lucas, R.E. 1978. "Asset Prices in an Exchange Economy." *Econometrica* 46, pp. 1429-1445.
- McDonald, J. 1989. "The Mochiai Effect: Japanese Corporate Cross-Holdings." *The Journal of Portfolio Management* (Fall) pp. 90-94.
- Myers, S.C., and N. S. Majluf. 1984. "Corporate Financing and Investment Decisions When Firms Have Information that Investors Do Not Have." *Journal of Financial Economics* 13, pp. 187- 221.
- Nakatani, I. 1984. "The Economic Role of Financial Corporate Grouping." In *The Economic Analysis of the Japanese Firm*, ed. M. Aoki. Amsterdam: Elsevier Science Publishers.
- Ooghe, H., A. Bekaert, and P. van den Bossche. 1989. "Venture Capital in the U.S.A., Europe, and Japan." *Management International Review* 29, pp. 29-45.
- Pozdena, R. 1987. "Tax Policy and Corporate Capital Structure." Federal Reserve Bank of San Francisco *Economic Review* (Fall) pp. 37-51.
- \_\_\_\_\_. 1987. "Commerce and Banking: The German Case." Federal Reserve Bank of San Francisco *Weekly Letter* (December 18).
- \_\_\_\_\_. 1989. "Do Banks Need Securities Powers?" Federal Reserve Bank of San Francisco *Weekly Letter* (December 29).
- \_\_\_\_\_. 1990. "Banking and Venture Capital." Federal Reserve Bank of San Francisco *Weekly Letter* (June 1).
- \_\_\_\_\_, and V. Alexander. Forthcoming. "Bank Structure in West Germany." In *Bank Structure in Major Countries*, ed. G. Kaufman. Kluwer.
- \_\_\_\_\_, and D. Martin. 1990. "Is Tax Policy Hurting Venture Capital?" Federal Reserve Bank of San Francisco *Weekly Letter* (August 24).

- QED Survey of Venture Partnerships. 1989. Palo Alto.
- Ross, S.A. 1987. "Arbitrage and Martingales with Taxation." *Journal of Political Economy* 95, (November 2) pp. 371-393.
- Smith, C.W., Jr. 1979. "Applications of Option Pricing Analysis." In *Handbook of Financial Economics*, ed. J.L. Bicksler, pp. 288-327.
- Stiglitz, J. and A. Weiss. 1981. "Credit Rationing in Markets with Imperfect Information." *American Economic Review* 71, pp. 393-410.
- Taylor, R.M., III. 1987. "Equity Investment Opportunities Available to Banks and Bank Holding Companies." *The Banking Law Journal* (January) pp. 127-153
- Testa, Richard J., and Rufus C. King. 1989. "Venture Capital Investment." *Securities and Commodities Regulation* (September 27) pp. 171-180.



# Can Bank Capital Regulation Work? Research Revisited

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The following two articles are reprinted here because they provide important theoretical analysis on the effectiveness of capital regulation. Over the past several years, regulatory policy has placed an increasing emphasis on the adequacy of bank and thrift capital. The argument is that raising bank capital is an effective way to protect the insurance system and taxpayers, since capital represents a buffer for absorbing losses. With higher levels of capital, banks should be safer and pose less of a risk to the deposit insurance system. This view is reflected in *Modernizing the Financial System* (U.S. Treasury 1991). That study states that "The single most powerful tool to make banks safe is capital."

However, the capital position of a bank is only one dimension of risk. The safety of a bank and the expected cost to the deposit insurance system also depend on a bank's portfolio risk, which reflects several factors such as credit risk, the degree of diversification, and interest rate risk. The controversy addressed in the following two articles is whether banks, when forced to hold more capital, can be expected to adjust their portfolio risk so as to offset, or even more than offset, the potential for higher levels of capital to reduce the risk exposure of the deposit insurance system.

The first article, "Capital Regulation and Bank Risk-Taking," concludes that when banks act to maximize their value, forcing them to hold more capital should reduce the risk exposure of the deposit insurance system. This is the case even though banks have an incentive to increase portfolio risk with subsidized deposit insurance. As shown in the article, a solvent bank's incentives to increase portfolio risk to exploit the insurance subsidy decline as its capital-to-asset ratio increases. Therefore, as long as the rise in the bank's capital ratio is not accompanied by a relaxation of regulatory efforts to constrain its portfolio risk, a higher level of capital at the bank should mean more protection for taxpayers.

This conclusion for risk-neutral, value-maximizing banks is at odds with the conclusions reached in earlier studies concerning the effectiveness of capital regulation on risk-averse, utility-maximizing banks. These earlier studies use a mean-variance framework and conclude that banks might react to more stringent capital standards by increasing portfolio risk to such an extent that the probability of failure increases. That is, these earlier studies argue that forcing banks to hold more capital could be counterproductive.

The second article, "A Reexamination of Mean-Variance Analysis of Bank Capital Regulation," demonstrates that the analyses in the earlier studies that rely on the mean-variance framework cannot be used to support the conclusion that capital regulation could be counterproductive.<sup>1</sup> These studies inappropriately apply the Markowitz two-period portfolio model, which assumes that the probability of failure is always zero, to address the question of how capital regulation affects the probability of failure. More specifically, the analyses in these studies leave out the option value of deposit insurance and use an inappropriate measure of risk, and, thus, misrepresent the return frontiers facing banks.

The two theoretical articles on capital regulation in this *Review* support the view that capital regulation can be effective. That is, banks operating with higher levels of capital should reduce the exposure of the deposit insurance system to losses. Moreover, the authors are not aware of any other theoretical or empirical studies that show that banks forced to hold higher levels of capital would adjust portfolio risk so as to actually increase the probability of failure.<sup>2</sup>

## NOTES

1. Keeton (1988) considers the effects of capital regulation on risk-averse banks in a more general framework. That study finds that for poorly capitalized banks, increases in capital ratios would be effective. For banks with relatively high capital ratios, further increases in capital could induce a bank to substitute asset risk for capital risk. However, the analysis does not indicate that the substitution would be such that capital regulation would be counterproductive.

2. Empirical work by the authors supports the proposition that capital regulation is not counterproductive. Furlong (1988) finds that for bank holding companies in the 1980s whether an institution was required to increase capital in order to meet minimum regulatory requirements did not have a bearing on its change in asset risk. Keeley (1990) finds that for bank holding companies risk is negatively related to the charter value of the holding company. This is consistent with the view that banks with more at stake tend to be less risky.

## REFERENCES

- Furlong, Frederick T. 1988. "Changes in Bank Risk-Taking." Federal Reserve Bank of San Francisco *Economic Review* (Spring) pp. 45-56.
- Keeley, Michael C. 1990. "Deposit Insurance, Risk, and Market Power in Banking." *American Economic Review* (December) pp. 1183-1200.
- Keeton, William R. 1988. "Substitutes and Complements in Bank Risk-Taking and the Effectiveness of Regulation." Unpublished paper. Federal Reserve Bank of Kansas City.

# Capital Regulation and Bank Risk-Taking: A Note

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*This paper examines theoretically the effects of more stringent capital regulation on bank asset portfolio risk. The analysis shows that, for a value-maximizing bank, incentives to increase asset risk decline as its capital increases. Thus, as long as regulatory efforts to contain asset risk and size are not reduced, more stringent capital regulation unambiguously reduces the expected liability of the deposit insurance system.*

Concern over the risk exposure of the federal deposit insurance system has been a major factor behind the increase in capital standards in banking in the 1980s. A central issue in bank capital regulation is whether the enforcement of higher capital ratio requirements gives banks greater incentive to increase asset risk, thereby partially or even fully offsetting the effect of a higher capital ratio on default risk. Indeed a major criticism of the regulatory attempts to raise bank capital ratios in the 1980s is that these efforts “drove” banks to seek out more risky activities. This view that more stringent capital regulation will exacerbate the problem of risk-taking appears to be held widely among commercial bankers and is evident in the financial press as well as in the academic literature.<sup>1</sup>

In this note, we address the question of how more stringent capital ratio requirements affect the incentives of a fully insured bank to increase the riskiness of its asset portfolio. The analysis builds on that of studies such as Sharpe (1978), Kareken and Wallace (1978), and Dothan and Williams (1980), which use state-preference models to examine the effects of deposit insurance, and those such as Merton (1977) and Pyle (1984), which model the deposit insurance guarantee as a put option. These studies show that, for a value-maximizing bank with subsidized deposit insurance, regulations are required to control both leverage and asset risk. What is not addressed fully is how a bank's incentives for increasing asset risk vary with changes in capital ratio requirements. It is important to fill this gap in order to assess the effect of bank capital regulation on bank default risk and the risk exposure of the deposit insurance system.

## I. A State-Preference Model

In this section, a state-preference model is used to analyze the portfolio and leverage decisions of an insured bank that maximizes its current value (the market value of its equity). We use a two-period model with two possible future states. The current prices of a dollar payout in the future states are  $P_1$  and  $P_2$ , for State 1 and State 2, respectively. These prices are taken as given and are unaffected by the portfolio decisions of banks.

To fund its current assets,  $A_0$ , a bank has an initial amount of capital,  $C_0$ , and issues insured deposits,  $D_0$ , so that  $A_0 = D_0 + C_0$ .<sup>2</sup> A unit of deposits pays off \$1 in each state and is summarized as  $D(1,1)$ . The current price of a unit of deposits is:

$$(1) \quad P_D = P_1 + P_2.$$

Deposits then earn the risk-free real rate,  $1/(P_1 + P_2) - 1$ .

A bank can invest in two risky assets, Security  $X$  and Security  $Y$ . One unit of Security  $X$  represents a promise by the issuer to pay  $x_1$  dollars if State 1 occurs and  $x_2$  dollars if State 2 occurs, and is summarized as  $X(x_1, x_2)$ . Security  $Y$

is summarized as  $Y(y_1, y_2)$ . Security  $X$  is the riskier security such that  $x_1 < y_1$  and  $x_2 > y_2$ . The current prices of Securities  $X$  and  $Y$  are:

$$(2) \quad P_X = P_1 x_1 + P_2 x_2$$

and

$$(3) \quad P_Y = P_1 y_1 + P_2 y_2,$$

respectively. Without loss of generality, the payouts in each state are defined to be such that the price of a unit of each security is the same, that is,

$$(4) \quad P_X = P_Y = P_D = P.$$

The equalities in (4), along with the assumption that Security  $X$  is riskier than Security  $Y$ , imply that  $x_1 < y_1 < 1 < y_2 < x_2$ .

The share of a bank's assets allocated to the riskier asset, Security  $X$ , is  $S$ , and the share allocated to Security  $Y$  is  $(1 - S)$ .

## II. Value of Deposit Insurance

For a bank that is capitalized such that it can meet its obligations to depositors in all future states, deposit insurance is redundant, and, thus, has no value. The current value,  $V_0$ , of a bank that can meet its obligations to depositors in both State 1 and State 2 equals the sum of the current value of the payoffs on assets in each of two states minus the current value of depositors' claims:

$$(5) \quad V_0 = \frac{C_0 + D_0}{P} [Sx_1 + (1 - S)y_1]P_1 + \frac{C_0 + D_0}{P} [Sx_2 + (1 - S)y_2]P_2 - D_0.$$

(5) simplifies to  $V_0 = C_0$ . That is, the value of a bank that can meet its obligations to depositors in both states is equal to its initial capital; there is no deposit insurance subsidy.

However, a bank that can fail—that is, one that cannot meet its obligations to depositors in one state—benefits from deposit insurance. Given that the initial capital position and asset risk of a bank is such that bankruptcy occurs

in State 1, and the deposit insurance premium rate is zero,<sup>3</sup> the current value of the deposit insurance subsidy,  $I_0$ , from (5) is

$$(6) \quad I_0 = \frac{D_0}{P} P_1 - \frac{C_0 + D_0}{P} P_1 [Sx_1 + (1 - S)y_1] > 0.$$

In (6),  $(C_0 + D_0)/P$  is the number of units of asset securities held and  $P_1 [Sx_1 + (1 - S)y_1]$  is the current value of the asset payoff in State 1 per unit of security.  $(D_0/P)P_1$  is the current value of depositors' claims in State 1. For deposit insurance to have a value to the bank, the value of the bank's assets in State 1 has to fall short of the claims of depositors. The current value of that short-fall, which corresponds to the option value of deposit insurance, is equal to the current value of the payout to depositors by the insurance fund in the bankruptcy state. Given  $C_0$ , a bank seeking to maximize the current value of its equity, which is  $V_0 = C_0 + I_0$ , will try to maximize the value of the deposit insurance option,  $I_0$ .

### III. Leverage and Risk

It is well known that a bank can maximize  $I_0$  by maintaining the highest degree of leverage (the lowest ratio of initial capital to initial assets) allowed by regulation and by increasing asset portfolio risk as much as possible. Under the traditionally invoked assumption that  $C_0$  is fixed (an assumption that will be dropped shortly) the effect of a change in leverage (a change in  $D_0/A_0$ ) on the value of the insurance guarantee is obtained by differentiating (6) with respect to  $D_0$ . Doing so yields

$$(7) \quad \frac{\partial I_0}{\partial D_0} \Big|_{C_0} = \frac{P_1}{P} \{1 - [Sx_1 + (1 - S)y_1]\} > 0.$$

The partial derivative is positive since, as stated above,  $x_1 < y_1 < 1$ , which means that  $[Sx_1 + (1 - S)y_1] < 1$ . Thus, the current value of the deposit insurance subsidy increases with leverage. With subsidized deposit insurance, a value-maximizing bank would limit its leverage only if forced to do so by regulation.

Constraints on bank asset risk also are required. In this model, increased asset risk is associated with a higher value of  $S$ . The effect of a change in risk-taking on  $I_0$ , as determined from (6), is

$$(8) \quad \frac{\partial I_0}{\partial S} = -A_0 \frac{P_1}{P} (x_1 - y_1) > 0.$$

The partial derivative is positive since  $x_1 < y_1$ . The positive relation between asset risk and the value of the deposit insurance guarantee indicates that a value-maximizing bank with underpriced deposit insurance would want to have  $S = 1$ . To prevent this, regulators would have to control asset risk, which in this model could mean limiting  $S$  to some maximum  $\bar{S}$  or imposing regulatory costs that are a positive function of  $S$ . For a bank to be at  $S < 1$ , regulatory cost would have to be such that the

marginal cost of exceeding that particular value of  $S$  was at least equal to the marginal value (in terms of increased value of deposit insurance) from doing so.

This condition for asset risk regulation to be effective is precisely the reason that the question of how capital regulation affects the incentives for increasing asset risk is important. Those who maintain that capital regulation leads to more asset risk implicitly argue that the marginal value from increasing asset risk is negatively related to changes in leverage (i.e., positively related to changes in the capital-to-asset ratio). This position implies that for higher capital standards to be fully effective they likely would have to be accompanied by the imposition of higher regulatory costs for violating asset-risk constraints. On the other hand, if the marginal value is either not related to or is positively related to changes in leverage, the enforcement of higher capital standards would not lead to greater asset risk, unless the restrictions on asset risk themselves were relaxed.

(8) indicates that the gain from increasing asset risk depends on asset size but not on the bank's leverage per se. Under the assumption of fixed capital, however, a change in leverage directly affects the volume of assets. A reduction in leverage can only be accomplished by selling assets and using the proceeds to retire liabilities. From (8), the marginal gain from increasing asset risk is positively related to a change in leverage. That is,

$$(9) \quad \frac{\partial^2 I_0}{\partial S \partial D_0} \Big|_{C_0} = -\frac{P_1}{P} (x_1 - y_1) > 0.$$

This means that a reduction in leverage achieved via retiring debt and shrinking assets would reduce the marginal gain from increasing asset risk. In other words, a bank would not be expected to respond to higher capital requirements by increasing the riskiness of its asset portfolio.

### IV. Allowing Capital to Vary

While the assumption of fixed capital may be suitable for certain banks, it is not appropriate for many larger banking organizations with access to capital markets. The ability of a bank to issue new capital is a potentially important consideration since, as we show below, a bank would prefer to do so when it reduces leverage in response to more stringent capital requirements. The reason for this preference is that, for a given degree of leverage, the total value of the insurance subsidy,  $I_0$ , is positively related to the volume of assets, holding leverage constant. This can be seen from the derivative of the value of the insurance

guarantee, in (6), with respect to assets, holding leverage constant, which is

$$(10) \quad \frac{\partial I_0}{\partial A_0} \Big|_{(D_0/A_0)} = \frac{1}{A_0} \left\{ \frac{D_0}{P} P_1 - \frac{A_0}{P} P_1 [Sx_1 + (1 - S)y_1] \right\} > 0.$$

The term in the braces is the expression for the value of the deposit insurance, which is positive given the bankruptcy conditions for State 1.

(10) indicates that, when a bank reduces leverage, it would receive a larger insurance subsidy by increasing  $C_0$  than by selling assets and reducing deposits. This is relevant to the analysis since the extent to which a bank alters its leverage by issuing new equity affects the volume of assets, which from (6) determines how the gains from increasing asset risk are affected. As we show next, however, allowing capital to vary does not change the earlier conclusion from (9) regarding the effects of leverage on the change in the value of the insurance subsidy with respect to changes in asset risk. The reason is that, even when a bank can increase  $C_0$ , requiring the bank to reduce leverage will result either in a net contraction in  $A_0$  or no change in  $A_0$ .

To see why initial assets would not expand, first note that from (10) a bank, as well as the banking industry as a whole, will expand as  $A_0$  much as possible, independent of any requirement to reduce leverage. Specifically, a bank would have expanded assets to the point where the marginal gain from increasing assets was balanced by the marginal cost of doing so. The main source of such a cost would be regulatory constraints.

Next, assuming no change in the marginal cost of increasing assets when leverage is reduced (that is, regulatory restrictions are not relaxed), a bank would expand assets only if the change in the value of the insurance

subsidy with respect to assets declines as leverage increases. However, from (10) the opposite is the case—that is:  $[\partial^2 I_0 / \partial A \partial (D_0 / A_0)] > 0$ . Therefore, a bank would not hold more assets when required to reduce leverage, even if the bank can increase  $C_0$ .

Given this result, the effect of leverage on the gains from increasing asset risk for a bank that can issue new capital (increase  $C_0$ ) are similar to those for a bank with fixed initial capital. That is, from (8),

$$(11) \quad \frac{\partial^2 I_0}{\partial S_A \partial (D_0 / A_0)} = - \frac{\partial A_0}{\partial (D_0 / A_0)} \frac{P_1}{P} (x_1 - y_1) > 0,$$

given that  $[\partial A_0 / \partial (D_0 / A_0)] > 0$ , which holds if  $A_0$  contracts when a bank is required to reduce leverage. In the limiting case in which  $A_0$  is unchanged, the partial derivative in (11) is equal to zero. Therefore, the incentives for a bank to increase asset risk do not rise as leverage falls.

The conclusion we draw from the state-preference model is that, if the costs to a bank from expanding asset risk and size are not reduced due to a relaxation of regulatory constraints, a value-maximizing bank, whether or not it can issue new capital, will not respond to more stringent capital requirements by increasing the riskiness of its assets. Thus, more stringent capital regulation unambiguously reduces the risk exposure of the deposit insurance system.

## V. Options Model

Options models also have been used to analyze the effects of leverage and asset risk on the equity value of a bank when deposit insurance is mispriced. One advantage of options models is that they are more general than the two-state model presented above. However, as with the studies using state-preference models, the studies modeling deposit insurance as a put option do not address fully the question of how capital regulation affects the gains from increasing asset risk nor do they discuss why this issue is important. In this section, we show that an options model yields conclusions similar to those derived from the state-preference model concerning the implications of capital regulation for asset risk among value-maximizing banks.

Following Merton (1977), the Black-Scholes formula for a European put option can be adapted to apply to the federal deposit insurance guarantee. Assuming all earnings are retained and a zero insurance premium, the current value of the insurance guarantee is

$$(12) \quad I_0 = D_0 F(\sigma \sqrt{t} - X) - A_0 F(-X)$$

where:

$I_0$  = the value of the option.

$D_0$  = the current value of insured deposits, which are assumed to constitute all deposits.

$A_0$  = the current value of assets (excluding the value of the insurance option).

$\sigma$  = the standard deviation of the rate of return on assets, which is the measure of risk.

$t$  = the interval to the next examination.

$$X = \frac{\log \left( \frac{A_0}{D_0} \right) + \left( \frac{\sigma^2 t}{2} \right)}{\sigma \sqrt{t}}$$

$F(\cdot)$  is the standard normal cumulative density function.

Assuming that capital is fixed, the familiar results regarding the effects of leverage and asset risk on the value of deposit insurance, the put option, can be derived from (12) as follows:



$$(13) \quad \frac{\partial I_0}{\partial D_0} \Big|_{C_0} = F(\sigma\sqrt{t} - X) - F(-X) > 0$$

and

$$(14) \quad \frac{\partial I_0}{\partial \sigma} = A_0\sqrt{t} F'(X) > 0$$

where  $F'(\cdot)$  is the standard normal density function.<sup>4</sup> From (13), it follows that a value-maximizing bank will increase leverage indefinitely unless constrained by regulation. (14) indicates that a bank has an incentive to increase asset risk.

How the incentives for increasing asset risk, holding  $C_0$  constant, would be affected by changes in leverage induced by regulation can be determined by taking the partial derivation of (14) with respect to the current value of deposits. This yields the result:

$$(15) \quad \frac{\partial^2 I_0}{\partial \sigma \partial D_0} \Big|_{C_0} = A_0\sqrt{t} F''(X) \frac{\partial X}{\partial D_0} + F'(X)\sqrt{t} > 0.$$

As long as a bank has positive initial capital, this last partial derivative will be positive because  $F''(X) < 0$  and  $\partial X/\partial D_0 < 0$  and  $F'(X) > 0$ . This result is qualitatively the same as that obtained from the state-preference model. The marginal gain from risk-taking increases with leverage, holding capital constant. Therefore, higher capital standards by themselves would not increase the incentives for insured banks to increase asset risk.

As in the state-preference model, this conclusion also

holds for a bank that can increase  $C_0$  in order to reduce leverage. Again, under the options model, a bank would expand assets, holding leverage constant, as much as possible, independent of any required change in leverage, since from (12)

$$\frac{\partial I_0}{\partial A_0} \Big|_{(D_0/A_0)} > 0.$$

However, regulatory costs that are sufficient to limit  $A_0$  at a given level of leverage will be sufficient at any lower level of leverage since

$$\frac{\partial^2 I_0}{\partial A_0 \partial (D_0/A_0)} > 0.$$

Therefore, a reduction in leverage will not lead to an increase in  $A_0$ , everything else equal.

With an increase in  $A_0$  ruled out, it follows from (14) that the effect of leverage on the gains from increasing asset risk is

$$(16) \quad \frac{\partial^2 I_0}{\partial \sigma \partial (D_0/A_0)} = \frac{\partial A_0}{\partial (D_0/A_0)} \sqrt{t} F'(X) + A_0\sqrt{t} F''(X) \frac{\partial I}{\partial (D_0/A_0)} > 0.$$

since  $[\partial A_0/\partial (D_0/A_0)] \geq 0$ . Thus, whether or not is  $C_0$  constant, higher capital requirements reduce the marginal gains from increasing asset risk. This in turn means that the risk exposure of the deposit insurance system is lower.

## VI. Conclusion

This note analyzes the theoretical relationships between capital regulation and bank asset risk. The key finding is that regulatory increases in capital standards by themselves will not require greater efforts to restrain asset risk. Higher capital requirements reduce the incentives for a bank to increase asset risk. Our results also indicate that a value-maximizing bank prefers to meet higher required capital ratios by raising additional capital, rather than merely by selling assets and retiring deposits. In this way the bank

maximizes its volume of assets and thereby the value of the deposit insurance subsidy.

The implication is that regulatory efforts to raise capital standards do not lead a value-maximizing bank to hold a more risky asset portfolio, as long as regulators do not also relax efforts to limit asset risk and size. Thus, a more stringent capital regulation will reduce the risk exposure of the deposit insurance system.

## NOTES

1. In a *New York Times* article on March 5, 1987, concerning a Federal Reserve proposal to require banks to hold capital in connection with interest rate and currency contracts, William McDonough, vice chairman of First National Bank of Chicago, is quoted as saying that "... the proposal could lead banks to take on riskier business to compensate for the lower returns they would almost assuredly get by having to maintain more capital."

In the academic literature, studies such as Kahane (1977) and Koehn and Santomero (1980), applying a mean-variance model to utility maximizing banks, conclude that

higher capital ratios can lead to greater asset risk. In a recent article in this journal, Keeley and Furlong show that the previous studies using such a framework are internally inconsistent and the models cannot be used to support the conclusion that a higher bank capital ratio can lead to greater risk-taking.

2. Thus,  $A_0$  and  $C_0$  exclude the value of any deposit insurance subsidy, which will be introduced shortly.

3. The conclusions from the analysis would be unchanged if the rate were a positive, fixed-rate premium.

4. See Jarrow and Rudd (1983).

## REFERENCES

Dothan, Uri, and Joseph Williams. 1980. "Banks, Bankruptcy, and Public Regulation," *Journal of Banking and Finance* 4, pp. 65-87.

Jarrow, Robert A., and Andrew Rudd. 1983. *Option Pricing*. Homewood, IL: Richard D. Irwin.

Kahane, Yehuda. 1977. "Capital Adequacy and the Regulation of Financial Intermediaries." *Journal of Banking and Finance* 1, pp. 207-218.

Kareken, John H., and Neil Wallace. 1978. "Deposit Insurance and Bank Regulation: A Partial Equilibrium Exposition." *Journal of Business* 51, pp. 413-438.

Keeley, Michael C., and Frederick T. Furlong. 1990. "A Reexamination of the Mean-Variance Analysis of Bank Capital Regulation." *Journal of Banking and Finance* 14, pp. 79-84.

Koehn, Michael, and Anthony M. Santomero. 1980. "Regulation of Bank Capital and Portfolio Risk," *The Journal of Finance* 35, pp. 1235-1244.

Merton, Robert C. 1977. "An Analytical Derivation of the Cost of Deposit Insurance and Loan Guarantees." *Journal of Banking and Finance* 1, pp. 3-11.

Pyle, David H. 1984. "Deregulation and Deposit Insurance Reform" Federal Reserve Bank of San Francisco *Economic Review* (Spring) pp. 5-15.

Sharpe, William F. 1978. "Bank Capital Adequacy, Deposit Insurance and Security Value." *Journal of Financial and Quantitative Analysis* (November) pp. 701-718.



# A Reexamination of Mean-Variance Analysis of Bank Capital Regulation

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*The mean-variance framework has been used to analyze the effects of bank capital regulation on the asset and bankruptcy risk of insured, utility-maximizing banks. This literature claims that more stringent capital regulation will increase asset risk and can increase bankruptcy risk. These conclusions are notable because they are opposite to those obtained for insured, value-maximizing banks. In this paper, we show that the utility-maximization literature does not support its conclusions regarding the effects of bank capital regulation because it has mischaracterized the bank's investment opportunity set by neglecting the option value of deposit insurance.*

In recent years, federal bank regulatory agencies have increased reliance on bank capital regulation, in part, because of heightened concerns over the risk exposure of the deposit insurance system. Indeed, the primary rationale for existing capital regulations, as well as proposals for more stringent capital regulation, is to reduce the insurance system's risk exposure by reducing leverage.

The idea that capital and other restrictions might be needed by liability holders in general to protect themselves from equity holders has been discussed extensively in the theoretical corporate finance literature. For example, Jensen and Meckling (1976), modeling the equity of a firm as a call option on its assets, show that equity holders have an incentive to increase the non-systematic risk of assets once debt has been issued or to issue additional debt. The reason is that increasing asset risk or issuing new debt increases the value of their option on the firm's assets and hence decreases the value of outstanding debt. As a result, bondholders often impose covenants constraining such things as future debt issues, dividend payments, and leverage.

In banking, the interests of the deposit insurance system parallel those of a private bondholder because the deposit insurance system, not the insured depositors, stands to lose in the event of a bank failure. In this vein, regulatory capital requirements and other portfolio restrictions could be viewed as similar to private bond covenants.<sup>1</sup>

It is within this context that a number of articles have analyzed the need for bank regulation. One strand of the literature has shown that when deposit insurance underprices risk, banks seeking to maximize the value of their stockholders' equity will attempt to maximize the value of the insurance subsidy by increasing asset risk and leverage (see Sharpe 1978, Kareken and Wallace 1978, and Dothan and Williams 1980). The reason is that the option value of deposit insurance increases as leverage or asset risk increases (see Merton 1977). As a result, with fixed-rate deposit insurance both capital and asset portfolio regulation are needed to limit the liability of the deposit insurance fund.

Moreover, as we have shown elsewhere (Furlong and Keeley 1989), the marginal value of the deposit insurance

option with respect to increasing asset risk declines as leverage declines. Consequently, value-maximizing banks would have less of an incentive to increase asset risk as a result of more stringent capital regulation. Thus, more stringent capital regulation will reduce the risk exposure of the insurance system as long as the stringency of the regulation of asset portfolio risk remains unchanged. (That is, as long as the resources devoted to enforcing, and the penalties for evading, asset regulations remain unchanged, more stringent capital regulation will cause the probability of bank failure to decline.)

In contrast, another strand of the literature focusing on utility-maximizing banks questions the effectiveness of capital regulation. The original contributions to this literature perhaps are best typified by Kahane (1977) and Koehn and Santomero (1980), hereafter referred to as KKS. Moreover, the basic framework developed by KKS continues to be used, as in the work of Kim and Santomero (1988) and others.<sup>2</sup> KKS claim to show that, in the context of a Markowitz two-parameter portfolio model, more stringent bank capital regulation will cause a utility-maximizing bank owner-manager to increase asset risk and may, as a result, increase the risk of bank failure (and thus implicitly increase the expected liability of the deposit insurance fund).<sup>3</sup> These results are notable in large part because they run counter to the general finance literature and suggest that capital regulation may be counterproductive.<sup>4</sup>

In this paper, we show that KKS's use of the Markowitz two-parameter portfolio model to analyze the effects of bank capital regulation on bankruptcy risk is inappropriate because of the model's assumption of constant borrowing rates and costs independent of portfolio (default) risk.<sup>5</sup> While this assumption is appropriate for certain investment decisions where the probability of bankruptcy (default on debt) is zero or can be ignored, it is logically inconsistent to use it to analyze the effects of bank capital regulation on bankruptcy risk.

First, in a world without deposit insurance when the probability of bankruptcy is nonzero, the promised deposit rate demanded by uninsured depositors will depend on the risk of the bank's portfolio, which in turn depends on leverage and asset risk. Also, if default is possible, the cost of deposits will be a random variable. Moreover, if depositors are risk-averse, the expected cost of deposits (per dollar) will rise with risk. Thus, the models of KKS, which

assume constant borrowing rates and costs, are not applicable to uninsured banks.

Second, and more importantly, while it might appear that the Markowitz assumption of constant borrowing costs employed by KKS is applicable to insured banks since insured depositors will supply funds at a constant risk-free promised rate, we show below that it is not.<sup>6</sup> The reason is that the expected net marginal cost (expected interest cost plus an assumed fixed-rate premium) of deposits (per dollar) to the bank declines as the quantity of deposits increases, because the option value of the deposit guarantee increases as leverage increases. In effect, KKS confuse the expected cost of deposits with the promised return under situations where the probability of default is nonzero.

By assuming that changes in the probability of bank failure do not affect deposit rates or costs, KKS mischaracterize the risk-return tradeoff even for a bank with fixed-rate deposit insurance by neglecting changes in the value of the insurance subsidy that occur when leverage or asset risk changes and by using an inappropriate measure of risk when bankruptcy is possible. These oversights are crucial since limiting the deposit insurance subsidy is the main reason for capital requirements in the first place.<sup>7</sup>

In Section I we first construct a prototype of the Markowitz portfolio model used by KKS to analyze the effect of bank capital regulation on asset risk. We show that when bankruptcy is not possible, and, thus, when there is no deposit insurance subsidy, the results from our prototypical model parallel those of KKS regarding the effects of capital regulation on increasing asset risk. However, increases in asset risk due to more stringent capital regulation cannot increase the probability of bankruptcy under the assumptions that KKS use to derive the model since these assumptions imply that the probability of bankruptcy must be zero.

In Section II, we demonstrate that accounting for deposit insurance and the possibility of bankruptcy markedly changes the bank's opportunity set. Moreover, the variance of return no longer adequately characterizes risk. As a result, KKS mischaracterize the risk-return tradeoff absent capital regulation as well as the effect of capital regulation on the risk-return tradeoff when bankruptcy is possible or when deposit insurance is subsidized. Because of this, KKS's model cannot be used to support their results.

Section III presents our summary and conclusions.

## I. A Prototypical Model of an Uninsured Bank's Portfolio Decisionmaking

KKS analyze bank risk-taking as a portfolio management problem for a risk-averse bank owner-manager whose entire net worth is invested in the bank. The owner-manager's equity risk depends on the bank's asset portfolio risk and on leverage. We assume that, in the absence of regulation, banks will leverage only efficient asset portfolios (those with maximum expected return for any given level of risk).<sup>8</sup> Given the owner's preferences towards risk, expected utility will be maximized subject to a constraint that relates the gross expected return (one plus the expected rate of return) on capital,  $E(Z)$ , to the standard deviation of that return,  $\sigma(Z)$ .

To derive this risk-return constraint, we assume that the bank's deposits are not insured but that the bank can attract deposits at a fixed promised deposit rate unrelated to the bank's risk. This implies that the bank has to choose a combination of leverage and asset risk to make bankruptcy impossible (that is, the realized return on assets will be such that the promised obligations to depositors always will be met). With bankruptcy not possible, the gross return on capital,  $Z$ , is given by the gross return on assets,  $A_0 P$ , minus the promised (which equals the actual) obligation to liability holders,  $L_0 R$ , divided by initial capital,  $K_0$ , or

$$(1) \quad Z = \frac{A_0 P - L_0 R}{K_0},$$

where

- $A_0$  = initial assets,
- $L_0$  = initial liabilities (deposits),
- $K_0$  = initial capital,
- $P$  = gross return on the bank's portfolio of assets, assumed to be random, which equals one plus the rate of return,
- $Z$  = gross return on capital, which is random, which equals one plus the rate of return,
- $R$  = promised (which equals actual) gross certain return paid on (and per dollar cost of) liabilities, which equals one plus the rate of return.

(1) may be rewritten by noting that  $L_0 = A_0 - K_0$  to give

$$(2) \quad Z = \left[ \frac{A_0}{K_0} \right] [P - R] + R.$$

The expected gross return on capital,  $E(Z)$ , may be found by taking expected values of both sides of (2). As long as  $R$  is fixed and not random, which it would be as long as bankruptcy were not possible, this gives:

$$(3) \quad E(Z) = \left[ \frac{A_0}{K_0} \right] [E(P) - R] + R.$$

Thus, increasing leverage, as measured by the asset-to-capital ratio, increases the owner's expected return on capital linearly when default is not possible for any given asset portfolio.

Similarly, the standard deviation of the return on capital,  $\sigma(Z)$ , may be derived from (2). When bankruptcy is not possible, the covariance of  $R$  and  $P$  is zero and

$$(4) \quad \sigma(Z) = \left[ \frac{A_0}{K_0} \right] \sigma(P).$$

so that the standard deviation of return on capital also varies linearly with leverage for a given asset portfolio.

(3) and (4) may be jointly solved to eliminate the  $[A_0/K_0]$  term to give

$$(5) \quad E(Z) = \left[ \frac{\sigma(Z)}{\sigma(P)} \right] [E(P) - R] + R$$

In other words, the expected (gross) return on capital varies linearly with the standard deviation of return on capital for a given expected asset return and asset standard deviation. This is a standard result in the CAPM models of the finance literature on investment (see Sharpe 1970).

In general, it is assumed that a bank faces a variety of different asset portfolio risk-return combinations (the asset risk-return frontier). Asset portfolios with more risk are assumed to yield larger expected returns and thus the asset risk-return frontier is convex (see Figure 1). Moreover, it is assumed that the banking sector is small enough that the asset risk-return frontier is unaffected by banks' behavior. Thus, the frontier is taken as given by banks in their optimizing decisions.

An unconstrained bank's efficient investment frontier consists of linear combinations of a particular asset portfolio and the single risk-free liability. As is well known (see Hirshleifer 1970, chap. 10, or Fama and Miller 1972, chap. 7), the most efficient asset portfolio is the one where a line from the constant (gross) borrowing rate,  $R$ , is tangent to the asset risk-return frontier. (This is depicted as point  $E(P_0)$ ,  $\sigma(P_0)$  in Figure 1.) By leveraging this asset portfolio the bank can obtain the highest expected return on its capital for any degree of risk. Since this tangency at point  $E(P_0)$ ,  $\sigma(P_0)$  does not depend on the bank owner's risk preferences, the asset portfolio chosen depends only on the risk-free interest rate and the asset risk-return frontier.

An unconstrained bank's optimal position on this linear investment (or capital) risk-return frontier is the point at which the marginal rate of substitution between risk and expected return,  $d\sigma^2(Z)/dE(Z) \big|_{U=\bar{U}}$ , is equated with the tradeoff between risk and expected return along the effi-

cient investment portfolio frontier. Following Koehn and Santomero, assuming the distribution of portfolio returns ( $Z$ ) is symmetric (as it would be for a diversified portfolio in which bankruptcy was not possible), and taking a second order Taylor-series expansion of the utility function,  $U$ , around the initial capital,  $K_0$ , of the bank, and then taking expected values gives:

$$(6) \quad E(U) = U(K_0) + U'(K_0) \{E(Z) - b[(E(Z))^2 + \sigma^2(Z)^2]\}$$

where

$$b = - \frac{U''(K_0)K_0}{2U'(K_0)}$$

is the coefficient of relative risk aversion of the underlying utility function and  $U'$  and  $U''$  are the first and second derivatives of  $U$ . For this utility function the marginal rate of substitution is:

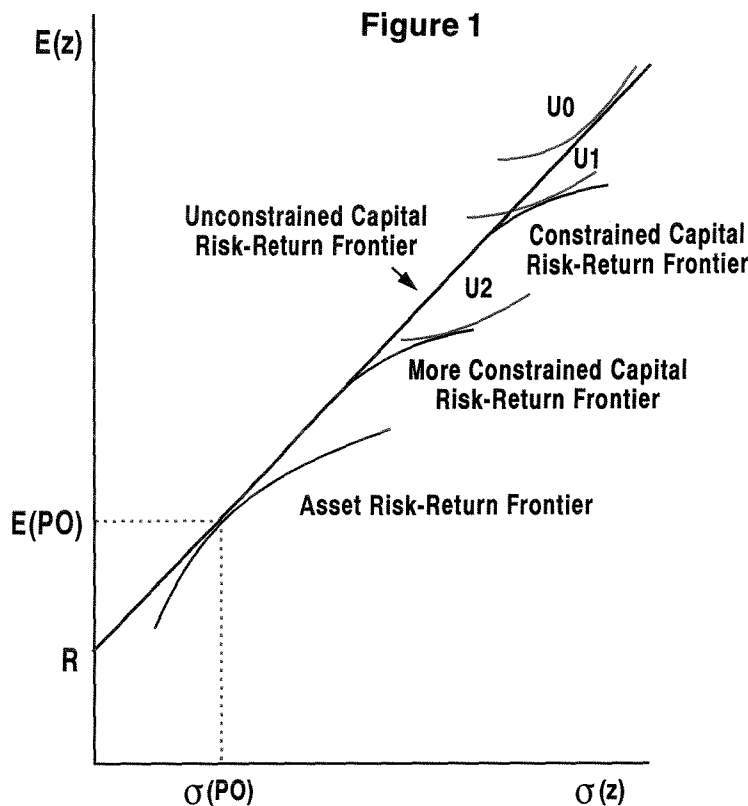
$$(7) \quad \frac{d(\sigma^2(Z))}{d(E(Z))} \bigg|_{U=\bar{U}} = \frac{1}{b} - 2E(Z) = MRS.$$

Thus, the optimal portfolio requires that  $MRS = \lambda$ , where  $\lambda$  is the tradeoff between variance and expected return on the efficient investment frontier. Thus, the degree of leverage chosen is determined by the owner's risk preferences,

although the assumption is that the unconstrained bank would choose a degree of leverage for which bankruptcy is not possible.

When capital constraints are imposed, the bank owner generally will be able to increase utility by leveraging asset portfolios with more risk than the one characterized by the parameters  $E(P_0)$  and  $\sigma(P_0)$ . The reason is that a binding capital constraint changes the shape and location of the capital risk-return frontier, making it convex once the constraint becomes binding. The capital risk-return frontier under binding capital regulation is convex because it represents a linear mapping of the asset risk-return frontier which is assumed convex.<sup>9</sup>

In Figure 1, the effect of such a binding capital constraint on the capital risk-return frontier is depicted. As Koehn and Santomero point out, a reduction in permissible leverage reduces expected return on capital and investment risk over the entire constrained frontier for any given asset portfolio. Moreover,  $\lambda$  is larger on the constrained frontier. Thus, if a binding capital constraint were imposed on a previously unconstrained bank (at  $U_0$ ), the bank would choose a more risky asset portfolio (and move to  $U_1$ ). (The bank could have chosen a less or equally risky asset portfolio when not constrained, but did not, which precludes a new equilibrium on the old capital frontier.) It



should be emphasized that this result of an unambiguous increase in asset risk depends critically on the assumption that capital regulation alters the bank's risk-return frontier from a linear to a convex constraint, thereby increasing  $\lambda$  and reducing expected return on capital. However, as we demonstrate in the next section, in the absence of capital regulation the capital risk-return frontier of a bank that can fail is not linear; nor does leverage have a linear effect on risk and return.<sup>10</sup>

The effects of further reducing leverage through regulation are ambiguous, however, and depend on the shape of the bank's (owner's) utility function. The case depicted in Figure 1 is one with constant relative risk aversion, where increasing the stringency of capital regulation (lowering the permissible degree of leverage) leads the bank to choose a more risky and higher-return asset portfolio (by moving to  $U_2$ ).<sup>11</sup> This result too, however, depends critically on the assumption that leverage affects the risk-return frontier linearly—a result that does not hold for banks that can fail.

This basic result of increased asset risk caused by more

stringent capital regulation is one result emphasized by KKS. More important is their claim that the increased asset risk caused by more stringent capital regulation could increase the probability of bank failure and thus could be counterproductive. However, under the constant borrowing cost assumption they use to derive their model, an increase in asset risk due to more stringent capital regulation cannot affect the probability of failure, which remains zero.

The reason is that the probability of failure must be zero in order for borrowing costs to be constant and for the effect of leverage on risk and return to be linear. As we show below, neither insured nor uninsured banks that can fail have constant borrowing costs, and thus there is not a linear effect of leverage on risk and return as KKS suppose. Moreover, with underpriced deposit insurance, the capital frontier may be nonconvex. Thus, KKS's model is not applicable to assessing the effects of capital regulation on the probability of bankruptcy. In the next section we show how the constraint changes and why KKS's analysis of capital regulation is inappropriate when a nonzero probability of bankruptcy and deposit insurance are introduced.

## II. Introducing Bankruptcy and Deposit Insurance

The analysis above, which is consistent with KKS, assumes that a bank always would make asset and leverage choices such that bankruptcy could not occur. Such a bank could attract deposits at the risk-free rate because it always would make the payments promised regardless of the return on assets realized. Consequently, the cost of deposits (per dollar) to such a bank would equal the promised risk-free deposit rate and would not be a random variable so that the capital risk-return frontier in the absence of capital regulation would be linear.

In the absence of deposit insurance a bank's expected borrowing cost would rise as leverage (and thereby the probability of bankruptcy) increases if depositors are risk-averse. Thus, leverage does not have a linear effect on risk and return for uninsured banks that can fail.

More importantly, even with fixed-rate deposit insurance (under which a bank could attract deposits at a promised risk-free rate even though bankruptcy is possible), the per dollar deposit cost is random and the expected per dollar cost of deposits to the bank would vary with default risk and would no longer be equal to the promised risk-free deposit rate plus the deposit insurance premium rate.<sup>12</sup> As a result, leverage would not have linear effects on risk and return. The reason is that a fixed-rate deposit insurance guarantee represents an option to the bank to put the bank's assets to the insuring agency at a striking price equal to the promised maturity value of its

liabilities. The value of the option (per dollar of deposits) increases as leverage (deposits) increases, but its price (per dollar of deposits) is fixed. This increase in the option's net value, in effect, lowers the expected marginal cost of deposits. As a result, the expected cost of deposits to the bank is less than the risk-free rate plus the deposit insurance premium. Moreover, the expected cost of deposits is not independent of the bank's asset portfolio risk—in fact, the expected cost of deposits also declines as asset portfolio risk increases because the net value of the deposit insurance option also increases as asset risk increases.

To demonstrate how the deposit insurance guarantee affects the risk-return tradeoff, it is assumed that a minimal form of capital regulation is in place (a bank owner must invest his or her entire net worth in the bank), and that the deposit insurance premium is zero.<sup>13,14</sup> The expected gross return on capital, then, is given by:

$$(8) \quad E(Z) = \int_{P^*}^{\infty} \left[ \frac{A_0 P - L_0 R}{K_0} \right] f(P) dP,$$

where

- $R$  = the promised gross rate on deposits,
- $f(P)$  = the probability density function of  $P$ ,
- $P^*$  =  $[L_0/A_0]R$ , which is the lowest asset return for which depositors are repaid in full, that is, when bank capital is exhausted.

(8) indicates that the expected gross return on capital is the expected value of gross asset returns minus liability obligations, conditional on nonbankruptcy. (If  $P < P^*$ , bankruptcy occurs and the gross return on capital is zero.) (8) can be rewritten by adding and subtracting the same term to give:

$$(9) \quad E(Z) = \int_{-\infty}^{\infty} \left[ \frac{A_0 P - L_0 R}{K_0} \right] f(P) dP \\ - \int_{-\infty}^{P^*} \left[ \frac{A_0 P - L_0 R}{K_0} \right] f(P) dP.$$

Noting that  $L_0 = A_0 - K_0$  and taking the integral of the first term of (9) and rearranging terms in the second integral gives:

$$(10) \quad E(Z) = \left\{ \left[ \frac{A_0}{K_0} \right] [E(P) - R] + R \right\} \\ + \int_{-\infty}^{P^*} \left[ \frac{L_0 R - A_0 P}{K_0} \right] f(P) dP.$$

Note that the first term of (10) in braces is identical to the right-hand side of (3), the formula for the expected gross returns on capital of a bank that cannot go bankrupt. However, the second term of (10) represents an integration over bankruptcy states of the obligations to depositors in excess of returns on assets, which, by definition, are positive in each bankruptcy state (since if  $P < P^*$ ,  $L_0 R - A_0 P > 0$ ). The value of this integral, however, depends positively on leverage. (That is, the derivative of the integral with respect to liabilities holding constant equity is

$$\int_{-\infty}^{P^*} \frac{[R - P]}{K_0} f(P) dP$$

which is positive since  $R > P$  for  $P < P^*$ .) This means that the cost of an additional dollar of deposits holding equity constant (which increases leverage), is not  $R$ , but is  $R$  minus the increase in the value of the integral.

This second term of (10), the expected value (conditional on bankruptcy) of the obligations to depositors in excess of returns on assets per dollar of invested capital, corresponds to the option value of deposit insurance as described by Merton (1977). This is the term that is neglected by both Kahane and Koehn and Santomero. By neglecting the option value of deposit insurance per dollar of invested capital, the linear relationship between expected return and leverage assumed by KKS no longer holds, nor does the linear relationship between risk and leverage.<sup>15</sup> In effect, the expected return on capital with deposit insur-

ance is the sum of the expected return posited by KKS plus the expected return of the option. Below, the implications of these changed relationships for the effects of bank capital regulation on the relationship between leverage and expected return are explored.

Following Merton (1977), under the stochastic assumptions employed by Black and Scholes (1973), the value of the integral neglected by KKS—the option value of deposit insurance per dollar of capital invested—is:

$$(11) \quad I_0 = \frac{L_0 F(\sigma\sqrt{t} - x) - A_0 F(-x)}{K_0},$$

where

$I_0$  = the value of the option per dollar of capital invested, which equals

$$\int_{-\infty}^{P^*} \left[ \frac{L_0 R - A_0 P}{K_0} \right] f(P) dP,$$

$L_0$  = the current value of insured deposits, which earn the risk-free interest rate and are assumed to constitute all deposits,

$A_0$  = the current value of assets (excluding the value of the insurance option),

$\sigma$  = the standard deviation of the rate of return on assets, which is the measure of risk,

$t$  = the interval to the next examination,

$$x = \frac{\log\left(\frac{A_0}{L_0}\right) + \left(\frac{\sigma^2 t}{2}\right)}{\sigma\sqrt{t}}, \text{ and}$$

$F(\cdot)$  = the standard normal cumulative density function.

First, consider how the value of the option varies with leverage, holding initial capital constant. (We chose this method of varying leverage since it corresponds to KKS's assumption that the bank owner's capital is fixed.) Using the results in Jarrow and Rudd (1983),

$$(12) \quad \frac{dI_0}{dL_0} \Big|_{K_0} = \left[ \frac{\partial I_0}{\partial L_0} + \frac{\partial I_0}{\partial L_0} \right] \left[ \frac{1}{K_0} \right]$$

or

$$(13) \quad \frac{dI_0}{dL_0} \Big|_{K_0} =$$

$$[F(\sigma\sqrt{t} - x) - F(-x)] \left[ \frac{1}{K_0} \right] > 0.$$

That is, increasing deposits, holding capital constant, increases the option value of deposit insurance. Moreover, the second derivate of  $I_0$  with respect to  $L_0$  is positive.



Thus, the overall expected return increases more rapidly and nonlinearly with leverage than the linear relationship posited by KKS, thereby making the relation between leverage and expected return nonconvex. Because of this, risk-aversion would no longer necessarily constrain bank risk-taking. In fact, as we have shown elsewhere (Furlong and Keeley 1987), for a binomial asset return distribution, as long as the bank owner is willing to risk bankruptcy, absent regulation, optimal leverage is infinite even though the bank owner is risk-averse.<sup>16</sup>

Moreover, consider how the expected return varies with increased asset portfolio risk. The value of the option varies with asset risk as

$$(14) \quad \frac{dI_0}{d\sigma} = \frac{A_0 \sqrt{t} F'(x)}{K_0} > 0.$$

Thus, independent of the positive market relationship between asset risk and return presumed by KKS, the value of the option also increases with asset risk, thereby changing the shape of the capital risk-return frontier holding leverage constant. That is, the capital risk-return frontier is no longer a linear mapping of the asset risk-return frontier.

Finally, as we have pointed out elsewhere (Furlong and Keeley, 1989), the gain from increased risk-taking (in terms of increased option value) increases as leverage increases because:

$$(15) \quad \frac{d^2 I_0}{d\sigma dL_0} \Big|_{K_0} = [A_0 \sqrt{t} F''(x) \frac{dx}{dL_0} + F'(x) \sqrt{t} \Big[ \frac{1}{K_0} \Big]] > 0$$

(which is positive because  $F''(x) < 0$ ,  $dx/dL_0 < 0$  and  $F'(x) > 0$ ). (15) implies that the gain from increased risk-taking is not independent of leverage as KKS assume.<sup>17</sup>

As the above results demonstrate, the relationship between expected return, leverage and asset risk is straightforward, but the relationship between true capital risk and return is not. Although the variance of  $Z$  under subsidized deposit insurance is easily calculated,  $\sigma(Z)$  alone no longer adequately characterizes risk for the bank owner when bankruptcy is possible. Specifically, it is well known that variance alone is an unreliable measure of risk for truncated, skewed distributions such as that of  $Z$  when bankruptcy is possible. Since the equity of the bank is a call option on its assets at a striking price equal to the promised maturity value of the deposits, the return on equity will be positively skewed. As Cox and Rubinstein (1985, pp. 317-342) show, for utility functions with constant proportional risk-aversion, expected utility depends on the skewness as well as the mean and variance of the return. By neglecting the skewness of the return distribution, KKS mischaracterize the shape of the capital risk-return tradeoff absent capital regulation and how that shape is affected by leverage and capital regulation.

Thus, KKS's analysis does not demonstrate that more stringent capital regulation would lead a utility-maximizing bank with fixed-rate deposit insurance to take on more asset risk. Moreover, from the analysis above, risk-aversion alone will not necessarily be sufficient to limit leverage and asset risk as is concluded by KKS. As a result, KKS's analysis cannot support their claim that more stringent capital regulation will be counterproductive for bank owners with certain preference structures. For example, Furlong and Keeley (1987) demonstrate that for a binomial asset return distribution, the probability of bankruptcy declines as the stringency of capital regulation is increased as long as the stringency of asset portfolio risk regulation remains unchanged regardless of the bank owner's preference structure.

### III. Summary and Conclusions

Two inconsistent strands of the finance literature come to opposite conclusions regarding the effects of capital regulation on bank risk-taking. On the one hand, the options literature suggests that for risk-neutral or value-maximizing banks capital regulation will reduce the risk exposure of the deposit insurance system under a given stringency of asset regulation. On the other hand, the utility-maximization literature utilizing the Markowitz two-parameter portfolio model, as typified by KKS, claims that for risk-averse banks more stringent capital regulation may increase the probability of bank failure (and hence implicitly the risk exposure of the insurance system) and thus be counterproductive.

In this paper we show that the KKS model does not support its claimed results. KKS apply the Markowitz two-parameter portfolio model to analyze bank risk-taking under a nonzero probability of bankruptcy inappropriately. Specifically they neglect the option value of the deposit insurance subsidy and use an inappropriate measure of risk, thereby mischaracterizing both the risk-return frontier absent capital regulation and the shift in the risk-return frontier due to capital regulation. Because of these oversights, the models used by KKS are not applicable to analyzing the effects of bank capital regulation on asset risk and cannot be used to support their results.

## NOTES

1. See Black, Miller, and Posner (1978) for a discussion of why bank regulation is analogous to the contractual enforcement of private lending agreements by private debtholders. Black, Miller, and Posner also argue, but do not formally prove, that the less capital the bank has, the greater its incentives for risk-taking. As a result, they call for more stringent capital requirements to protect the insurance fund.

2. Also, see articles by Wall (1985), Lam and Chen (1985) and Hanweck (1985).

3. As Koehn and Santomero (1980, p. 1244) put it, "In fact, a case could be argued that the opposite result can be expected to that which is desired when higher capital requirements are imposed."

4. Although Kahane and Koehn and Santomero conclude that both capital and asset regulation are necessary, as does the value-maximizing literature typified by Sharpe, Kareken and Wallace, and Dothan and Williams, it is important to recognize that KKS's models cannot support this conclusion. (It is true that, under the assumption of value maximization, both capital and asset regulation are needed to limit the liability of the deposit insurance system.) KKS claim that both capital and asset regulation are needed because more stringent capital regulation leads to greater asset portfolio risk, which in turn can increase the probability of failure. However, as we show later, KKS's models cannot be used to show that more stringent regulation will lead to an increased probability of failure.

5. Koehn and Santomero explicitly assume a constant deposit rate and corresponding constant borrowing cost per dollar of liabilities. Similarly, Kahane, following Hart and Jaffee (1974), assumes that the deposit rate is stochastic but unrelated to the bank's portfolio risk. For example, Kahane (1977, p. 209) states that "... the distributions of the random variables (the returns on assets and liabilities) must be exogenously given and independent of the value of the vector  $x$  (the portfolio allocation). . . ." (parenthetical statements added).

6. In private correspondence Anthony Santomero indicated that the Koehn and Santomero model was properly interpreted as applying to insured banks. Moreover, the more recent Kim and Santomero (1988) model specifically is claimed to apply to insured banks.

7. It should be noted that the analysis of KKS is not applicable to uninsured banks either. To analyze uninsured banks, one would have to account for the increase in expected borrowing costs as bank risk increased and the variance of deposit returns increased, which would result from the behavior of risk-averse depositors.

8. See Merton (1972) for a discussion of how quadratic programming can be used to solve for the efficient asset portfolio.

9. To derive the shape of the capital risk-return frontier, the risk-return combination resulting from leveraging each asset portfolio to the maximum degree allowed may be

traced out. As (3) and (4) show, both expected return,  $E(Z)$ , and risk,  $R_z$ , are linear functions of leverage. Thus, the risk and return on capital for a given asset portfolio and leverage can be found geometrically by extending a ray from the constant borrowing rate through the particular asset portfolio up to the maximum leverage allowed. The locus of such points is the constrained capital risk-return frontier. Also, note that a particular point on a capital risk-return frontier has greater asset risk than another point on the same or on a different frontier if the slope of a line from  $R$  through the point is smaller.

10. Although the shape of the risk-return frontier depends on whether the bank's deposits are insured at a fixed rate, neither insured nor uninsured frontiers are linear.

11. For a formal proof see Koehn and Santomero (1980).

12. An anonymous referee noted that once it is realized that the deposit rate (from the bank's perspective) is random, the nonlinearity of the investment frontier is self-evident since it is simply a combination of positive and negative risky assets. While this is true, our point is that a fixed-rate deposit insurance guarantee alters the risk-return frontier in a specific way so as to subsidize risk-taking.

13. The assumption implicit in the utility maximization framework is that a (potential) bank owner has an exogenously given initial capital (wealth)  $K_0$ , all of which must be invested in the bank in order to obtain deposit insurance. However, this assumption implies some form of capital regulation since a risk-averse bank owner generally would prefer to segregate his capital (and make a relatively safe investment) and start a bank with no capital, thereby acquiring an option of potentially unlimited value. This suggests that the utility-maximization model may not be applicable to many actual banks since even owners of small banks have limited liability, and, absent capital regulation, would not have to risk all of their own funds. It also suggests that this limited form of capital regulation must reduce the probability of bank failure—a result opposite to KKS.

14. Since we are interested in fixed-rate deposit insurance systems, the analysis of a zero-premium rate system is essentially the same as a positive fixed-rate system.

15. With fixed-rate deposit insurance, a more risky asset portfolio, even if it has the same expected return, increases the expected return on capital because the option value of deposit insurance increases. Similarly, by increasing leverage, the owner can increase without limit the expected return on capital as long as some part of the asset distribution exceeds the promised rate. Under these circumstances, even if the expected rate on assets were less than the promised rate on deposits, a bank with underpriced deposit insurance would gain from leverage. This is in sharp contrast to the results without deposit insurance when bankruptcy is not possible. In that case, leverage can increase expected return only if the expected return on assets exceeds the expected cost of

deposits (see (3)). Thus, the provision of underpriced deposit insurance can cause risk-averse bank owners to assume more risky portfolios.

16. Rationality implies that a lottery that costs \$1 and pays \$100 with a 50 percent chance and \$0 with a 50 percent chance will be preferred to one that also costs \$1 but pays \$10 with a 50 percent chance and \$0 with a 50 percent chance, even though the variance of the first lottery's outcomes is higher. Thus, for some asset distributions, such as the binomial, a bank owner's true risk is limited (for sufficiently high leverage there is a constant probability, which is invariant with greater leverage and is less than one, that he will lose his capital), but his (certain) return if failure does not occur (and thus his expected return) is unlimited as leverage increases. (That is, as leverage increases, end-of-period capital increases without limit as long as bankruptcy does not occur and is zero if bankruptcy does occur. See Furlong and Keeley (1987, p. 39) for a more detailed discussion.)

Thus, even a risk-averse bank owner (willing to risk bankruptcy in return for a sufficiently high payoff) might prefer unlimited leverage. A similar result applies to asset risk. In contrast, KKS argue that risk-aversion necessarily limits bank risk-taking. While this may be the case in the absence of subsidized deposit insurance, it need not be so with subsidized deposit insurance. It may be the case that even a risk-averse bank owner-manager will try to maximize the option value of deposit insurance. Thus, in general it is not meaningful to analyze the effects of capital regulation absent asset regulation as do KKS.

17. (15) also implies that, for value-maximizing banks, more stringent capital regulation will reduce the risk exposure of the deposit insurance system as long as the stringency of asset portfolio regulation is not reduced. See Furlong and Keeley (1989) for a more complete discussion.

## REFERENCES

- Black, Fischer, Merton Miller, and Richard Posner. 1978. "An Approach to the Regulation of Bank Holding Companies." *Journal of Business* 51, pp. 379-413.
- \_\_\_\_\_, and Myron Scholes. 1973. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy* 81, pp. 632-659.
- Cox, John C., and Mark Rubinstein. 1985. *Options Markets*. Englewood Cliffs, NJ: Prentice Hall.
- Dothan, Uri, and Joseph Williams. 1980. "Banks, Bankruptcy and Public Regulation." *Journal of Banking and Finance* 4, pp. 65-88.
- Fama, Eugene F., and Merton H. Miller. 1972. *The Theory of Finance*. New York: Holt, Rinehart and Winston.
- Furlong, Frederick T., and Michael C. Keeley. 1987. "Bank Capital Regulation and Asset Risk." Federal Reserve Bank of San Francisco *Economic Review* (Spring) pp. 20-40.
- \_\_\_\_\_, and \_\_\_\_\_. 1989. "Capital Regulation and Bank Risk-taking: A Note." *Journal of Banking and Finance* 13, pp. 883-891.
- Hanweck, Gerald A. 1985. "A Theoretical Comparison of Bank Capital Adequacy Requirements and Risk-related Deposit Insurance Premia." Research Papers in Banking and Finance, no. 72. Board of Governors of the Federal Reserve System.
- Hart, Oliver D., and Dwight M. Jaffee. 1974. "On the Application of Portfolio Theory to Depository Financial Institutions." *Review of Economic Studies* 41, pp. 129-147.
- Hirshleifer, J. 1970. *Investment, Interest, and Capital*. Englewood Cliffs, NJ: Prentice Hall, Inc.
- Jarrow, Robert A., and Andrew Rudd. 1983. *Option Pricing*. Homewood, IL: Richard D. Irwin, Inc.
- Jensen, Michael C., and William H. Meckling. 1976. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics* 3, pp. 305-360.
- Kahane, Yehuda. 1977. "Capital Adequacy and the Regulation of Financial Intermediaries." *Journal of Banking and Finance* 2, pp. 207-217.
- Kareken, John H., and Neil Wallace. 1978. "Deposit Insurance and Bank Regulation: A Partial Equilibrium Exposition." *Journal of Business* 51, pp. 413-438.
- Kim, Daesik, and Anthony M. Santomero. 1988. "Risk in Banking and Capital Regulation." *Journal of Finance* 43 (December) pp. 1219-1233.
- Koehn, Michael, and Anthony M. Santomero. 1980. "Regulation of Bank Capital and Portfolio Risk." *Journal of Finance* 35 (December) pp. 1235-1250.
- Lam, Chun H., and Andrew H. Chen. 1985. "Joint Effects of Interest Rate Deregulation and Capital Requirements on Optimal Bank Portfolio Adjustments." *Journal of Finance* 40 (June) pp. 563-576.
- Merton, Robert C. 1972. "An Analytic Derivation of the Efficient Portfolio Frontier." *Journal of Financial and Quantitative Analysis* (December) pp. 1851-1872.
- \_\_\_\_\_. 1977. "An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees." *Journal of Banking and Finance* pp. 3-11.
- Sharpe, William F. 1970. *Portfolio Theory and Capital Markets*. New York, McGraw-Hill.
- \_\_\_\_\_. 1978. "Bank Capital Adequacy, Deposit Insurance and Security Values." *Journal of Financial and Quantitative Analysis* (November) pp. 701-718.
- Wall, Larry D. 1985. "Regulation of Banks' Equity Capital." Federal Reserve Bank of Atlanta *Economic Review* (November) pp. 4-18.