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Optimal Futures Positions for Large Banking Firms

GEORGE EMIR MORGAN, DILIP K. SHOME, and STEPHEN D. SMITH*

ABSTRACT

In this paper, we extend earlier work on hedging models so that uncertainty about both deposit supply and loan demand is incorporated as well as random rates of return on loans and CD's. Our model suggests that the optimal forward position is the sum of three ratios that should be estimated simultaneously. Using bank-specific data, the optimal hedge ratios are estimated in both the pre-deregulation and deregulation subperiods. Our results show that previous studies of bank hedging with interest rate futures have greatly overstated (a) the volume of short futures positions that banks should take and (b) the degree of homogeneity of optimal hedge ratios across the banking system. Similarly, deregulation has not uniformly affected the interest rate risk borne by different institutions.

AS THE FINANCIAL FUTURES markets have matured, there has been increased interest in the use of these markets to hedge the risks faced by financial intermediaries. The literature on hedging with financial futures has grown dramatically with studies by Ederington [4], Franckle [5], Schweser, Cole, and D'Antonio [17], Arak and McCurdy [2], Dew and Martell [3], Picou [13], Ho and Saunders [6], Koppenhaver [8], and Morgan and Smith [9, 10]. With the exception of some of the more recent work, most articles that have addressed the use of financial futures have described the hedging problem as a relatively simple risk management situation. Even studies that have focused on intermediaries have viewed the hedging problem as one-dimensional; the intermediary wants either to hedge a cash position in a security such as a T-bill or to hedge an anticipated issue of a CD. This viewpoint does not incorporate the complexity of the situation faced by intermediaries (or other firms) that may be subject to uncertainty from a variety of sources. The more recent literature incorporates some of this additional uncertainty by considering quantity risk in lending (partial takedown of loan commitments) or deposits for which the intermediary acts as a "rate setter." Seldom are both sources of uncertainty incorporated in the same model. For example, Koppenhaver [8] allows for quantity uncertainty in deposits and in the rate that the intermediary will pay on CD's but not for uncertainty in loan rates or loan quantity. Morgan and Smith [9] allow for uncertainty in loan quantity but not in deposit supply. In this paper, we extend Koppenhaver's [8] model and that of Morgan and Smith [9] so that uncertainty about both deposit supply and loan demand is incorporated as well as random rates of return on loans and CD's.

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The extended theoretical model developed here has a basic form that does not require the use of internally inconsistent assumptions. Also, the model incorporates additional sources of uncertainty and demonstrates a role played by capital that has gone largely unrecognized in the literature (with the exception of Morgan and Smith [10]).

The empirical results reported in Ederington [4], Franckle [5], Koppenhaver [8], and others are also extended in a number of ways. First, the optimal forward position is the sum of three ratios that should be estimated simultaneously. Furthermore, in previous work on banks, hypothesis tests have been based on cross-sectional variances of hedge ratios across the system rather than on the variances and covariances of the specific estimators for each bank. There would be no difference between these two techniques if the estimators had the same underlying distribution; however, we hypothesize that the optimal forward position is likely to be vastly different for different intermediaries because of different relationships between loan and market rates, different capital-to-asset ratios, and different relationships between the volume of loans demanded and deposits supplied. Thus, the optimal hedge ratios published in the literature, for example, in Koppenhaver [8] and Ederington [4] or Franckle [5], may be misinterpreted by many intermediaries that are trying to hedge their risks. (Of course, the latter two articles did not purport to be appropriate in this context.) In general, the previously reported hedge ratios are higher than would be appropriate for many firms, and there are intermediaries for which the optimal forward position is a short position and some for which the optimal is a long position in practice as well as in theory.

To test these hypotheses, it is necessary to obtain information beyond aggregative data such as the prime rate, the CD rate, and aggregate deposits and loans for the banking system. Koppenhaver [8] has moved in this direction, but more progress is made here. Thus, in this study, we obtain bank-specific data on lending and deposit flows and loan rates.[1] The statistical relationships between the variables are estimated so that an efficient estimate of the "optimal hedge ratio" can be made and correct tests of hypotheses can be constructed.

The paper is structured as follows. In Section I, the theoretical model is presented and the optimal forward position derived. In Section II, the empirical methodology is discussed, including statistical techniques and the construction of a data set. Section III reports the results of the empirical analysis on a set of eighty-three large banking organizations and discusses some of the implications of the results. Concluding remarks are made in Section IV.

I. A Model of Bank Hedging

The financial intermediary is viewed here as facing uncertainty from a number of sources. We presume that the intermediary makes its loans through loan commitments. Of course, most financial intermediaries operate in this fashion

[1] We did not find a feasible method for obtaining bank-specific CD rates, and furthermore it seemed more reasonable to assume that the largest banks in the country borrow in the CD market at the "market rate."

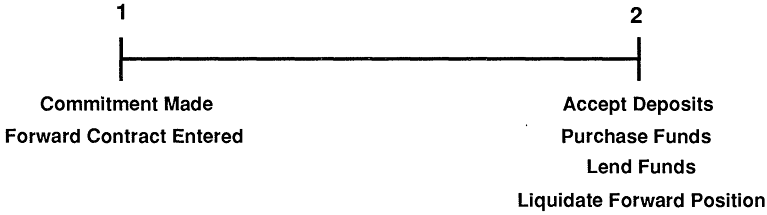

Figure 1. Timing of Events in the Model

whether the period of the commitment is as long as 90 days (for a mortgage lender, for example) or as short as a few minutes (in the case of an "instantaneous" approval at an automobile company's captive finance company). Even variable rate lending can be considered a spot loan combined with a commitment to lend at future points in time (e.g., to not recall the loan) on the terms specified in the loan agreement. In this paper, uncertainty in loan demand arises because the financial intermediary commits to a line of credit but knows neither the quantity of the line that will be taken down by the borrower nor the rate of interest it will earn on the loan.[2] That is, to keep the model general, it is presumed here that the lender commits only to a formula for pricing the loan, say, prime plus two, and therefore is uncertain about the precise rate of return it will earn on the loan.[3]

The quantity of deposits that the financial intermediary will receive is uncontrollable in the short run and therefore is uncertain because the intermediary is assumed to be a "rate setter" in markets such as the demand and savings deposit markets. Therefore, it may be necessary to purchase or sell funds in the CD market to make the balance sheet balance. The intermediary is assumed to operate as a quantity setter in the CD market. That is, the CD market is assumed to be perfectly competitive. If the volume of deposits that the intermediary obtains plus its capital base is insufficient to finance the revealed quantity of loans demanded, the intermediary must purchase more funds in the CD market at a competitive but uncertain (at the time of the commitment) cost.[4]

The timing of events in the model is illustrated in Figure 1. At the initial time point, the loan commitment is made to the borrower. Recognizing the existence of uncertainty, the financial intermediary may, at the initial point in time, also enter a forward contract if it desires to hedge the rate and quantity uncertainties connected with its assets and liabilities. To maintain generality, the forward contract does not necessarily have to call for delivery of either a bank loan or a bank CD, but those possibilities are not excluded. Forward contracting is also assumed to present the financial firm with "basis risk" as a result of a difference between the delivery date or maturity of the contract and the date at which the financial intermediary will be subject to loan requests and deposit flows. All uncertainty is resolved at the second time point; the loan commitment is partially

[2] See Morgan and Smith [9] for a discussion of the origins of such quantity uncertainty.

[3] The situation where the loan rate is fixed is just a special case of the more general model.

[4] The relationship between the deposit flow and the CD market is similar to that in Pringle [14] and Koppenhaver [8].

or fully taken down; deposits flow in or out; funds are purchased or sold in the CD market to balance the balance sheet; and the forward position is liquidated. Profits are then realized based on the loan rate revealed at time point 2 and the structure of the balance sheet at time point 2.

The balance sheet constraint at time point 2 is $L = D + B + k$, where

L is the actual quantity of loans demanded at time 2 under the line-of-credit agreement,
D is the level of uncontrollable deposits received by the financial intermediary,
B is the amount of funds borrowed or lent in the competitive CD market, and
k is the amount of capital financing the firm.

Profits are obtained from the loan revenue less the cost of debt in the two markets in which the firm borrows plus any gain or loss in the forward market resulting from the intermediary's forward position. The profit function can therefore be written as

$$\pi = LR_L - Dr_D - BR_B + f(R_f - r_f), \tag{1}$$

where

R represents the rate on the various securities: loans and borrowing,
r_D is the known regulated cost of savings and demand deposits,
f is the quantity of forward contracts that the financial intermediary enters ($f > 0$ corresponds to a short position and $f < 0$ corresponds to a long position),
r_f is the known forward rate at which the contract is initially undertaken, and
R_f is the forward rate that will prevail on the date of liquidation of the forward contract.

Upper case letters denote variables that are random when viewed from time point 1. The balance sheet constraint can be used to express B in terms of the other quantities. Substituting back into the profit function gives

$$\pi = L(R_L - R_B) - D(r_D - R_B) + kR_B + f(R_f - r_f).$$

The financial intermediary is presumed to desire to maximize expected utility of profits (as in Sealey [18] and Koppenhaver [8]) where the utility function, $U(\pi)$, exhibits constant absolute risk aversion.[5] The appropriateness of the expected utility assumption versus that of value maximization remains an open issue. Santomero [16] provides a general discussion of the controversy. See Sealey [19] for an example of the use of the alternative of value maximization.[6] The

[5] This approach has been termed "macro hedging" as opposed to "micro hedging"—the hedging of a specific asset (T-bill) or liability (CD issue) on the balance sheet.

[6] Whether utility should be defined over the level of profits or rate of return on capital is also an issue open to controversy. (See, for example, Mossin [11], pp. 216–17.) If capital is a choice variable or is constrained relative to assets, the use of rate of return on capital may be more appropriate as the argument in the utility function. (See Koehn and Santomero [7].) However, because neither of those considerations enters our model, the results are identical whether utility is defined over profits or rate of return, and furthermore, utility of profits makes our model structure more comparable to the earlier work on the use of interest futures by financial intermediaries.

first-order condition is

$$E[U'(\pi)(R_f - r_f)] = 0, \tag{2}$$

which can be written as

$$E[U'(\pi)]E[R_f - r_f] + \text{cov}\{U'(\pi), R_f - r_f\} = 0. \tag{3}$$

Assuming that the joint distribution of π and R_f can be closely approximated by a joint normal distribution, we may use the result noted by Rubinstein [15], Sealey [18], and Koppenhaver [8] to state the first-order condition as

$$E[R_f - r_f] + a\ \text{cov}\{\pi, R_f - r_f\} = 0, \tag{4}$$

where a is the measure of absolute risk aversion, $-U''(\pi)/U'(\pi)$, which has been assumed to be a constant. Equation (4) can now be solved for the optimal volume of forward contracting. First, we note that (4) can be rewritten as

$$E[R_f - r_f] + a[\text{cov}\{LR_S, R_f - r_f\} - \text{cov}\{D(r_D - R_B), R_f - r_f\} \\ + k\ \text{cov}\{R_B, R_f - r_f\} + f^*\text{cov}\{R_f - r_f, R_f - r_f\}] = 0,$$

where $R_S = R_L - R_B$, the spread between the loan rate and the CD rate. Noting that $\text{cov}\{X, X\} = \text{var}\{X\}$, the first-order condition may now be solved for f^*:

$$f^* = \frac{-E[R_f - r_f]}{a\,\text{var}\{R_f\}} - \frac{\text{cov}\{LR_s, R_f\}}{\text{var}\{R_f\}} + \frac{\text{cov}\{(r_D - R_B)D, R_f\}}{\text{var}\{R_f\}} - \frac{k\,\text{cov}\{R_B, R_f\}}{\text{var}\{R_f\}}. \tag{5}$$

We focus on the demand for forward contracting at the unbiased forward rate because that point on the demand curve is traditionally viewed as providing the pure hedging demand by the firm. (See Anderson and Danthine [1], Newbery and Stiglitz [12], Ho and Saunders [6], and Ederington [4], for example.) Thus, the first term on the right-hand side of (5) is zero. It may be noted that, rather than viewing the terms in equation (5) as ratios of covariances to variances, a more efficient viewpoint is that the ratios are regression coefficients. Thus, the optimal forward position can be written as

$$f^* = -\beta_{SL,f} + \beta_{RD,f} - (k)\beta_{B,f}, \tag{6}$$

where $\beta_{y,x}$ is the regression coefficient between y and x with y as the dependent variable. The subscript "f" refers to the variable R_f, "SL" refers to net profit on loans, R_sL, "RD" refers to the opportunity cost of deposits, $(r_D - R_B)D$, and "B" refers to R_B.[7]

Equation (6) says that the optimal forward position is a linear combination of regression coefficients from three regressions: (a) the regression between the

[7] If the interest rates and quantities in the model are also joint normally distributed (as Koppenhaver [8] assumed), then the relationship $\text{cov}\{XY, Z\} = E[X]\text{cov}\{Y, Z\} + E[Y]\text{cov}\{X, Z\}$ can be employed to show more directly that (6) has an additional term as well as to add consideration of capital compared with Koppenhaver's [8] equation (8); however, rates and quantities cannot be joint normally distributed if profits and rates are joint normally distributed. The extent to which this incorrect normality assumption affects hedge ratios can be tested by comparing estimates that employ and that do not employ the assumption. The results of such a test are reported in the empirical section of this paper.

financial intermediary's dollar interest spread and the forward rate, (b) the regression between the opportunity cost in dollars of deposits and the forward rate, and (c) the regression between the cost of purchased funds and the forward rate. Notice that the optimal forward position is not a function of the degree of risk aversion of the financial intermediary, and so it is a universally applicable (within the class of CARA utility functions) formula for the optimal volume of forward contracting. Different regression coefficients will result in different optimal hedge ratios across different financial intermediaries. Of course, where different financial intermediaries have different amounts of capital, the optimal forward position will differ even when the various regression coefficients are the same. This role of capital in the optimal forward position has largely been ignored in the empirical literature to date. Consequently, although the formula for the optimal forward position is universally applicable, there should be a wide diversity of optimal hedge ratios across different institutions with some close to one, some close to zero, some positive, and some negative. Section III of this paper presents an empirical investigation of this issue.

II. Empirical Methodology

The analysis in the previous section suggests a method for estimating the optimal forward position for a financial intermediary. Rather than calculate the variances and covariances individually and then compute the appropriate ratios, the regression coefficients can be estimated directly for any individual institution. Furthermore, it is most appropriate to estimate the regression coefficients simultaneously rather than separately. Thus, a seemingly unrelated regressions (SUR) approach can be employed to estimate the betas in equation (6), and the optimal forward position can be efficiently estimated. Tests of the statistical significance of the forward position can be conducted using standard techniques for testing hypotheses about "linear contrasts" between regression coefficients in SUR estimation accounting for the correlation between the estimators of the betas.

It should be noted that the SUR technique gives the same estimates as Ordinary Least Squares (OLS) in the case of identical independent variables; however, SUR is necessary in order to estimate the covariances between the error terms in the three regressions and, in turn, the covariances of the estimators across equations. Those covariances are important (although omitted from all previous studies of this issue) for accurately testing the statistical significance of the estimated optimal hedge ratio that is a linear combination of the regression coefficients. Without a SUR technique, hypothesis tests would be biased and inefficient. Although this problem with OLS may not be large in the context of previous models, it is shown in the next section that, in our extended and disaggregated model, OLS is substantially inferior to SUR.

We desire to test the two standard hypotheses that (a) the optimal hedge ratio is significantly different from one and (b) the optimal hedge ratio is not significantly different from zero. In the first case, the implication would be that the "naive" financial intermediary that hedges *all* of its loans would be acting suboptimally whereas, in the second case, hedging *any* portion of loans would be acting suboptimally. These two tests are in a sense the two extremes, but both extremes may exist within the banking system simultaneously for different banking organizations.

The following three time-series regressions are run as a SUR model:

$$\Delta(\text{Rate Spread: Loans}) = a + \beta_1(\Delta\text{Futures Rate}) + \Omega_1$$

$$\Delta(\text{Deposit Rate Differential: Deposits}) = b + \beta_2(\Delta\text{Futures Rate}) + \Omega_2$$

$$\Delta(\text{CD Rate}) = c + \beta_3(\Delta\text{Futures Rate}) + \Omega_3,$$

where Δ signifies the change from time t to time $t - 1$. Based on the assumption that the current futures rate is an unbiased estimate of the futures rate next period,[8] the variable (ΔFutures Rate) is the deviation of the futures rate from its expectation. Therefore, the betas in the SUR equations are precisely the coefficients based on equation (6) because covariances are independent of one of the means—provided that the mean is stationary across time.[9] Also, we use the first difference of spreads and CD rates as the dependent variables based on the assumption that existing loans and CD's will experience a change in their rates over the period of a quarter. With loans this is essentially an assumption that most of an institution's loans are very short term or are made with variable rates. Recent *Federal Reserve Bulletins* report surveys of large banks that provide evidence that a vast majority of loans are made with floating rates or are very short term.

Because one of the objectives of this study is to compare the optimal forward positions across institutions of various sizes, the quantity of contracting must be "normalized" by some factor. Two alternatives are to divide the optimal amount of forwards by the expected size of the financial intermediary or by the volume of CD's. Neither variable is entirely satisfying because the entity being hedged is a "flow" whereas assets and purchased funds from the balance sheet are "stocks." Total assets (i.e., Loans in the model) appear to be the better alternative as a normalizing factor because they are a measure of the overall size rather than portfolio composition. The normalized ratio has been referred to as the "optimal hedge ratio" but differs from hedge ratios used in other studies that were

[8] While this assumption may not be accurate in general, it is a more accurate depiction of the futures contract that is the nearest to delivery. This may be the case either because bias does not exist in futures prices or because in the nearest contract the bias is small enough to be imperceptible. The futures contract used in the empirical analysis in this paper is always the nearest contract to delivery, and therefore there are never more than three months to delivery.

[9] The technique used here assumes that the change in dollar loan revenue has a stationary, though undetermined, expectation over the time period. An alternative would be to construct a lagged regression model to incorporate additional information and cyclicality in forecasts of loan revenue and to use the deviation from forecast as the dependent variable in the SUR regressions. While this alternative methodology would be expected to give better forecasts, the distribution of hedge ratios is identical to that in Figure 2 based on a Kolmogorov-Smirnoff two-sample D-statistic of .06 compared to the critical value of .134 at the ten percent level. The mean hedge ratio is .098 with a standard deviation of .265, and the number of negative hedge ratios that are significantly different from zero is increased by two banks when this alternative method of calculating the expectation is used. Thus, our estimates of hedge ratios appear to be robust to alternative specifications for the mean loan quantity.

calculated based on the level of CD's. The distribution of the hedge ratios across institutions will be examined under both definitions to determine how important the normalizing factor is in the final results.

The purpose of the empirical analysis is to investigate the optimal magnitude of hedging in the futures market for a variety of banking organizations to determine the cross-sectional variation in such hedge ratios and whether those organizations could find futures contracting useful for reducing risk. For this purpose, estimates of the components of equation (6) must be banking organization specific. That is, we cannot rely entirely on variables that are aggregates or variables that are market rates of interest common to a large number of intermediates. The Quarterly Bank Compustat tape provides data for computing banking organization-specific regression coefficients and parameters for estimating equation (6) over the period from the first quarter of 1977 to the first quarter of 1985. Data relating to the statistical relationships between rate spreads, dollar volume differentials, and deposit flows were obtained for specific banks. Over the sample period, eighty-three banking organizations had complete data. (Continental Illinois was discarded as a result of its massive restructuring during this sample period.) Futures rates on T-bills were obtained from the *IMM Yearbooks* for the relevant years for the contract nearest to delivery. The CD rates were obtained from the *Federal Reserve Bulletin*. It was assumed that all banking organizations had access to the latter two markets at the rates compiled for this study. The deposit rate was approximated by 5.25 percent on both savings and demand deposits, which subsumes an estimate of the noninterest cost of the latter. The expense data are not broken out by type of deposit, and the assumption of a zero cost of demand deposits is unrealistic.[10] All other variables were calculated for each banking organization. The loan portfolio was estimated as Total Loans less Fed Funds Sold.[11] The "CD" variable used for comparison with some other studies was calculated as the Total Time Deposits plus Fed Funds Purchased.

[10] Functional Cost Analysis data were obtained to provide more specific information about the cost of deposits to banks in the sample. The annual FCA data is aggregated for banks larger than $200 million in assets, but of course the cost estimates vary over time. Interpolation was used to obtain quarterly estimates of the net cost of funds. Using those figures in the calculation of optimal hedge ratios produced a distribution of hedge ratios that was identical to that shown in Figure 2 (where a 5.25 percent cost was assumed) based on a Kolmogorov-Smirnoff two-sample D-statistic of .012 compared with the ten percent level critical value of .134. The mean hedge ratio in this case was .093 with a standard deviation of .276. Therefore, our estimates of hedge ratios appear to be relatively insensitive to alternative specifications of the net cost of deposits, though better bank-specific figures may have a stronger influence than the FCA data do.

[11] To test the model under the normality assumption regarding rates and quantities, the model requires the organization's expectation regarding deposits and loans. In this study, a "perfect foresight" approach is taken as opposed to an ad hoc approach to generating estimates of the organization's expectation. Thus, we employed the actual values as a measure of the expectation. Note that this was employed only in calculating the parameters of equation (6) as of the end of the sample period and in calculating the normalizing factor for the hedge ratios but was not employed for computing the regression coefficients. That is, the regression coefficients were estimated using historical data, and the optimal hedge ratio was computed for the second quarter of 1985 based on a distribution of the unknown loan, deposit, etc., centered on the values that prevailed for the second quarter of 1985.

The sample period starts after the T-bill futures market had matured. The end of the sample period was the most recently available data at the time of this study. In order to test the stability of the regression coefficients, especially in the face of the deregulation started by the DIDMCA of 1980, which ushered in the "era of deregulation," the data were run over the whole sample period and over two subperiods from I-77 to IV-80 and from I-81 to I-85. The choice of I-81 as the start of the deregulation subperiod was based on the fact that legal implementation of DIDMCA was not begin until January 1, 1981. In particular, we are interested in determining whether the distribution of the optimal hedge ratios changed significantly as a result of the deregulation, which was touted as having a significant effect on the volatility of bank interest rates relative to market interest rates such as T-bills.

It should be made clear that we are are not examining the actual amount of futures trading that these organizations have undertaken. That information is not on the Compustat data set and is not generally available (not even to the CFTC). Instead, we are examining the potential for the optimal use of futures by these organizations based on the prescriptions of the model developed in the previous section. The extent to which those optimal prescriptions are generally followed by banking organizations would be an interesting and valuable study but one that must await a data set that reflects more than just anecdotal evidence.

III. Empirical Results

The results of the SUR estimation and the optimal hedge ratios across the eighty-three banking organizations in the sample are reported in Table I. The regression coefficient estimates are reported, as well as the linear combination of the regression coefficients as required by equation (6). The third column of the table gives the regression coefficient for the CD rate versus the futures rate and therefore is the same for all the banks in the sample; however, the other coefficients vary across the sample. The first and second columns are of a different order of magnitude from the third column because they involve regressions of dollar quantities against futures rates (instead of rates versus rates).

Of primary interest in this study is the final column of the table, which reports the optimal hedge ratios for each of the eighty-three banking organizations. The wide diversity of optimal hedge ratios is quickly apparent. Figure 2 shows the frequency distribution of the estimated hedge positions relative to size of bank. Notice that the range of ratios goes from −.68 to +.87. The ratios exhibit a frequency plot that partially resembles a normal distribution with a positive mean and variance; however, the right tail is fatter than what would occur with a symmetric distribution. This is a frequency plot that could be characterized as coming from a mixture of distributions. A mixture of distributions is what is expected here because the estimators are believed to each have different means and variances. If the underlying "true" hedge ratios were identical for all organizations and the estimators were randomly distributed around the true, common hedge ratio, then the cross-sectional frequency distribution would appear to be normally distributed. Thus, Figure 2 provides support in a number of dimensions

Table I

SUR Results and Optimal Hedge Ratios (Full Sample Period)

Bank	$\beta_{S,f}$	$\beta_{RD,f}$	$\beta_{B,f}$	h^*
American Fletcher	−1,651.72	−1,036.05	1.31	.16* (.05)
American Security	−1,731.02	−933.74	1.31	.29* (.07)
Ameritrust	−3,966.31	−2,608.86	1.31	.11 (.05)
AmSouth Bancorp	−1,978.38	−1,374.05	1.31	.10 (.04)
Arizona Bancwest	−1,521.16	−1,076.36	1.31	.09* (.03)
Atlantic Bancorp	−976.44	−1,387.80	1.31	−.54* (.06)
Banc One	−2,335.25	−1,793.64	1.31	−.07 (.03)
Bank New England	−1,658.74	−1,809.11	1.31	−.12 (.28)
Bank of New York	−6,380.04	−3,791.55	1.31	.15 (.07)
Bank of Virginia	−2,248.72	−1,106.96	1.31	.34* (.05)
BankAmerica	−79,617.50	−32,262.50	1.31	.54* (.09)
Bankers Trust	−18,761.60	−9,180.54	1.31	.34* (.10)
Barnett Banks	−2,647.05	−3,175.30	1.31	−.18* (.03)
Bay Banks	−2,138.34	−2,316.17	1.31	−.17* (.04)
Centerre Bancorp	−2,138.66	−1,649.47	1.31	.04 (.09)
Chase Manhattan	−57,566.60	−21,075.50	1.31	.54* (.08)
Chemical Bank	−28,783.50	−14,304.50	1.31	.32* (.07)
Citicorp	−89,818.50	−11,860.50	1.31	.71* (.08)
Citizens & Southern	−3,017.72	−2,492.31	1.31	−.02 (.03)
Colorado National	−913.94	−746.49	1.31	−.04 (.05)
Commerce Union	−1,385.81	−799.30	1.31	.23* (.05)
Continental Bancorp	−1,766.23	−880.30	1.31	.19* (.05)
Corestates Financial	−3,917.53	−2,589.92	1.31	.07 (.07)
Equimark	−1,713.11	−1,165.66	1.31	.30* (.06)
Fidelcor	−2,163.73	−1,556.65	1.31	.08 (.07)
First Atlanta	−1,937.24	−1,816.27	1.31	−.11 (.08)

Table I—*Continued*

Bank	$\beta_{S,f}$	$\beta_{RD,f}$	$\beta_{B,f}$	h^*
First Bank System	−9,135.52	−4,711.20	1.31	.24* (.06)
First Chicago	−21,923.70	−5,053.16	1.31	.65* (.08)
First Cincinnati	−5,914.08	−4,326.90	1.31	.03 (.06)
First FID	−2,315.60	−1,894.46	1.31	−.06 (.07)
First Interstate	−22,212.80	−14,787.20	1.31	.15* (.06)
First Kentucky	−1,211.15	−858.02	1.31	.02 (.05)
First Maryland	−1,816.60	−1,223.73	1.31	.10 (.05)
First National Cincinnati	−572.09	−1,041.70	1.31	−.68* (.07)
First Pennsylvania	−4,390.85	−1,722.69	1.31	.87* (.15)
First Tennessee	−1,835.35	−1,623.37	1.31	−.05 (.05)
First Union	−2,335.24	−1,529.85	1.31	.02 (.05)
First Virginia	−1,279.37	−1,084.74	1.31	−.05 (.09)
First Wisconsin	−3,513.04	−1,141.14	1.31	.64* (.12)
Fleet Financial	−2,569.44	−1,766.25	1.31	.05 (.08)
Florida National	−1,197.14	−1,609.88	1.31	−.24* (.05)
Hartford National	−1,646.59	−1,859.61	1.31	−.21 (.11)
Huntington National	−1,752.96	−1,380.84	1.31	−.02 (.06)
Intrawest	−2,027.69	−1,581.46	1.31	.53 (.86)
Irving Bank	−9,914.05	−7,399.95	1.31	.11 (.08)
Manufacturers Hanover	−39,767.90	−17,275.60	1.31	.35* (.08)
Marine Corp.	−1,454.04	−895.53	1.31	.15* (.04)
Marine Midland	−12,629.30	−4,726.65	1.31	.47* (.08)
Marshall & Ilsley	−1,603.74	−1,149.66	1.31	.06 (.11)
Maryland National	−3,329.01	−2,079.42	1.31	.14 (.07)
Mellon Bank	−10,236.20	−6,003.69	1.31	.12 (.06)
Mercantile Bancorp	−2,305.36	−1,432.31	1.31	.11 (.09)
Morgan (J.P.) & Co.	−32,854.50	−13,877.00	1.31	.42* (.09)

Table I—*Continued*

Bank	$\beta_{S,f}$	$\beta_{RD,f}$	$\beta_{B,f}$	h^*
National City	−3,516.86	−2,234.92	1.31	.08 (.18)
NBD Bancorp	−5,567.11	−4,860.09	1.31	−.08 (.06)
NCNB Corp.	−4,274.18	−2,653.12	1.31	.06 (.04)
Norstar	−1,597.20	−1,826.89	1.31	−.28* (.08)
Northern Trust	−3,087.66	−1,488.92	1.31	.39 (.14)
Northwestern Financial	−1,434.21	−907.82	1.31	.18* (.05)
Norwest Corp.	−10,048.40	−5,505.46	1.31	.24* (.04)
PNC Financial	−3,666.90	−2,667.82	1.31	−.05 (.05)
Rainer Bancorp.	−4,344.74	−2,137.26	1.31	.29* (.05)
RepublicBank Corp.	−7,559.22	−3,583.57	1.31	.18* (.05)
Riggs National	−1,802.01	−1,742.52	1.31	−.15 (.09)
RIHT Financial	−1,224.59	−357.22	1.31	.48* (.07)
Security Pacific	−23,336.50	−12,015.20	1.31	.29* (.05)
Shawmut Corp.	−2,658.70	−2,234.86	1.31	−.02 (.07)
Society Corp.	−2,178.52	−1,602.90	1.31	.03 (.06)
South Carolina	1,132.55	−1,031.14	1.31	−.10 (.05)
Southeastern Banking	−3,055.60	−3,050.56	1.31	−.10* (.04)
Sovran Financial	−2,122.17	−1,574.10	1.31	−.03 (.03)
State Street Boston	−915.96	−1,319.75	1.31	−.66* (.12)
SunTrust Banks	−2,058.03	−2,292.14	1.31	−.17 (.09)
Texas American	−2,263.15	−1,398.61	1.31	.08 (.05)
Texas Commerce	−6,685.99	−4,462.01	1.31	.05 (.06)
Third National	−1,208.52	−946.61	1.31	−.04 (.05)
U. S. Bancorp	−3,670.12	−2,454.90	1.31	.11* (.04)
Union Planters	−600.65	−627.31	1.31	−.18 (.09)
United Banks of Colorado	−1,869.91	−1,394.64	1.31	.06 (.10)
United Jersey	−1,845.61	−1,516.88	1.31	.02 (.07)

Table I—*Continued*

Bank	$\beta_{S,f}$	$\beta_{RD,f}$	$\beta_{B,f}$	h^*
United Virginia	−3,099.70	−1,949.77	1.31	.14* (.03)
Wachovia	−3,408.18	−2,803.04	1.31	−.04 (.05)
Wells Fargo	−20,092.60	−9,381.74	1.31	.40* (.05)

* Significantly different from zero at the one percent level using a two-tailed test. With the exception of First Pennsylvania and Intrawest, all hedge ratios are significantly different from one at the one half percent level using a one-tailed test. Standard deviations are shown in parentheses beneath the estimated hedge ratios.

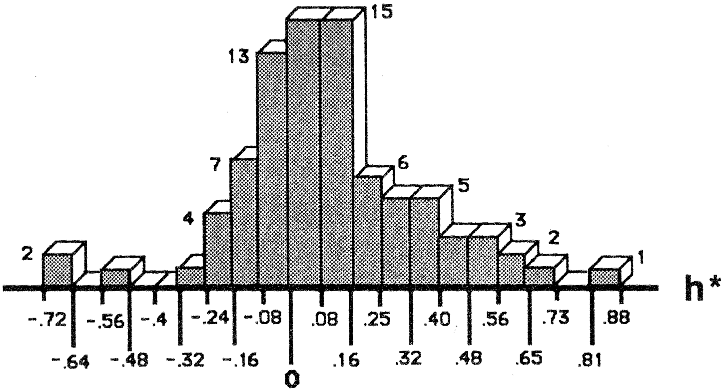

Figure 2. Cross-Sectional Histogram of Optimal Hedge Ratios—Full Sample Period

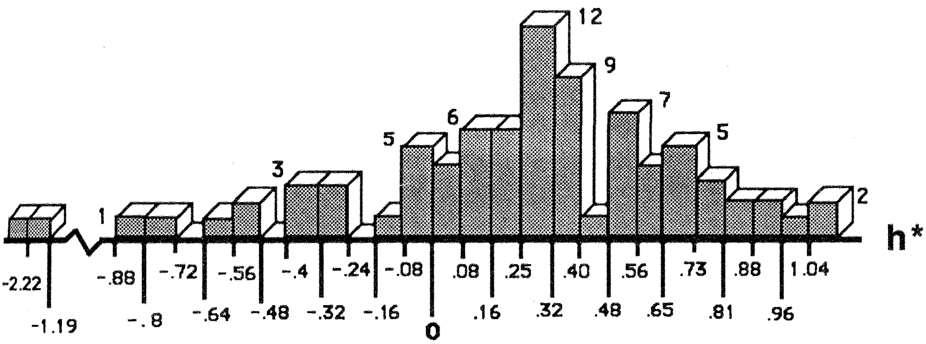

Figure 3. Cross-Sectional Histogram of Optimal Hedge Ratios—Pre-deregulation Era

to our hypothesis of heterogeneity across the sample.[12] Also, it may be noted that, for the vast majority of firms, the optimal hedge ratio is below the values reported in previous studies (approximately +.50 to +.90). Although some firms should take positions of that size (for example, BankAmerica, Chase Manhattan,

[12] A principal-components analysis of the variables in (6) showed that no one variable can be identified as the major source of the cross-sectional variation in hedge ratios.

Citicorp, First Chicago, First Pennsylvania—notorious for problems relating to its large negative gap—First Wisconsin, and Intrawest), the vast majority of firms in our sample are estimated to have optimal hedge ratios below that size.

A closer investigation of the data provides two other broad conclusions. First, each of our extensions of the economic theory and statistical methodology (stochastic loan demand, nonzero capital, proper characterization of covariances, and use of the SUR technique) makes a significant contribution to differentiating the results in this work from those reported elsewhere. Second, the influences of the added economic variables appear relatively robust with respect to variable specification. The location of the distribution of hedge ratios is shifted to the left, and a greater degree of heterogeneity of the hedge ratios is revealed when the economic extensions are employed.[13] The use of SUR increases the number of hedge ratios that are significantly different from zero. On the other hand, use of alternative measures of relevant variables in the model resulted in virtually the same estimates of the hedge ratios.[14]

Using our methodology, rigorous tests of the two main hypotheses are examined in Table I. Thirty-nine of the eighty-three hedge ratios are significantly different from zero at the one percent level (using a two-tailed test). Of these, eight are significantly negative and thirty-one are significantly positive. This is substantially higher than would be expected by chance at the one percent level: sixteen times more than by chance for the negative ratios and sixty times more for the positive ratios. Thus, we may conclude that the tests provide evidence that many banking organizations could employ futures beneficially. Notice that a significant number of organizations could employ a *long* position in the futures market to hedge their risk. Considering only the average hedge ratio for the sample would obscure this significant heterogeneity within the sample. Of course, there is also evidence that over half of the sample has an optimal hedge ratio that is not distinguishable from a zero position. In addition, the results allow a test of whether "complete hedging," i.e., a hedge ratio of one, is generally appropriate for banking organizations. In only two cases out of eighty-three, the null hypothesis of a hedge ratio equal to one is not rejected at the one half percent level of confidence. Thus, although this is four times more than expected by chance, we conclude, as Koppenhaver [8] did based on the average for the industry, that a hedge ratio of one is generally inappropriate, but a few institutions have optimal hedge ratios that cannot be distinguished statistically from one in this study even though theoretically the hedge ratio should be less than one.

The era of deregulation that was ushered in by the implementation of the DIDMCA of 1980 may have presented a different risk and hedging situation to

[13] The mean hedge ratio increased from .10 to .20 when capital was assumed to be zero and from .10 to .66 when stochastic loan demand was removed. The means of the distributions are reported above only for purposes of comparability. Because it is argued here that each bank is not an observation from the same population distribution, the mean is not an estimator of the expected value of any of the potentially eighty-three distributions.

[14] The distributions were in fact not statistically different from the original estimates when either using a nonstationary mean forecasting method for loan demand, using Functional Cost Analysis data on deposit costs, or using a different normalizing factor (expected borrowing) in calculating the hedge ratios. Thus, the estimates are robust to the alternative measures we investigated.

banking organizations. To test whether the "era of deregulation" shifted the level or dimension of risks faced by banking organizations and therefore shifted the optimal hedge ratios, we split the sample into two subperiods: pre-deregulation and deregulation. The hedge ratios were estimated using equation (6) in the periods from the first quarter of 1977 to the fourth quarter of 1980 and from the first quarter of 1981 to the first quarter of 1985.[15] The comparison of the estimated optimal hedge ratios for the pre- and post-periods is given in Table II, and the frequency plot for the pre-deregulation period is shown in Figure 3. Using a Kolmogorov-Smirnoff two-sample test, the distributions of optimal hedge ratios in the pre-deregulation and deregulation subperiods were significantly different at the one percent level. The optimal hedge ratio increased for twenty-one organizations from pre-deregulation to deregulation. In the pre-deregulation period, there were nearly two and a half times as many firms with significantly negative hedge ratios. Thus, for many firms, the deregulation era has meant an increased need for taking a short position or decreasing their long position in the forward market. This is consistent with the view that deregulation has shortened the effective maturity of liabilities relative to assets. On the other hand, the deregulation era has also meant that, for sixty-three banking organizations, the optimal hedge ratio dropped and has resulted in more than a doubling of the number of organizations (from twenty-seven percent to sixty-three percent of our sample) for whom the optimal hedge ratio is indistinguishable from *zero*. Furthermore, as a result of deregulation, there was a significant drop in the number of firms for which the optimal hedge position is positive. Given that over seventy-five percent of the sample had a drop in their optimal hedge ratios, the effects of deregulation cannot be characterized as increasing the interest rate risk faced by banking organizations. Deregulation has allowed the majority of firms to decrease the level of interest rate risk by virtue of permitting a closer relationship between their costs and revenues. This greater ability to hedge on their balance sheet means that their optimal futures hedging position (even before the consideration of transactions costs) is not significantly different from doing nothing.

The evidence presented here indicates that previous studies of bank hedging with interest rate futures have greatly overstated the volume of short futures positions that banks should take as well as obscured the great variety across banking organizations of the appropriate futures positions to take. A good number of firms should take short positions smaller than is generally recognized; some firms should take no position (particularly in this era of deregulation); and a significant number should take long futures positions to hedge the risk to owners of fluctuations associated with interest rates. One implication of these conclusions is that strict rules that indicate the optimal position to take in the futures market are likely to be grossly inappropriate for a large number of institutions. Advisors and managers of such organizations cannot rely on "rules of thumb" that have been generated from aggregative analyses. Perhaps most relevant to this issue is the question of regulation of firms' positions in these markets. Regulations that

[15] Splitting the sample at the date of passage of DIDMCA (I-80) does not qualitatively alter the conclusions regarding the heterogeneity of the effect of deregulation.

Table II

Optimal Hedge Ratios: Pre-deregulation and Deregulation Era

Bank	Pre-deregulation	Deregulation	Change
American Fletcher	.39*	.10	−
	(.08)	(.04)	
American Security	.55*	.15	−
	(.07)	(.06)	
Ameritrust	.36*	.00	−
	(.07)	(.04)	
AmSouth Bancorp	.27*	.11	−
	(.06)	(.05)	
Arizona Bancwest	.25*	.09*	−
	(.03)	(.03)	
Atlantic Bancorp	−.77*	−.59*	+
	(.09)	(.06)	
Banc One	.23*	−.09	−
	(.07)	(.04)	
Bank New England	.86*	−.44	−
	(.12)	(.38)	
Bank of New York	.26*	.30*	+
	(.08)	(.07)	
Bank of Virginia	.74*	.25*	−
	(.07)	(.05)	
BankAmerica	.73*	.53*	−
	(.07)	(.10)	
Bankers Trust	.72*	.19	−
	(.09)	(.10)	
Barnett Banks	−.58*	−.16*	+
	(.07)	(.04)	
Bay Banks	−.29*	−.13*	+
	(.06)	(.04)	
Centerre Bancorp	.12	.07	−
	(.10)	(.09)	
Chase Manhattan	.76*	.51*	−
	(.07)	(.09)	
Chemical Bank	.65*	.27*	−
	(.07)	(.09)	
Citicorp	1.12*	.63*	−
	(.08)	(.08)	
Citizens & Southern	−.07*	.08	+
	(.05)	(.04)	
Colorado National	.01	.03	+
	(.10)	(.05)	
Commerce Union	.61*	.08	−
	(.05)	(.06)	
Continental Bancorp	.65*	.20*	−
	(.09)	(.06)	
Corestates Financial	.31*	.11	−
	(.09)	(.09)	
Equimark	.36*	.23*	−
	(.06)	(.07)	
Fidelcor	.38*	−.01	−
	(.09)	(.08)	
First Atlanta	−.29*	.04	+
	(.15)	(.09)	

Table II—*Continued*

Bank	Pre-deregulation	Deregulation	Change
First Bank System	.56*	.25*	−
	(.07)	(.07)	
First Chicago	.96*	.61*	−
	(.06)	(.09)	
First Cincinnati	.11	.09	−
	(.10)	(.06)	
First FID	.12	−.05	−
	(.10)	(.09)	
First Interstate	.20*	.29*	+
	(.04)	(.06)	
First Kentucky	.24	.03	−
	(.13)	(.05)	
First Maryland	.27*	.14	−
	(.05)	(.06)	
First National Cincinnati	−2.22*	−.54*	+
	(.25)	(.06)	
First Pennsylvania	1.08*	.34*	−
	(.13)	(.07)	
First Tennessee	−.02	−.04	−
	(.07)	(.05)	
First Union	.24*	.08	−
	(.05)	(.07)	
First Virginia	.15*	−.11	−
	(.03)	(.13)	
First Wisconsin	.93*	.58*	−
	(.17)	(.09)	
Fleet Financial	.49*	−.07	−
	(.08)	(.10)	
Florida National	−1.19*	−.14	+
	(.13)	(.05)	
Hartford National	−.02	−.30	−
	(.14)	(.14)	
Huntington National	−.13	.13	+
	(.07)	(.07)	
Intrawest	.07	1.11	+
	(.10)	(1.9)	
Irving Bank	.18	.17	−
	(.11)	(.08)	
Manufacturers Hanover	.54*	.44*	−
	(.07)	(.11)	
Marine Corp.	.36*	.20*	−
	(.06)	(.05)	
Marine Midland	.78*	.44*	−
	(.09)	(.09)	
Marshall & Ilsley	.30	.03	−
	(.21)	(.08)	
Maryland National	.38*	.18	−
	(.07)	(.09)	
Mellon Bank	.31*	.18	−
	(.06)	(.08)	
Mercantile Bancorp	.25	.24	−
	(.14)	(.11)	
Morgan (J.P.) & Co.	.72*	.36*	−
	(.07)	(.10)	

Table II—*Continued*

Bank	Pre-deregulation	Deregulation	Change
National City	−.41*	.44	+
	(.12)	(.25)	
NBD Bancorp	−.03	−.05	−
	(.06)	(.07)	
NCNB Corp.	.34*	.11	−
	(.09)	(.05)	
Norstar	−.58*	−.26	+
	(.12)	(.10)	
Northern Trust	.48*	.44*	−
	(.15)	(.15)	
Northwestern Financial	.42*	.13	−
	(.05)	(.06)	
Norwest Corp.	.49*	.26*	−
	(.05)	(.04)	
PNC Financial	.32*	−.09	−
	(.07)	(.06)	
Rainer Bancorp.	.59*	.28*	−
	(.04)	(.07)	
RepublicBank Corp.	.51*	.21*	−
	(.06)	(.07)	
Riggs National	−.05	−.17	−
	(.10)	(.08)	
RIHT Financial	.85*	.44*	−
	(.08)	(.08)	
Security Pacific	.52*	.31*	−
	(.04)	(.06)	
Shawmut Corp.	.07	.02	−
	(.11)	(.07)	
Society Corp.	.19	.02	−
	(.10)	(.06)	
South Carolina	−.27*	−.00	+
	(.04)	(.07)	
Southeastern Banking	−.37*	.02	+
	(.07)	(.04)	
Sovran Financial	.25*	−.03	−
	(.04)	(.04)	
State Street Boston	−.85*	−.49*	+
	(.18)	(.11)	
SunTrust Banks	−.50*	−.14	+
	(.06)	(.13)	
Texas American	.31*	.14	−
	(.09)	(.05)	
Texas Commerce	.23	.11	−
	(.09)	(.07)	
Third National	.37*	−.13	−
	(.08)	(.07)	
U. S. Bancorp	.30*	.05	−
	(.03)	(.03)	
Union Planters	−.39*	.01	+
	(.09)	(.10)	
United Banks of Colorado	.13	.17	+
	(.16)	(.09)	
United Jersey	.11	.10	−
	(.10)	(.08)	

Table II—*Continued*

Bank	Pre-deregulation	Deregulation	Change
United Virginia	.31*	.19*	–
	(.04)	(.03)	
Wachovia	.04	−.01	–
	(.07)	(.04)	
Wells Fargo	.67*	.32*	–
	(.04)	(.05)	

* Significantly different from zero at the one percent level using a two-tailed test. Standard deviations are shown in parentheses beneath the estimated hedge ratios.

are inflexible and do not account for the wide heterogeneity in the banking system will place inappropriate constraints on abilities of the regulated firms to reduce their risk. Alternatively, insurance premia charged to banks (whether charged explicitly or implicitly) that deviate from an inflexible regulatory standard will in all likelihood impose a cost on bank shareholders that is higher than is appropriate and that will encourage excessive risk taking on the part of the regulated firms. Some bank regulators have only recently adopted this view, while other regulators still believe that imposing constraints on institutions is the risk-minimizing position.

IV. Conclusions

In this paper, we have presented a theoretical derivation of the optimal hedge ratio for financial intermediaries that assumes constant absolute risk aversion and a joint normal distribution between profits and forward rates. The optimal hedge ratio at the unbiased rate does not depend on the degree of risk aversion exhibited by the hedger. The theory adds a new term to the theoretically optimum hedge ratio and includes a role for the amount of capital that the intermediary uses (or alternatively the amount of deposits that the intermediary does not need to finance assets).

The theoretical prescription provides a focus on a type of statistical analysis that has heretofore not been used in the study of optimal hedge ratios. By employing the SUR technique and bank-specific data, we have been able to provide accurate tests of whether the optimal hedge ratios are significantly different from zero and one.

The empirical results show that there is a great deal of heterogeneity within a sample of eighty-three banking organizations available on the quarterly Compustat data files. The number of significant positive and *negative* hedge ratios was substantially greater than chance would have generated in a sample of eighty-three firms. A large number of banking organizations do not have optimal hedge ratios that are distinguishable from zero, though virtually all have ratios that are significantly different from one even at the one half percent level (one-tailed). We believe that the evidence presented here indicates that previous studies of bank hedging with interest rate futures have greatly overstated the volume of short futures positions that banks should take. Some should take short positions smaller than is generally believed; some should take no position; and a significant number should take long futures positions to hedge the risk to owners of fluctuations in interest rates. Regulations that do not account for the wide heterogeneity in the banking system will inappropriately restrict the risk-reducing activities of the regulated firms.

It was also seen that the recent deregulation has meant that some institutions should be taking much smaller long positions than they had prior to deregulation and that many institutions should be going more short relative to the "pre-deregulation era." However, over seventy-five percent of our sample showed the opposite, and most important, sixty-three percent of our sample showed an optimal hedge ratio that was indistinguishable from a zero forward position compared with only twenty-seven percent in the "pre-deregulation era." This is evidence that deregulation has not affected institutions uniformly. For many institutions, the effect was to *decrease rather than increase the level of interest rate risk.* This result highlights that the issue is not whether deregulation increases deposit cost variability but whether it increases the association between costs and revenues, thereby reducing the risk of the portfolio. When considering the effects of deregulation, we must recognize that there are two sides of the balance sheet, not just one.

REFERENCES

1. R. Anderson and J. Danthine. "Hedger Diversity in Futures Markets." *Economic Journal* 93 (June 1983), 370–89.
2. M. Arak and C. McCurdy. "Interest Rate Futures." *Quarterly Review*, Federal Reserve Bank of New York 5 (Winter 1979-80), 33–46.
3. K. Dew and T. Martell. "Treasury Bill Futures, Commercial Lending, and Synthetic Fixed Rate Loans." *Journal of Commercial Bank Lending* 63 (April 1981), 27–38.
4. L. Ederington. "The Hedging Performance of the New Futures Markets." *Journal of Finance* 34 (March 1979), 157–70.
5. C. T. Franckle. "The Hedging Performance of the New Futures Markets: Comment." *Journal of Finance* 35 (December 1980), 1273–79.
6. T. Ho and A. Saunders. "Fixed Rate Loan Commitments, Take Down Risk, and the Dynamics of Hedging with Futures." *Journal of Financial and Quantitative Analysis* 18 (December 1983), 499–516.
7. M. Koehn and A. Santomero. "Regulation of Bank Capital and Portfolio Risk." *Journal of Finance* 35 (December 1980), 1235–44.
8. G. D. Koppenhaver. "Bank Funding Risks, Risk Aversion, and the Choice of Futures Hedging Instrument." *Journal of Finance* 40 (March 1985), 241–55.
9. G. Morgan and S. Smith. "Basis Risk, Partial Take Down, and Hedging by Financial Intermediaries." *Journal of Banking and Finance* 10 (December 1986), 467–90.
10. ———. "The Role of Capital Adequacy Regulation in the Hedging Decisions of Financial Intermediaries." *Journal of Financial Research* 10 (Spring 1987), 33–46.
11. J. Mossin. "Optimal Multiperiod Portfolio Policies." *Journal of Business* 41 (April 1968), 215–29.
12. R. Newbery and J. Stiglitz. *The Theory of Commodity Price Stabilization.* London: Oxford University Press, 1981.
13. G. Picou. "Managing Interest Rate Risk with Interest Rate Futures." *Bankers Magazine* 64 (May–June 1981), 69–87.
14. J. J. Pringle. "The Imperfect Markets Model of Commerical Bank Financial Management." *Journal of Financial and Quantitative Analysis* 9 (January 1973), 69–87.
15. M. Rubinstein. "Valuation of Uncertain Income Streams and the Pricing of Options." *Bell Journal of Economics* (Autumn 1976), 407–25.

16. A. Santomero. "Modeling the Banking Firm: A Survey." *Journal of Money, Credit and Banking* 16 (November 1984, Part 2), 576–602.
17. C. Schweser, J. Cole, and L. D'Antonio. "Hedging Opportunities in Bank Risk Management Programs." *Journal of Commercial Bank Lending* 62 (January 1980), 29–41.
18. C. W. Sealey. "Deposit Rate Setting, Risk Aversion, and the Theory of Depository Financial Intermediaries." *Journal of Finance* 36 (December 1981), 1139–54.
19. ———. "Valuation, Capital Structure, and Shareholder Unanimity for Depository Financial Intermediaries." *Journal of Finance* 38 (June 1983), 857–71.