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AN ANALYSIS OF INTEREST RATE HEDGING STRATEGIES FOR AGRICULTURAL LENDERS

The Ohio State University Ph.D. 1984

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AN ANALYSIS OF INTEREST RATE HEDGING STRATEGIES
FOR AGRICULTURAL LENDERS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
Peter J. Heffernan, B.S., M.S.

* * * * *

The Ohio State University
1984

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To Debra and Alissa
I wish to express my deepest appreciation to my advisor, Professor Warren F. Lee, for his guidance, encouragement and friendship throughout my graduate program. His counsel was an invaluable resource during the course of this study.

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I am especially indebted to my wife, Debbie, for making the sacrifices that a graduate education entails. Her love, patience and understanding made this effort possible. Our daughter, Alissa, who was born while this study was being undertaken, made our effort more enjoyable, and its completion more meaningful.
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CHAPTER I
INTRODUCTION

Background

The environment within which agricultural lenders and borrowers
must operate has changed dramatically in the last several years. This
is evidenced by substantial increases in debt outstanding to agricul-
ture as well as by changing market shares of the principal lenders (5,
53, 66). Much of this change has been fostered by inflation, volatile
interest rates, changes in the regulatory environment, and general
economic conditions within and outside of the agricultural sector.

The move toward fewer and larger farm operating units, increased
capitalization of operations, increasing prices and rising land values
have all contributed to increased borrowing by farmers (5, 7). As a
result of these forces total farm debt grew at an annual rate of 14.4%
between 1975 and 1980, making it the fastest growing sector in U.S.
credit markets (5, 23). At the same time many rural banks experienced
difficulty in achieving the deposit growth rates needed to keep up with
loan demand (6, 23, 53). Their problems have been compounded by the
relatively small size of most rural banks which limits their access to
funds markets outside of rural areas and forces expensive loan

\footnote{Numbers in parentheses refer to literature listed in the
bibliography.}
participation arrangements with correspondents when customer needs exceed a bank's legal lending limit. The result was a decline in the share of farm credit serviced by commercial banks.

The Farm Credit System (FCS), on the other hand, enjoyed an increase in its market share of agricultural credit during this period. This was facilitated by the system's virtually unrestricted access to national money markets which allowed it to raise sufficient funds for lending. Only the U.S. Treasury acquires more funds in national money markets than the FCS (48). By issuing bonds and notes, the system makes funds available to cooperatives through the Banks for Cooperatives, to Federal Land Banks and their associations for real estate loans and to Federal Intermediate Credit Banks (FICBs) and Production Credit Associations (PCA) for short and intermediate term loans. The FCS makes loans available to farmers at its current average cost of funds plus a margin for operating costs. In a period of generally rising interest rates, the FCS has been able to offer more favorable rates, vis-à-vis commercial banks, to farm borrowers. This rate differential became most pronounced after 1979, with PCA's offering loans at rates averaging 2 to 4 percentage points lower than non-real-estate farm loans from commercial banks (54).

As farmers acquire more debt to operate and expand their holdings, agricultural lenders find themselves exposed to greater risks. Increases in interest rates and the amount of debt outstanding caused farmers' interest expense to double between 1978 and 1981, making it the second largest farm expense category. As a result, lenders are faced with greater default and interest rate risks. Against this
backdrop, an examination of the risks and lenders' responses to them is then in order.

A major risk facing lenders is that of default which involves the loss of principal or interest on a loan. The lenders' default risk also involves the cost of funds acquired to support the loan and the cost of administering it. A typical response by lenders faced with anticipated default has been an extension or refinancing of the loan. Agricultural lenders were comfortable with this mechanism through much of the 1970s because appreciation in land values provided a cushion of equity. However, the recent ebb in land prices and the persistent use of this strategy has exhausted much of its usefulness (47). Furthermore, if a loan is not repaid the lender loses the opportunity to roll those funds over into new loans. This problem becomes particularly acute if the funds supporting the defaulted loan have a longer maturity and the lender must continue to carry this cost. While default rates are not presently posing severe problems in rural financial markets, the continued increase in debt financing along with high and volatile interest rates on loans constitute a growing pressure on the cash flow of many borrowers. This pressure does indicate the presence of a potential threat to the historically smooth operation of the market.

Further complicating the lenders' situation is the increased interest rate risk that current conditions have created. Interest rate risk arises from volatile interest rates and the effect of this volatility on the costs of funds and on the values of fixed rate assets. When the maturities of assets and the liabilities supporting them are mismatched
and cannot be adjusted (e.g. by variable rates on loans) the lender is exposed to interest rate risk. For example, if a financial institution is unable to adjust the rate of its loans and if it must roll over liabilities supporting its loans before the portfolio matures, it finds itself exposed to the risk of having to pay more for funds to support a loan portfolio that will decrease in value should interest rates rise unexpectedly. While the converse of this scenario (interest rates falling) results in obvious benefits to the lender, few institutions could enjoy the roller coaster ride they would be subjecting themselves to in a volatile interest rate environment.

Financial institutions have developed a variety of methods to modify the risks inherent in lending. Institutions attempt to diversify their portfolios into as many profitable and low risk alternatives as possible. However, the smaller and more agriculturally oriented institutions have fewer opportunities to diversify. Their response to increased risk is more likely to involve leverage limits, closer supervision of loans, higher down payments and insurance requirements (8, 43). Another method is the matching of asset and liability maturities. This would only be effective, however, if the borrower was locked into the loan with a penalty for prepayment (65). The use of variable rate loans can also reduce interest rate risk for lenders. The FCS has incorporated a variable rate provision into its loan contracts for some time. Commercial banks, while slower to move in this direction, essentially made rates more variable by shortening the average maturity of their loans (57).
Statement of the Problem

The shortcoming of the above mentioned strategies is that they merely shift lender risk to or share it with the borrower. However, there is an underlying tradeoff between default and interest rate risk. By shifting a larger proportion of interest rate risk to borrowers, lenders place greater pressure on borrowers' cash flow positions, hence increasing the possibility of default. Similarly, minimizing default risk would require lenders to take on more of the interest rate risk inherent in lending. As such, these strategies enjoy only limited effectiveness in mitigating the overall risk of lending.

An additional alternative is available to financial institutions which may be more effective in reducing their exposure to interest rate risk. That is, they could hedge their positions in the financial futures market. Hedging opportunities exist for that portion of the balance sheet that is fixed in terms of its cost or rate of return or having mismatched maturities between assets and liabilities. While the theory behind hedging will be fully addressed in the next section, it is important to note there the fundamental difference between hedging and the other risk reducing strategies mentioned above. Through hedging, interest rate risk can be shifted out of the financial intermediation process into another market willing to bear that risk. Through this mechanism, the tradeoff between default and interest rate risk can be largely avoided. This shifting of risk comes about because the risk of interest rate changes is no longer shared between lender and borrower but rather is passed to the futures market.
The focus of this study is an examination of the applicability of a hedging strategy for reducing the interest rate risk faced by agricultural lenders. While financial hedging opportunities exist for both lenders and borrowers, it is felt that financial institutions maintain a comparative advantage in executing such a strategy. Because of their financial expertise and specialization, lenders are more apt to be willing and able to adapt their operations to opportunities in the futures market. The time and effort devoted to developing competence in futures trading is essentially the same for an institution or an individual, but the potential uses and returns are far greater for the lender. Furthermore, there are potential economies for lending institutions to exploit, in that they may be more cost efficient in implementing this strategy across the various elements of their balance sheet whereas individuals would be hedging only their individual loans.

The potential to reduce risk through hedging can allow lenders to perform the task of intermediation more effectively and efficiently. By reducing fluctuations in the cost of funds and the value of assets, hedging affords lenders opportunities for better planning of their operations and more nearly optimum use of their portfolio. Furthermore, it allows for the separation of interest rate risk from the overall risk in lending. There are also benefits passed on to the borrower to the extent that funds may be more readily available, for longer terms and at lower and less volatile rates. Such opportunities can enhance the income potential of both lenders and borrowers and the overall performance of financial markets (25, 60).
Although possibilities for hedging by financial intermediaries exist in a theoretical sense, few institutions presently employ such a strategy (18). The Federal Reserve Bank of Kansas City surveyed commercial banks with the largest farm loan portfolios about their use of financial futures. They found that only 7% of the respondents were currently using financial futures (21). The purpose of this study is to determine if hedging in financial futures markets is a viable strategy and how it might benefit agricultural lenders and borrowers.

**Objectives of the Study**

The general objective of the study is to examine the potential application of interest rate hedging strategies by agricultural lending institutions. To facilitate this objective the theory underlying hedging will be reviewed and a description of hedging strategies one might undertake with financial futures presented. The specific objectives of the study are:

1. to identify opportunities for hedging by rural banks and FCS lenders;
2. to compare the relative effectiveness of a portfolio analysis determined hedge versus a routine hedge position;
3. to compare the effects on cost and revenue of different hedging strategies with an unhedged position;
4. to evaluate any factors which may be limiting the effectiveness or use of financial futures hedging by agricultural lending institutions.
In meeting the objectives of the study several hypotheses are tested:

1. The case study institutions are exposed to interest rate risk.
2. Hedging can be effective in reducing variability in the cost of funds.
3. A portfolio analysis determined hedging is more effective at reducing interest rate risk than a routine hedge.
4. Practical problems associated with implementing a hedging program limit the use of financial futures by agricultural lenders.

Organization of the Study

The study is organized into six chapters. The next chapter provides a discussion of futures markets and the theory of hedging along with examples of how a financial institution might execute a hedge. Chapter III describes the method of analysis, and data used to undertake the case studies. The following two chapters analyze the effects of two hedging strategies on the portfolios of a Federal Intermediate Credit Bank and a commercial bank, respectively. The final chapter summarizes the study and offers some conclusions regarding the effectiveness of hedging strategies in reducing the interest rate risk confronting the case study institutions.
CHAPTER II
FUTURES MARKETS AND THE THEORY OF HEDGING

This chapter is divided into three sections. The first reviews the economic functions performed by futures markets. The second section discusses the development of hedging theory applied to the more traditional commodities traded on futures markets and integrates it with the hedging activities of financial institutions. The final section is intended to familiarize the reader with hedging opportunities available to financial institutions with several examples of hedging strategies under various scenarios.

Economic Role of Futures Markets

Futures markets have always performed a number of economic functions and a financial futures market is no different in this regard. The market facilitates the flow of information among decision makers. Information about prices, volume of contracts traded and market reactions to various economic factors and events provide an environment conducive to the rigors of competition. The informational flow enhances market efficiency by reducing information costs. The futures market also creates a forum for integrating buyers and sellers of diverse geographic and economic circumstances. These functions foster a competitive marketplace and reduce the potential for the development of monopoly power (60, 72).
Given the competitive nature of the futures market, it provides an ideal medium for conveying current expectations about future prices. In the case of the financial futures market it provides a continuously updated interpretation of expectations about future interest rate levels.

One of the most important economic functions performed by financial futures markets, alluded to earlier, is that of shifting interest rate risk from the financial intermediation process to the futures market. This risk transfer takes place through the process of hedging. The hedger, in this case the lending institution, shifts the risk of interest rate fluctuations to other market participants. The transfer is facilitated by the futures contracts.

The label "speculator" is generally applied to those individuals who take a position in the futures market without having an offsetting position in the cash market (27). In the financial futures market, they are the individuals willing to bear the risk of change in the level of interest rates (the price of money). These individuals buy (sell) contracts when they anticipate prices for money will increase (decrease) and then take their profit or loss, after the accuracy of their prediction has been verified over time, with an offsetting transaction. This profit seeking behavior on the part of speculators contributes to the allocative and pricing efficiency of the market as well as absorbing much of the interest rate risk the hedger wishes to avoid (27).
Hedging Theory

The risk shifting aspect of hedging is what the traditional theory centered on as set forth by Keynes and Hicks (35, 41). Hedgers enter the futures market by taking an equal and offsetting position to the one they hold in the cash market to avoid the risk of price change. This risk is then carried by the speculators who have no offsetting cash market position. However, the theory contends that in order to induce speculators to assume price risk the hedger pays a risk premium.

The traditional theory argues that hedgers enter the futures market to reduce the price risk associated with a planned sale of output or purchase of inputs. However, it suggests that hedgers are more likely to cover the price risk associated with sales than with inputs. It is argued that output in the near future is largely determined by a production process that has already begun, while producers have more control over the acquisition of inputs to begin a new production process (35). Therefore, hedgers predominantly sell futures to protect themselves from adverse price movements for their products. Speculators, on the other hand, attempt to profit by buying futures when the futures price currently prevailing is below the futures price expected to prevail later (40). In other words, a speculator who takes a long position in futures (buy) must expect that later futures prices will be above the current ones so that a profit is made when the contract is sold to close out the position.

The theory argues that under stable conditions, when cash prices are expected to remain unchanged over time, the futures price will fall
below the cash price. The difference between these two prices repre-
sents what Keynes referred to as normal backwardation (41). It is the
amount that hedgers must concede to speculators to induce them to take
on the risk of price fluctuations (35). The opposite situation, when
the futures price exceeds the cash price, is referred to as a con-
tango. This is generally due to an excess of supply that forces cash
prices to abnormally low levels. However, a contango does not preclude
the payment of a risk premium. The theory contends that the current
futures price, although above the current cash price, falls below the
expected cash price by at least the amount of normal backwardation
(74).

The Keynes-Hicks theory raised considerable controversy as to
whether or not speculators do indeed receive remuneration for risk-
taking through normal backwardation. Numerous attempts to determine if
backwardation is positive, i.e. it does provide speculators with a
premium, have provided mixed results (34, 74). This led to Working's
criticism that the Keynes-Hicks theory overemphasized the risk avoid-
ance function of hedging. Working theorized that hedging positions are
entered into with the expectation of profiting from a favorable change
in the cash and futures price relationship, and to facilitate business
decisions and reduce costs (76, 77).

Working's theory suggests that the shifting of price risk is only
an incidental benefit of hedging and provides little incentive to take
such a position (76). He argues that hedgers in fact speculate on
movements in the basis (difference between cash and futures price). In
his opinion examples of the perfect hedge, parallel movements in cash
and futures prices, have contributed to the misconception that hedging is a risk reducing strategy analogous to insurance.

Working's criticism of the traditional hedging theory grew out of his observations of futures trading in wheat, corn, and oats from 1949-1952 and from his inquiries into the hedging behavior of flour mills (77). The trading data indicated periods of losses and gains in terms of cents per bushel. However, he contends it would be wrong to assume that hedgers would take losses on the same volume of stocks as they would take gains. This contention stems from the current cash and futures price relationship which Working sees as a reliable indicator of potential gains or losses. Thus, hedgers would take a position in the futures market according to their expectations of movements in the basis. This basis speculation, rather than risk reduction is the true incentive for hedging according to Working.

The risk shifting incentive for hedging is also criticized by Working on the grounds of observed hedging behavior by flour mills. Because mills are exposed to little price risk, with their stocks and forward orders fairly well balanced, and because of the great variation of stocks and orders among mills that hedge, Working questions the applicability of the risk shifting theory (76). Rather, he sees these phenomena as evidence of the use of hedging to facilitate business operations. That is, the mills use the futures market for wheat as a means of pricing flour for sales and as a temporary substitute for the purchase of cash wheat. As for the variation among mills, he sees it as a result of the intermittent and competitive nature of flour sales. Because of diversity in the timing and amount of flour sales, different
firms will enter the market for different volumes and at different times.

One can conceivably view financial intermediaries as the flour mills of the financial market. Like their counterparts in the milling industry, financial institutions buy a commodity, transform it to a more useable form, and then sell the product. The commodity in this instance is money, which is purchased in a wide variety of volumes (e.g. deposits or bonds issued) and then pooled in appropriate sized units (e.g. loans or government securities) to meet the demand for money by the institution's customers. Furthermore, hedging can be used by lending institutions to facilitate the pricing of loans, and differences in hedging activities among institutions can in part be attributed to their varying portfolio distributions.

However, this analogy to Working's discussion of flour mills becomes strained with respect to financial institutions' exposure to price risk. Rather than having little reason to hedge price risk, there is considerable incentive for institutions to shift this risk out of the intermediation process. When assets and liabilities are mismatched in terms of liquidity and maturity, and their rate of return or cost is fixed, the lender is exposed to the risk of volatile interest rates increasing the cost of funds and eroding the value of its assets.

With the traditional theory emphasizing hedging as a risk shifting strategy and Working's theory barely acknowledging this function, the two theories appear to represent the polar extremes of interpreting the motivation for hedging. Yet, elements of both theories are applicable
to the behavior of financial institutions. Therefore, the reformulated theory of hedging by Johnson, shared with Stein, which offers a synthesis of the two theories, is more appropriate to the study of hedging by financial institutions. Johnson noted that "in general, hedging activities appear to be motivated by the desire to reduce risk, as described in traditional theory, but levels of inventory held appear to be not independent of expected hedging profits, as emphasized by Working.

Furthermore, that an individual may hold a mix of hedged and speculative positions in response to his expectations concerning absolute price changes is a practice not well explained in either traditional theory or in Working's theory" (40).

To explain the mixed hedging and speculative behavior of traders Johnson evokes the portfolio approach. The variance of expected return is used to measure risk, and it is assumed all individuals prefer less risk for a given level of return and greater return for a given level of risk. He stipulates that traders have an expected return for both hedged and unhedged stock and that the variance of these returns represents the risk associated with the positions. The hedgers problem then becomes one of determining the optimum position in the futures market such that the price risk of holding a number of units in the cash commodity and a position in the futures market is minimized (40). The problem can be stated mathematically in the following manner. The expected return is given by:

\[ E(R) = X_i U_i + X_j U_j \]  

where \( X_i \) and \( X_j \) are the trader's position in the cash and futures markets respectively and \( U_i \) and \( U_j \) are the means of the probability
distributions of returns in the two markets. The variance of return is then:

\[ V(R) = \sigma_1^2 + \sigma_j^2 + 2\rho_{1j} \sigma_1 \sigma_j \]  

(2)

where \( \sigma_1^2 \) and \( \sigma_j^2 \) represent the variance of return to the positions held in the two markets and the third term of the expression represents the covariance of return due to price changes between the cash and futures markets. As stated previously, the optimum hedge in market \( j \) is given by the \( \sigma_j^* \) which minimizes \( V(R) \). To determine this value equation (2) is differentiated with respect to \( \sigma_j^* \) and the derivative set equal to 0. Solving for \( \sigma_j^* \) yields the expression:

\[ \sigma_j^* = \frac{-\rho_{1j} \sigma_1 \sigma_j}{\sigma_j^2} \]  

(3)

This value represents the hedge position to be taken in the futures market that will minimize the variance of return for the combination \( \sigma_1^*, \sigma_j^* \).

Johnson goes on to demonstrate how the correlation coefficient, \( \rho_{1j} \), is associated with the degree of price risk reduction brought about by the hedge. By substituting \( \sigma_j^* \) into equation (2) we have \( V(R)^* \), the minimum variance of return for the combination \( \sigma_1^*, \sigma_j^* \):

\[ V(R)^* = \sigma_1^2 (1-\rho_{1j}^2) \]  

(4)

"Generally speaking the larger the (absolute) value of the correlation coefficient, the greater the reduction in price risk of holding \( \sigma_1^* \) that can be effected by carrying the hedge \( \sigma_j^* \)" (40). Johnson
measures the effectiveness of a hedge \((e)\) by the ratio of the variance of return with hedging to the variance of return with no futures position such that

\[
e = 1 - \frac{\text{V}(R)^*}{\chi_1^2 \sigma_1^2} \quad \text{or} \quad e = \rho_{1j}^2
\]

(5)

This reformulated measure of the effectiveness of a hedge is quite different from that of traditional theory where effectiveness is measured by the degree to which gains in one market are offset by losses in the other. Instead, it is measured in subjective terms as to the degree to which the trader believes the variance of return is reduced by holding the hedge combination of positions. "In other words, neither the expected nor the actual return of the combination need be equal to zero to make possible a perfectly effective hedge" (40).

Ward and Fletcher add to the basic portfolio approach of Johnson the possibility of long hedging (buying futures) (75). In their analysis, this type of hedging strategy is employed by market participants who have currently established a commitment to deliver a commodity at a future date and intend to defer purchase of the commodity until that time. In the case of a financial institution, this type of scenario would be synonymous to committing to a loan at a future date at a specific rate, but not funding it until disbursement. To hedge against having to pay more for the liabilities to support the loan if rates increased, the institution might buy CD futures. If rates do rise, the profit from the futures transaction could be used to mitigate the higher cost of issuing cash CDs. If rates fell the loss in the
futures market would be cushioned by lower cash CD rates. The additional dimension of long hedging provides financial intermediaries with another option in their portfolio decisions.

Hedging Strategies

Financial institutions may employ financial futures to reduce their interest rate risk exposure, thereby reducing the effects of unanticipated movements of interest rates on their portfolios. The gains from hedging are in the form of stabilized asset values or funding costs and they can be realized when rates are rising or falling. As such, hedging affords lenders a number of opportunities under various conditions to reduce interest rate risk exposure and the potential to increase income.

The position taken by the lender can be short or long and can involve a direct or a cross hedge. A short position refers to selling a contract and to be long is to buy a futures contract. A direct hedge is established between identical cash and futures market instruments such as 90 day CDs and 90 day CD futures. A cross hedge, on the other hand, involves using a futures contract whose interest rate is determined in a different but related market (65). One might cross hedge corporate bonds, for example, with T-bond futures.

When establishing a hedge between instruments with different maturities and face values, the hedger must maintain dollar equivalency in the cash and futures positions. Besides matching the face value of the positions in the cash and futures markets, the yield of a one basis point movement in the cash position must be matched by an equivalent
change in the futures position. The value of a one point movement is based on the coupon and maturity of the instrument. For example, the value of a one point movement in CDs or T-bills, denominated in units of $1,000,000, is $25 for a 90-day instrument, $50 for a six month instrument and $100 for a one year instrument. So, if a bank wished to hedge a $2,000,000 cash position in six month CDs with 90 day T-bill futures it would need four contracts. Similarly, hedging bonds with coupons different from the futures contract standard of 8% requires the hedge to be adjusted to account for differences in the price movements of the instruments. The price of bonds with higher coupons change more with a given change in yields than those with lower coupons.

The Short Hedge

Short hedging strategies involve selling futures contracts to protect one's position in the cash market. This type of strategy might be employed by banks or the FCS lenders to lock in the cost of funds in a rising rate environment. If rates do rise, the profit from the futures transaction can help to offset the cost of rolling over liabilities at higher rates.

An example of a short hedge to lock in the cost of funds is provided in Figure 1. On August 1, 1979 a bank issues $1,000,000 in 90 day CDs and anticipates reissuing them on November 1, 1979. To hedge against the possibility of paying a higher rate in November the bank sells one 90 day T-bill future for December delivery. On November 1 the bank would close out its futures position by purchasing a December T-bill future and reissue the CDs. Interest rates for 90 day CDs did
Figure 1  Locking in the Cost of Funds

August 1, 1979

Issue $1,000,000 in 90 day CDs at 10.69%
Sell 1 December 90 day T-bill future at 8.81%

November 1, 1979

Reissue $1,000,000 in 90 day CDs at 13.90%
Buy 1 December 90 day T-bill future at 11.83%

321 basis point movement on cash market offset by 302 point movement in futures.

Additional cost of CDs in November = 19 x $24 = $475

Figure 2  Hedging the Value of Assets

July 18, 1980

Bank holds $1,000,000 in 8% T-bonds at 80-16
Sell 10 September T-bond futures at 79-06

December 1, 1980

Bank sells $1,000,000 in 8% T-bonds at 77-02
Buy 10 Sept. T-bond futures at 75-22

3 14/32% movement in cash market offset by 3 16/32% movement in futures.
rise over this period but this rise was almost entirely offset by the gain in the futures transaction. Without hedging the reissued CDs would have cost an additional $8,025 compared to an additional $475 after hedging.

Besides increasing the cost of funds, rising interest rates can also erode the value of fixed rate assets. To hedge against this risk financial institutions can sell futures. Figure 2 demonstrates how one might hedge the price of an asset when rates are expected to rise. On July 18, 1980, our hypothetical bank is holding $1,000,000 of 8% T-bonds it plans to sell in two weeks. To protect itself from a price decline over this period the bank sells 10 September T-bond futures. Although prices fell, decreasing the value of the cash T-bonds by $34,375, the gain from buying the ten T-bond futures on August 1 provides $35,000 to more than offset the loss.

The Long Hedge

Financial institutions can also find themselves exposed to interest rate risk when rates are falling. If, for example, lenders have liabilities locked in at a high cost and rates fall, they find themselves at a disadvantage. The futures strategy to be employed in this situation is long hedging or buying futures contracts. If rates do fall the futures can be sold at a profit and the gains used to offset the cost of holding high rate liabilities.

As demonstrated in Figure 3, a bank can unlock the cost of fixed rate 90 day CDs issued at 10.9% by purchasing a 90 day T-bill contract. If rates fall, as they did between May and August of 1980, the
Figure 3 Unlocking the Cost of Liabilities

May 1, 1980

Issue $1,000,000 in 90 day CDs at 10.90%
Sell 1 September T-bill future at 9.64%

August 1, 1980

Reissue $1,000,000 in 90 day CDs at 9.91%
Sell 1 September T-bill future at 8.79%

99 basis point movement on cash market offset by 85 point movement in futures.

Cost of May CDs reduced by 85 x $25 = $2,125

Figure 4 Pre-funding Existing Assets

March 1, 1980

Purchase one 90 day T-bill yielding 15.05%
Buy 1 June 90 day T-bill future at 14.01%

June 1, 1980

90 day T-bill yield 8.00%
Sell 1 June 90 day T-bill future at 7.27%

705 basis point movement in cash market offset by 674 point movement in futures.

Cost increase to refund asset in June is reduced to $775
futures market gain in effect reduces the costs of holding the high rate CDs. Moreover, by establishing the long position in the futures market, the fixed rate cash CD was transformed into a variable rate instrument.

Another long hedging strategy is to pre-fund existing assets with futures. If an institution holds a portfolio of securities maturing over a period of declining interest rates, it may wish to reinvest that money at current rates. An alternative to be considered is the purchase of a dollar equivalent amount of futures contracts. If rates do fall between the time the hedge is enacted and reinvestment takes place, hedging profits will help lower the cost of new investments.

For example, in Figure 4 the drop in rates on 90 day T-bills was 705 basis points from March to June 1980. This translates to an additional outlay of $17,625 to buy a 90 day T-bill in June. However, the gain in the futures position offsets all but $775 of the cost increase. This allows the bank to purchase the June instrument at a price comparable to that prevailing in March.

These illustrations of various hedging strategies have emphasized avoidance of the down-side risk associated with interest rate fluctuations. On the other hand, if an institution hedges against a rise in the cost of liabilities or declining asset values due to rising interest rates and, in fact, rates declined, the gain in the cash position would be precluded by the futures position. Therefore, under a routine hedge, one in which the cash and futures positions are opposite and equal, the institution is as well off whichever way interest rates move (or even if they do not). Thus, interest rate risk (up or down)
is reduced to the extent of variations in the basis. Of course, as has been demonstrated in the above examples, the basis is likely to change, but such movements are less drastic than changes in the actual rates.

Institutions may also choose to take opposite but unequal positions in the cash and futures market. A position such as this is taken if it is observed that rate movements in a particular futures contract are more or less variable than in the cash instrument being hedged. While this type of hedge can reduce interest rate risk exposure, depending on the size of the futures position, there is a speculative element to it in that the institution hopes to accurately predict the relationship of rate changes between instruments.

This section has illustrated a number of hedging techniques which might be employed by financial institutions. The strategy selected and the instruments used to implement it will vary across institutions according to their needs and expectations. The various interest rate futures instruments available to them are described in Appendix A.
CHAPTER III

METHODOLOGY AND DATA

The objective of the study is to examine the potential application of interest rate hedging strategies by agricultural lenders. A case study approach is employed. The study evaluates the interest rate risk exposure of two agricultural lending institutions and simulates the effect that two alternative hedging strategies would have had on the performance of these institutions during a specific period of time characterized by highly variable interest rates. The two hedging strategies are the routine hedge, which involves equal but opposite positions in the cash and futures markets, and a weighted hedge employing a portfolio analysis approach to determine a risk minimizing ratio of cash and futures. The next section of the chapter briefly discusses portfolio theory and is followed by a section describing the application of this approach to hedging. The final sections of the chapter outline the procedures to achieve the objectives of the study and the sources of data used.

Portfolio Theory

Portfolio theory is generally applied to the diversification of portfolios of securities to reduce the risk associated with their return. As discussed in Chapter II, Johnson extended this theory for application to hedging in futures markets. In terms of hedging,
portfolio theory involves the diversification of a portfolio of cash and futures instruments to mitigate the risk of price changes in the cash instruments.

Portfolio theory assumes that individuals maximize their expected utility which is a function of expected return and its variance. When more than one investment is considered the covariance of return must also be included to account for the total variance of the portfolio. These three measures, expected return, variance and covariance of returns, constitute the inputs for the portfolio model.

By using the variance as a measure of risk one is implicitly assuming that the distribution of returns is symmetric. That is, negative deviations from the expected return are closely matched by positive ones. If this is not the case (i.e. if the distributions are asymmetric), the variance may not properly specify the risk associated with a given return. For example, if the distribution of expected returns for a particular investment is skewed to the right those individuals undertaking the investment would experience more frequent positive deviations from expected returns. Hence, a substantial portion of the "risk" measured by the variance would be a greater return than expected in the transaction. Therefore, in this situation the variance would tend to overestimate the risk associated with the investment (55). Markowitz suggested the use of semi-variance as a measure of risk when distributions are not symmetrical (50). This approach to the delineation of risk incorporates only negative deviations from expected return, equating all positive deviations to zero. This point about the appropriate measure of risk is particularly
Important in the application of portfolio models to hedging with financial futures. Opposite positions are established in the cash and futures markets because it is assumed that gains or losses in one market will be mirrored by the other. That is, greater or less than expected changes in the cash market will be offset by corresponding changes in the futures market. Therefore, when the objective is to minimize the variance of a portfolio of cash and futures instruments, both positive and negative deviations may represent risk. The variance, which incorporates both, appears to be the most appropriate measure of risk when applying portfolio models to hedging decisions when the objective is to minimize risk.

As mentioned previously, portfolio theory assumes a utility function \( U \) that is fully specified by expected return \( E \) and the variance of return \( V \). It is further assumed that, for all utility functions, more return is preferred to less and less variance is preferred to more. That is, the partial derivatives of the utility function with respect to expected return and variance are positive and negative, respectively. Stated mathematically:

\[
U = f(E, V) \quad \text{with} \quad \frac{\partial u}{\partial E} > 0 \quad \text{and} \quad \frac{\partial u}{\partial V} < 0
\]

Given the expected returns and the variance-covariance matrix, a portfolio analysis determines the efficient \((E-V)\) frontier. The frontier identifies the various combinations of return and risk associated with the efficient portfolios. By meeting the dual criteria of having the maximum return for a given variance and the minimum
variance for a given level of return, efficient portfolios are differentiated from inefficient ones. Decision makers then select the efficient portfolio which offers the combination of return and risk consistent with their utility function.

**Portfolio Analysis Approach to Hedging**

The portfolio approach to hedging may be directly applied to the asset side of financial institutions' balance sheets if one assumes their utility functions are characterized by expected return and variance of return. That is, a bank searches for an optimum combination of return and risk in making hedging decisions. Given the level of its holdings of cash instruments, a bank attempts to establish a position in the futures market, consistent with its expectations concerning interest rates, that reduces the risk of realizing unfavorable price changes in its cash instruments.

Alternatively, a lender might hedge its liabilities that are exposed to risk. In some instances it may be easier to identify liabilities exposed to risk. In others, a bank may wish to lock-in the cost of its funds in a rising rate environment or unlock costs when rates are falling. This type of strategy can reduce the interest rate risk exposure of both borrowers and lenders by transferring part of this risk to the futures market. In so doing, variable rate loans may become less of a threat to a borrower's cash flow position and fixed rate loans less risky for banks.

Of course, an institution should hedge only that portion of its portfolio which is exposed to interest rate risk. If, for example, a
bank hedged a portion of its portfolio for which the assets and liabilities are matched in maturity it could actually increase its risk exposure. Because the assets and liabilities can be rolled over at the same point in time, it is quite likely the spread between the return earned on the assets and the cost of the liabilities can be maintained. If, for example, the bank sold futures contracts to hedge against a rise in its cost of funds and, in fact, rates fell, the spread would be narrowed by the amount of the loss on the futures transactions. Hedging in this situation increases the institution's risk exposure by compounding the risk of changes in the spread between assets and liabilities. Therefore, it is imperative that hedging strategies only be employed when interest rate risk arises from a mismatch of the maturities of assets and liabilities or when the spread between assets and liabilities is changing.

In determining its exposure to interest rate risk, an institution uncovers the particular set of assets or liabilities that are mismatched. This set of instruments represents the given cash position of the lending institution to be hedged. The problem then becomes one of maximizing the expected return, adjusted for risk, of holding a portfolio of the particular set of cash instruments and of futures. The typical approach is to express the objective function \( \Psi \) to be maximized as

\[
\Psi = E(R) - \lambda V(R)
\]  

where \( E(R) \) and \( V(R) \) are expected return and variance of return, respectively, as described earlier in equations 1 and 2 of the discussion of Johnson's Theory of hedging, and \( \lambda \) is a risk parameter (59). Assum-
ing that lenders are risk averse requires that $\lambda$ be positive. Given
the cash market position, the problem is solved for the optimal futures
market position. By varying $\lambda$ an efficient set of portfolios can be
determined that correspond to different levels of risk aversion. These
efficient portfolios provide the greatest return for any level of risk
and the least risk for any level of return.

This study, however, places a constraint on the risk parameter.
The institutions analyzed are assumed to have no taste for risk (i.e.
$\lambda = \infty$). Under this formulation of the problem the first term in
equation (7), representing expected return, becomes insignificant and
the problem becomes one of simply determining the futures position that
will minimize the variance of a portfolio comprised of a given cash
position and futures holdings. Following Johnson's analysis, the
minimum-risk hedging ratio is determined by differentiating the
variance of return with respect to the size of the future position and
setting the derivative equal to zero. The risk minimizing ratio is
given by

$$\frac{X_j}{X_i} = - \frac{\sigma_{ij}}{\sigma_j^2}$$  \hspace{1cm} (8)

where $X_i$ and $X_j$ are the cash and futures positions, respectively,
$\sigma_{ij}$ is the covariance between cash and futures, and $\sigma_j^2$ is
the variance of the futures position. This risk minimizing ratio can
be estimated by regressing yields on the cash instruments on futures
yields. The resulting slope coefficient will equal the risk minimizing
hedging ratio.
Procedures to Achieve the Objectives of the Study

The study focuses on financial institutions serving the agricultural credit markets of Ohio. The Fourth District Federal Intermediate Credit Bank, (FICB) located in Louisville, and a relatively small rural commercial bank in Ohio were analyzed. The first objective of the study was to identify opportunities for these institutions to hedge their cash market positions with financial futures instruments. This entailed examining their respective balance sheets to determine the portion of their portfolio that is exposed to interest rate risk. The FICBs, however, insulate themselves from interest rate risk through variable rate lending. They receive funds from the Federal Farm Credit Banks Funding Corporation, formerly known as the Fiscal Agency, for lending to PCAs. These institutions then lend directly to agricultural producers in the form of short and intermediate term loans. This lending is done on a variable rate basis according to the FICB's average cost of funds. Therefore, it is determined that the objective of this institution is to minimize the variability in its cost of funds.

Another aspect of determining opportunities for hedging by both banks and FICBs is to determine how closely interest rate movements in cash instruments are matched by movements in futures contracts. This implies a correlation analysis of the rate movements of the various instruments. Correlation coefficients were calculated using the Statistical Package for the Social Sciences (SPSS) program designed for this purpose.

The second objective involves examining the difference between the portfolio analysis determined hedge and the routine hedge. Again, a
routine hedge involves taking an equal but opposite position in the futures market to that held in the cash market, while the portfolio analysis determined hedge weights the futures position to compensate for changes in the basis. A comparison of the effect on cost or revenue of these two hedging techniques with an unhedged position is the third objective. In order to meet these objectives, the appropriate futures transactions were enacted and their effects on cost and revenue analyzed and compared with the unhedged performance of the institutions during the study period.

The final objective of the study is to evaluate any factors limiting the effectiveness or use of financial futures for hedging purposes. The practical problems associated with establishing and maintaining a financial futures hedge were developed as the study progressed. These factors are more fully addressed in the conclusions of the study.

Data Sources

A detailed breakdown of the asset and liability portfolios (the balance sheets) of the two case study institutions was required to determine the extent of their interest rate risk exposure. Extensive interviews with personnel at the commercial bank and access to data on their various asset and liability portfolios provided the framework from which to establish the bank's interest rate risk profile. Detailed information on the asset and liability portfolios of the FICB as well as that institution's participation in FCS bond issues during
the period of analysis was obtained from the financial operations department of the Federal Intermediate Credit Bank of Louisville.

In order to determine the degree of correlation between the various cash and futures instruments used in the study, data on the historical price movements of the instruments was needed. The International Monetary Market Yearbook and the Statistical Annual of the Chicago Board of Trade provided data for their respective futures contracts and associated cash instruments. Additional data on cash instruments were obtained from the Wall Street Journal.

Farm Credit System institutions issue two types of securities. These are Federal Farm Credit Banks consolidated system-wide bonds and discount notes. Additional securities were issued by individual banks until 1979, but are no longer offered. Most of the currently issued securities have six or nine month maturities, but longer term bonds are also issued. Shorter term maturities (less than 13 months) are issued in multiples of $5,000 while longer term issues are denominated in multiples of $1,000. These securities are issued at par and then traded in the secondary market above or below par according to a market determined yield. Data on historical price and yield movements on a sample of these securities were obtained from the Wall Street Journal.
CHAPTER IV
ANALYSIS OF HEDGING STRATEGIES
FOR A FARM CREDIT SYSTEM LENDER

The Farm Credit System (FCS) was established to facilitate the flow of credit to the agricultural sector. Under the supervision of the Farm Credit Administration, the system provides real estate loans through the Federal Land Banks, shorter term operating loans through the Federal Intermediate Credit Banks and PCAs, and loans to cooperatives through the Banks for Cooperatives. The system generates funds, through its Funding Corporation, by issuing bonds and discount notes in the national money markets to meet the credit demand of its customers. During 1981 the FCS made $73.9 billion in loans and had total loans outstanding of $78.7 billion at year end.

This study focuses on one of the twelve Federal Intermediate Credit Banks (FICBs) providing short and intermediate term loans to agricultural producers. The FICBs, by participating in FCS bond issues, provide funds for Production Credit Associations (and to a lesser extent for other financial institutions) to make operating loans to farmers. An FICB lends funds to its Production Credit Associations (PCAs) at its average cost of funds plus a small margin to cover operating costs. The PCAs then add a margin to cover their costs to arrive at the rates they charge borrowers. The PCAs then make loans on
a variable rate basis, the rate being adjusted to reflect changes in their FICB's average cost of funds.

The FICB of Louisville provides the focal point for this analysis of hedging strategies for FCS lenders. The Louisville bank, through its PCA offices, serves the fourth Federal Farm Credit District, which covers the states of Ohio, Indiana, Kentucky, and Tennessee. During 1981, the bank's average volume of loans outstanding to PCAs and other financial institutions in these states approached $3 billion.

The generally increased level of interest rates experienced in 1981 raised the Louisville FICB's average cost of funds for the year to 13.43%, an increase of almost 2.5 percentage points over the previous year. However, this debt cost was still 22 basis points below the FICB system average for 1981. Furthermore, rather than passing the entire increase on to the PCAs and their customers, the bank reduced its margin from .75% to .25% above its cost of funds. Consequently, the average lending rate to PCAs increased from 11.73% in 1980 to 13.70% in 1981. The reduced margin also accounted for much of the decline in the bank's net income for the year (29).

While the Louisville FICB fared better than most in containing its cost of funds, it is important to note that the increase in the cost of borrowed funds accounted for 98% of the increase in total expenses for the bank between 1980 and 1981. This should not be surprising given the nature of the institution, but it does highlight the sensitivity of the institution, and the system, to volatile interest rates. Having reduced its margin to a minimum, continued upward pressure on interest rates would threaten the profitability of the bank, its PCAs and
obviously, the farmer borrowers. The intent of this analysis of interest rate hedging strategies is to provide a framework within which the bank can manage its exposure to interest rate volatility and, thereby, the exposure of other participants in the system.

**FICB Debt Portfolio Activity**

A highly volatile interest rate environment encouraged the Louisville FICB to adopt a conservative strategy with regard to its debt portfolio (29). This strategy consisted of issuing primarily six and nine month bonds, and only a limited amount of term issues throughout 1981. The objective of this strategy was to avoid having to carry relatively high rate bonds over an extended term in an uncertain interest rate environment.

The debt portfolio activity of the Louisville FICB during the period of analysis, July to December 1981, is depicted in Figure 5. All of the bonds issued had maturities of nine months or less with the exception $25 million sold at a relatively low rate in December. This would be expected given the strategy of the Bank and the fact that debt costs were at their highest levels of the year through much of the period. The variability in rates is emphasized here as well in that December debt cost represents the yearly low.

Figure 5 illustrates an inverse relationship between the cost of debt and the amount issued. That is, as interest rates on FCS bonds approached their peak in September, the amount of debt issued by the bank declined dramatically. Then, at the end of the year, as rates
Figure 5: Average Rate and Amount of Louisville FICB Participation in FCS Bond Issues, July-December 1981

Average Rate on Issues

Amount of Issues

July: $450 M.
August: $275 M.
September: $160 M.
October: $175 M.
November: $225 M.
December: $125 M.
fell rapidly, the amount of debt issued rose steadily. However, the substantial drop in rates during the fourth quarter did not elicit a similarly large response in additional debt issuance. The explanation for this occurrence is twofold. The bank made a conscious effort to reduce its investment portfolio throughout the year, and it experienced an historically high seasonal paydown from the September peak in its loan volume (29).

The total debt portfolio of the Louisville FICB, its maturity structure and average cost are shown in Table 1. The total amount of debt outstanding during the six month period hovered around $3 billion. However, one can see the effect of the seasonal paydown on the size of the debt portfolio during the final months of 1981. The effect of the bank's debt management strategy on the maturity structure of the portfolio is also shown. The average maturity of the portfolio declined steadily over the period and the proportion of debt maturing in more than one year fell significantly. The upturn in the proportion of long term debt at the end of the year is at least partially due to the decline in the total amount outstanding along with the reduction in debt issued when rates were high.

The overall effect of shortening the maturity structure of the bank's debt portfolio is to make their lending rate more susceptible to a volatile interest rate environment. By issuing bonds of various maturities and charging borrowers according to the average cost of debt the FICB attempts to dampen swings in interest rates. However, as the maturity of the portfolio becomes shorter it begins to isolate
Table 1: FICB of Louisville Debt Portfolio, 1981

<table>
<thead>
<tr>
<th>Month</th>
<th>Amount of Debt (in $, 000)</th>
<th>Average Maturity (in years)</th>
<th>Proportion Maturing In Over 1 Year (%)</th>
<th>Average Cost Of Debt (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$3,144,069</td>
<td>.98 yrs.</td>
<td>21.49%</td>
<td>13.80%</td>
</tr>
<tr>
<td>August</td>
<td>3,167,098</td>
<td>.94</td>
<td>21.39%</td>
<td>13.93%</td>
</tr>
<tr>
<td>September</td>
<td>3,145,272</td>
<td>.90</td>
<td>17.81%</td>
<td>14.10%</td>
</tr>
<tr>
<td>October</td>
<td>3,019,477</td>
<td>.89</td>
<td>16.06%</td>
<td>14.27%</td>
</tr>
<tr>
<td>November</td>
<td>2,941,153</td>
<td>87</td>
<td>16.42%</td>
<td>14.23%</td>
</tr>
<tr>
<td>December</td>
<td>2,965,388</td>
<td>87</td>
<td>17.38%</td>
<td>13.74%</td>
</tr>
</tbody>
</table>

1All figures are for the beginning of the month.
particular periods of time. That is, periods of unusually high or low rates begin to dominate the cost of the portfolio. This can be seen in Table 1 in that the bank's average debt cost rose and then declined 50 basis points over the six month period. While this was certainly less volatile than the movements in market rates, it still constitutes a considerable burden to be passed on to borrowers. Furthermore, continuing this strategy over an extended period of time would make the average cost even more variable. The analysis of hedging strategies for the FICB will demonstrate how this variability can be further dampened.

Instituting Hedging Strategies for the FICB

A major consideration in any hedging program for a financial institution is its exposure to interest rate risk. The FICB, however, negates its exposure through variable rates on its loans. The spread between their cost of funds and return on loans is always maintained because the loan rate is directly tied to the bank's cost of funds. Seemingly, this would eliminate any need to hedge. In fact, it would appear that any hedging activity might actually create interest rate risk exposure for the institution. However, this reasoning ignores the fact that all interest rate risk has been passed on to borrowers and that risk may merely resurface as increased default risk. Therefore, one might think of the FICB's objective in its hedging strategy as reducing its overall lending risk by minimizing variations in its cost of funds and, hence, its lending rate. This objective is entirely consistent with the design of the FCS. By tying its variable lending rate
to the average cost of funds, FCS lenders are endeavoring to avoid passing the wide swings of the marginal cost of funds through the system.

A short hedging strategy with respect to the FICB's debt issues would reduce fluctuations in the institution's marginal cost of funds and, in turn, further reduce variability in the average cost. In a rising rate environment a short position in futures would lower the institution's marginal cost of funds. When rates are falling, on the other hand, the hedge would result in keeping the marginal cost of funds at a higher level. At first glance this would seem to negate much of the value of a hedging program. However, there are two aspects of the hedging strategy that must be considered. The objective of the strategy is to protect the FICB and, thereby, the borrowers from adverse movements in interest rates. Presumably, the system grants loans on the basis of their borrowers' abilities to meet their debt commitments at the specified interest charge at the time of the loan. Therefore, eliminating potential gains to borrowers, in the form of lower interest payments, would not threaten their ability to repay. Furthermore, reevaluation of expectations concerning rate movements can and should take place over the life of the hedge. When market conditions indicate a sustained downward movement in the cost of funds the hedge can be lifted, allowing the institution to take advantage of new market conditions.

A long position in futures with respect to its bond issues would be inappropriate for the FICB's objective of decreasing variability in its cost of funds. If interest rates were expected to decline, a long
position could reinforce a reduction in market rates. If, however, expectations proved incorrect, a long position would compound the increase in the cost of funds. A long position with respect to the FICB's debt portfolio would represent a speculative position and, given the imperfect nature of expectations, could actually exasperate swings in the cost of funds.

Hedging Opportunities

Because there are no futures instruments based on FCS bonds, the system must explore opportunities for cross-hedging. That is, hedging with a different but related instrument. Since the Louisville FICB decided to concentrate its participation in FCS bond issues during 1981 in the system's six and nine month bonds, it would seem that a futures instrument of similar maturity would provide the most effective hedging vehicle. This would suggest the use of the 90 day treasury bill futures contract. The other actively traded futures considered in this study, T-bonds and GNMA, are based on securities which differ substantially from the FCS bonds under consideration. However, these longer term instruments will not be dismissed from the analysis at this point.

The first step in determining the appropriateness of a particular futures instrument for cross-hedging is to examine the correlations of rate movements between the securities. Table 2 shows the results of correlations between various futures instruments and FCS six and nine month bonds. The data on the FCS bonds are observations of the bid prices for these securities in the secondary market. The futures data represents settlement prices for that particular futures contract.
Table 2: Correlations Between Farm Credit System Bonds and Futures, February 1980 to June 1981

<table>
<thead>
<tr>
<th></th>
<th>Six-Month FCS Bonds</th>
<th>Nine-Month FCS Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 1981</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-Bill Futures</td>
<td>.87</td>
<td>.88</td>
</tr>
<tr>
<td>December 1981</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-Bill Futures</td>
<td>.86</td>
<td>.86</td>
</tr>
<tr>
<td>December 1981</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-Bond Futures</td>
<td>.75</td>
<td>.77</td>
</tr>
<tr>
<td>December 1981</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNMA Futures</td>
<td>.72</td>
<td>.74</td>
</tr>
</tbody>
</table>
All observations were taken on a weekly basis using Friday prices. September and December futures contracts were tracked because they were the contracts to be used for the period of analysis. To ensure a basis of comparison among all futures and cash instruments a time period was selected in which all the instruments were actively traded. This period was from February 8, 1980 to June 26, 1981.

FCS bonds are quoted on a coupon yield basis, while treasury bill futures are quoted on a discount basis. The results of correlating these yield movements after adjusting the futures to coupon equivalent yields are reported in Table 2. As the table illustrates, the correlation among the FCS bonds and the treasury bill futures were quite high and stable. The correlations with treasury bond and GNMA futures were also stable, but substantially lower.

Table 3 reports the standard deviations of FCS bonds and of the basis between FCS bonds and futures. As one can see from the table, the standard deviations of the basis are lower than that of the FCS bonds. This indicates that hedging should be successful in reducing fluctuations in interest rates. Again, the variability in the basis using T-bonds and GNMA's is greater than T-bill futures. Given the similarities between short-term FCS bonds and T-bill futures, their higher correlations and the lower standard deviation of their basis, it was concluded that treasury bill futures do indeed offer the best hedging opportunities for these FCS securities.
Table 3: Standard Deviations of Farm Credit System Bonds and Basis of Farm Credit System Bonds and Futures, February 1980 to June 1981

<table>
<thead>
<tr>
<th></th>
<th>Six-Month FCS Bonds</th>
<th>Nine-Month FCS Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FARM CREDIT SYSTEM BONDS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.31%</td>
<td>3.13%</td>
</tr>
<tr>
<td><strong>BASIS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>September 1981</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-Bill Futures</td>
<td>1.95%</td>
<td>1.78%</td>
</tr>
<tr>
<td>December 1981</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-Bill Futures</td>
<td>2.16</td>
<td>1.98</td>
</tr>
<tr>
<td>T-Bond Futures</td>
<td>2.84</td>
<td>2.60</td>
</tr>
<tr>
<td>GNMA Futures</td>
<td>2.80</td>
<td>2.56</td>
</tr>
</tbody>
</table>
Interest Rate Hedging Strategies for the Louisville FICB

Given the restrictive monetary policy of the Federal Reserve Board, continuing uncertainty of U.S. Treasury borrowing needs and substantial variability of rates in previous weeks, it would not be surprising if during June 1981, the FICB of Louisville Treasurer was experiencing some trepidation regarding future levels of interest rates. Although they were prohibited from entering into positions in the financial futures markets, the following analyses examined the potential role these markets might have played in reducing uncertainty about interest rates. Two alternative strategies will be contrasted to the actual situation as events unfolded in the second half of 1981. The first strategy will be the routine hedge which involves simply an equal and offsetting position in the futures market. The second, utilizing a portfolio analysis approach to identify an optimum hedging ratio, requires establishing an offsetting but unequal position in futures to account for variations in yield movements between the instruments.

The Routine Hedge

This section examines the effectiveness of a routine hedge in reducing the variability of monthly bond issue costs for the FICB of Louisville. Bond issues over a six month period, from July to December 1981, were examined. The starting point for the analysis is June 23, 1981. This date was chosen because it was the pricing day for the FCS July issue of bonds and one business day following the deadline for individual banks in the system to notify the fiscal agent of their desired level of participation in the issue. The basic assumption of
the analysis is that the Louisville FICB decided to lock in its bond cost at this level for the remainder of the year.

Participation in the system's July issue by the Louisville bank was known to be $450 million. In order to approximate the participation level of the bank in the five subsequent issues the total amount of the debt portfolio maturing over this period was determined. This amount was then reduced to account for the seasonal paydown experienced by the bank each year. This calculation yielded a conservative estimate of the institutions' average debt requirements of $235 million per month.

The appropriate size of the futures market position depends on matching not only face value but dollar equivalence of yield movements in the two markets as well. The strategy employs 90 day T-bill futures contracts to hedge anticipated issues of six and nine month FCS securities. Therefore, the futures position must be weighted to account for the different maturities of the instruments in question. For the purposes of this study, it is assumed that the FICB will continue to issue six and nine month bonds in roughly the same proportion as in July. This would require approximately 2.4 T-bill futures contracts for each $1 million of six and nine month bonds issued to maintain dollar equivalence in the positions.

In order to lock in its cost of funds, the FICB would sell 90 day T-bill futures contracts. The two nearest term contracts that extend over the period of analysis are the September and December 1981 futures contracts. The September contract will be used to offset the cost of
bond issues for the first three months of the period and December for the final quarter of the year.

On June 23, 1981 the hedge is instituted. The FICB sells 2,228 September T-bill futures and 1,692 December contracts to stabilize its cost of funds for the remainder of the year. All contracts were sold on the IMM. The market index price for September contracts was 87 (13%) and December's price was 87.59 (12.41%). The 3,920 futures contracts sold on June 23 require a margin deposit of $7,840,000. The funds for the margin deposit can be covered by either cash or treasury bills. This study assumes that the FICB would choose the latter option, essentially eliminating the opportunity cost that would be associated with a cash margin deposit. However, any margin calls resulting from futures losses while the hedge is in place would require cash deposits, and could represent a substantial opportunity cost.

The futures position is retired by purchasing contracts as bonds are issued each month. For each $1 million of six and nine month bonds issued the bank would buy back two and three futures contracts respectively. All bond issues for July through September are hedged using September futures contracts, with the entire September futures position being retired on September 1. Similarly, bond issues for the fourth quarter of 1981 are hedged by selling December contracts.

\[\text{September contracts} = 1,100 + (2 \times 235 \times 2.4) = 2,228.\]
\[\text{December contracts} = (3 \times 235 \times 2.4) = 1,692.\]
Because FCS bonds are quoted at coupon rates and T-bill futures on a discount basis, additional computations must be made to determine the effect of the hedge on bond yields. This exercise involved converting the coupon rate of the bonds to a discount yield, deducting the appropriate number of basis points to reflect the profit from the futures transaction and converting back into a coupon rate. For example, the coupon rate on six month bonds issued in July 1981 was 15.80% which corresponds to a discount yield of 14.46%. The gain from the futures transaction was 59 basis points, less 2 points to account for the cost of a round turn in the market (assumed constant at $50). The 57 point profit from futures results in a discount yield of 13.89% on the six month bonds. This rate translates into a coupon yield equivalent of 15.13%. Similar calculations were carried out to determine the after hedge cost of funds for each of the bond issues over the period of analysis.

The results of the futures transactions are depicted in Table 4. As the table illustrates, the transactions themselves proved quite profitable. On July 1 the bank purchased 1,100 September contracts to offset the cost of the month's bond issue at a discount rate of 13.59%. This represents a basis point gain of 59 points over the earlier selling price of 13.00%. Again, the basis point gain reported in column 4 deducts two points or $50 from the total basis point movement to account for transactions costs. The product of the number of contracts purchased times the basis point gain, multiplied by $25 (the value of one basis point) results in a profit of $1,567,500 from the transaction. Having offset its position in September futures by 1,100
### Table 4: Profits from Futures Transactions

<table>
<thead>
<tr>
<th></th>
<th>(1) 6 Month Bonds ($,000,000)</th>
<th>(2) 9 Month Bonds ($,000,000)</th>
<th>(3) Contracts Purchased</th>
<th>(4) Basis Pt. Gain¹</th>
<th>(5) Profit (Cols.3X4X$25)</th>
<th>(6) Margin Withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$250</td>
<td>$200</td>
<td>1,100</td>
<td>57</td>
<td>$1,567,500</td>
<td>2,200,000</td>
</tr>
<tr>
<td>August</td>
<td>175</td>
<td>100</td>
<td>650</td>
<td>191</td>
<td>3,103,750</td>
<td>1,300,000</td>
</tr>
<tr>
<td>September</td>
<td>80</td>
<td>80</td>
<td>478</td>
<td>219</td>
<td>2,617,050</td>
<td>956,000</td>
</tr>
<tr>
<td>October</td>
<td>50²</td>
<td>125</td>
<td>408</td>
<td>260</td>
<td>2,652,000</td>
<td>816,000</td>
</tr>
<tr>
<td>November</td>
<td>150</td>
<td>75</td>
<td>1,284</td>
<td>6</td>
<td>192,600</td>
<td>2,568,000</td>
</tr>
</tbody>
</table>

¹Two basis points deducted to account for cost of round turn.

²Reopening of 8/3/81 issue due 12/1/81.
contracts the bank can reduce its margin deposit by $2,200,000 (1,100 x $2,000). Similarly, on August 3, the FICB buys 650 September futures at 14.93% to cover its issue of $275 million in short-term bonds. The profit and the margin requirement for those contracts can now be withdrawn from the institution's account. At this point in time the bank has recovered $8,171,250 in profits and margin withdrawals. By withdrawing these funds as the futures position is retired, they quickly recouped the use of the funds of the initial $7,840,000 margin deposit.

On September 1, the remaining 478 September contracts were bought back at 15.21%. These contracts are more than sufficient to offset the $160 million bond issue that month. The additional 78 contracts contributed to the substantial profit from the transaction allowing for a further reduction in bond costs.

The remainder of the bank's futures position is in December T-bill contracts. On October 1, 408 contracts were bought at 15.03%. The 260 basis point gain translates into a profit of $2,652,000. To offset the cost of $125 million in nine month bonds 375 contracts were purchased. As noted in the table, the $50 million in the six month bonds column represents a reopening of a previous six month issue. This issue matures in two months so only 33 contracts, or two thirds of the face value issued, are required to hedge the reopening.

At this point in time it might have appeared that interest rates had peaked and were starting to decline. Rates on T-bills at auction and in the secondary market had steadily declined from their highs during the summer. The yields on FCS securities in the secondary market had also declined markedly. These trends continued downward through the month of
October to levels below what they had been at the end of June. In addition, the discount rate on the December futures contracts declined almost continuously from the peak level on October 1. Finally, the bank's bond cost for November was determined on October 27 as 15.25%, well below the July issue rate when the hedge was instituted.

These circumstances would have certainly caused them to reevaluate their expectations about the levels of interest rates and to consider lifting the hedge. The final factor which would have certainly affected this decision was the 99 basis point drop in yields on December futures contracts during the final week in October.

For the purposes of the analysis this drop in rates to 12.49% on October 30 was sufficient to trigger lifting the entire hedge. At this point the 1,284 remaining contracts were purchased at a gain of six basis points. While hedging the $225 million in bonds issued that month would have required buying only 525 contracts, the entire position was closed out and the profit directed toward lowering the bond cost. The additional 759 contracts bought further reduced the average rate for November's issue.

If, in fact, the hedge had been maintained until November 2, the issue date for the bonds, the FICB would have purchased the contracts at 12.57%. This would have yielded a 14 basis point gain and an even larger profit from the futures transaction. However, in the interest of maintaining as realistic a simulation as possible the 12.49% rate of October 30 was deemed sufficient to warrant lifting the hedge.

While closing the futures position at the first sign of potential losses seems to violate the basic premise of hedging, the particular
circumstances of the situation warranted such action. First, yields on cash T-bills had been declining for some time. In addition, yields in the futures market, after lagging behind the cash market, had begun to decline rapidly during October. And, perhaps most importantly, the actual issue rate on November bonds was known to be substantially below July's rate. If rates had suddenly turned upward during November or December a new hedge position could have been established to once again lock in rates near July levels. Under different circumstances a decline in the futures yield to 12.49% might not have justified lifting the hedge, but in this instance it was one of a number of factors that contributed to the decision.

The effect of the profits from the futures transactions on monthly bond costs for the period will now be considered. The total amount of bonds issued each month, their actual cost and their cost after hedging, are presented in Table 5. These rates represent the average paid on the entire issue plus a selling commission of .1%. As one can see from the table, the average rate paid for bonds was substantially reduced by hedging. The average weighted cost of debt from July to November was reduced from 16.41% to 14.81% by the hedging transactions. As discussed previously, closing out the September futures position more than offset the rate in the cash market for that month. Buying only 400 contracts would have compensated for the rate increase of $160 million of six and nine month bonds. Disregarding the rate reduction brought about by the additional 78 contracts purchased, September's issue rate would have been 15.25%. Similarly, November's rate would have been higher had the December futures position not been closed out. If only 525 December
Table 5: Louisville FICB Participation in FCS Bond Issues and Average Coupon Rate Before and After Hedging

<table>
<thead>
<tr>
<th>Month</th>
<th>Bonds Issued (in millions)</th>
<th>Average Coupon Rate(^1)</th>
<th>Average Coupon w/Hedge(^1)</th>
<th>Reduction from Hedging</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$450</td>
<td>15.93%</td>
<td>15.24%</td>
<td>.69%</td>
</tr>
<tr>
<td>August</td>
<td>275</td>
<td>17.21</td>
<td>14.88</td>
<td>2.33</td>
</tr>
<tr>
<td>September</td>
<td>160</td>
<td>17.96</td>
<td>14.74</td>
<td>3.22</td>
</tr>
<tr>
<td>October</td>
<td>175</td>
<td>16.45</td>
<td>13.35</td>
<td>3.10</td>
</tr>
<tr>
<td>November</td>
<td>225</td>
<td>15.25</td>
<td>15.08</td>
<td>.17</td>
</tr>
<tr>
<td>December</td>
<td>325</td>
<td>11.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Average coupon rates include .1% concession to sellers.
futures had been purchased to cover the November issue the average cost plus concession would have been 15.19%. The important point here is that even though the number of futures contracts needed to hedge bond issues was overestimated, the results of the routine hedging strategy were very effective at maintaining bond costs at July levels.

It is not possible for any institution to predict with certainty its future levels of debt needs and hence the size of its futures position. In this particular case there was an overestimation of the number of contracts needed. However, the overestimation was not large considering that, had rates remained high, approximately 525 contracts would have been needed to offset the cost of short-term bonds in December. This suggests that the approach used in the study provides a good rule of thumb for the bank. Furthermore, more intimate knowledge of the institution's debt portfolio activity could certainly improve upon this method and its resulting estimates.

**Portfolio Analysis Determined Hedge**

The portfolio analysis approach to hedging determines an optimum ratio of cash to futures that will minimize the variance of the overall portfolio. By examining historical rate movements between the cash and futures instruments involved in a hedge, this approach attempts to compensate for different rates of change in yields between the two markets. The futures position established in the hedge is then weighted accordingly to reflect any difference in the rate of change.

As discussed previously, the optimum hedging ratio between a cash and futures instrument can be estimated by regressing the yield of the cash instrument on the futures yields. The same set of observations
used to determine correlations and standard deviations earlier was employed in the regressions. The discount rates on T-bill futures were adjusted to their coupon equivalent to match the yield quotes on the FCS securities.

The slope coefficients of the regressions, representing the risk minimizing hedging ratios, are presented in Table 6. The results of the regressions imply that yields on FCS securities in the secondary market tend to move more than the T-bill futures rate. This suggests that the futures position must be larger than what is required to maintain dollar equivalence in order to completely offset rate changes in the cash instruments. For example, slightly more than 1.5 times the number of futures contracts used in the routine hedge would be needed to hedge $1 million in FCS nine month bonds. Since all the slope coefficients are substantially larger than one, the number of contracts sold under this hedging strategy will be substantially larger than for the routine hedge.

The futures positions established under the routine hedge must be increased to reflect the differences in rate changes. The average of hedging ratios suggested by the regressions will be used for this purpose. The average ratios for hedging six and nine month bonds with September futures are 1.65 and 1.54 respectively. Again assuming that six and nine month bonds will be issued in approximately a 3:2 ratio over the period, the September futures position must be increased approximately 1.6 times. Similarly, the December futures position must be increased by a factor of 1.8.
Table 6: Risk Minimizing Hedging Ratios

<table>
<thead>
<tr>
<th></th>
<th>Six-Month FCS Bonds</th>
<th>Nine-Month FCS Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>September 1981</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-Bill Futures</td>
<td>1.65</td>
<td>1.54</td>
</tr>
<tr>
<td><strong>December 1981</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-Bill Futures</td>
<td>1.86</td>
<td>1.73</td>
</tr>
</tbody>
</table>

Table 7: Profits From Futures Transactions and Effect On Average Cost of Bonds Issued

<table>
<thead>
<tr>
<th></th>
<th>(1) Contracts Purchased</th>
<th>(2) Basis Point Gain</th>
<th>(3) Profit (Cols.1X2X$25)</th>
<th>(4) Average Coupon After Hedge</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>1,749</td>
<td>57</td>
<td>$2,492,325</td>
<td>14.83%</td>
</tr>
<tr>
<td>August</td>
<td>1,040</td>
<td>191</td>
<td>4,966,000</td>
<td>13.50</td>
</tr>
<tr>
<td>September</td>
<td>765</td>
<td>219</td>
<td>4,188,375</td>
<td>12.84</td>
</tr>
<tr>
<td>October</td>
<td>715</td>
<td>260</td>
<td>4,647,500</td>
<td>11.01</td>
</tr>
<tr>
<td>November</td>
<td>2,331</td>
<td>6</td>
<td>349,650</td>
<td>14.94</td>
</tr>
</tbody>
</table>

1Two basis points deducted to account for cost of round turn.

2Average coupon rate includes .1% concession to sellers.
On June 23 the weighted hedge is instituted by selling 3,554 September T-bill futures and 3,046 December T-bill contracts. The futures position is then retired as before, except that additional contracts are purchased each month to account for the weighted position. The results of the hedging transactions under this strategy and their effect on average monthly bond cost are presented in Table 7.

As expected, the profit from the futures transactions and subsequent reduction in monthly issue cost exceed the routine hedge case in proportion to the weighting factors used. However, rather than holding the monthly cost of debt issued fairly stable, this hedging strategy greatly reduced debt costs through October. The basis point gain from the futures in November was small and, despite closing out the position, that month's debt issue was at a much higher rate than the others. Still, the overall reduction from the actual issue cost was 1.8 times the reduction from routine hedging.

Comparison of Results

In order to estimate the effects of hedging on the Louisville FICB lending rate through the period, the monthly issue rates after hedging were substituted for the actual rates. Data on the total amount of debt outstanding and the average cost of the portfolio were provided by the financial operations office of the Louisville FICB. The amount and cost of each month's new issue was then deducted from the total portfolio to determine an average rate for the remainder. Averaging this value with the monthly debt issues and their rates after hedging provided an estimate of the new cost of the debt portfolio. For
example, on July 1 the total debt outstanding was $3,144,069,000 with an average rate of 13.8%. Of this total, $450,000,000 was acquired that month at a rate of 15.93% implying that the remainder, $2,694,069,000, had an average rate of 13.44%. Stated mathematically:

\[ 2,694,069,000(X) + 450,000,000(.1593) = 3,144,069,000(.138) \]  (9)

Then by substituting the after hedging rate on July bonds (14.83%) for the actual rate, an average cost for the portfolio after hedging is determined:

\[ 2,694,069,000(.1344) + 450,000,000(.1483) = 3,144,069,000 \]  (10)

Then by substituting the after hedging rate on July bonds (14.83%) for the actual rate, an average cost for the portfolio after hedging is determined:

\[ 2,694,069,000(.1344) + 450,000,000(.1483) = 3,144,069,000 \]

\[ Y = .1364 \]

The effect of hedging on the total cost of funds in subsequent months was calculated in a similar fashion. In December $50,000,000 of the October issue matured. Therefore, October's contribution to the total portfolio in December was adjusted accordingly.

The results of these calculations provided estimates of the institution's average cost of funds each month under both the routine and portfolio hedging strategies. The FICB's operating margin of .25% was added to the average cost of funds in each instance to arrive at the monthly lending rate. Table 8 presents a comparison of the bank's actual lending rates and the lending rates under the alternative hedging strategies for the period of analysis.

The average reduction in the lending rate over the six month period was .48% and .78% for the routine and weighted hedges respectively. These rate reductions represent a considerable savings to the institution's borrowers. A 78 basis point reduction in the cost of the $3
Table 8: Changes in FICB Lending Rate After Hedging

<table>
<thead>
<tr>
<th>Month</th>
<th>Actual Lending Rate</th>
<th>Rate After Routine Hedge</th>
<th>Rate After Weighted Hedge</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>14.05</td>
<td>13.95</td>
<td>13.89</td>
</tr>
<tr>
<td>August</td>
<td>14.18</td>
<td>13.88</td>
<td>13.70</td>
</tr>
<tr>
<td>September</td>
<td>14.35</td>
<td>13.89</td>
<td>13.61</td>
</tr>
<tr>
<td>October</td>
<td>14.52</td>
<td>13.85</td>
<td>13.43</td>
</tr>
<tr>
<td>November</td>
<td>14.48</td>
<td>13.78</td>
<td>13.34</td>
</tr>
<tr>
<td>December</td>
<td>13.99</td>
<td>13.35</td>
<td>12.95</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Ave. Mo. Change</th>
</tr>
</thead>
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<tr>
<td></td>
<td>14.26</td>
<td>.22</td>
<td>.20</td>
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<tr>
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<td>13.78</td>
<td>.22</td>
<td>.12</td>
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<tr>
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<td>13.49</td>
<td>.33</td>
<td>.19</td>
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</tbody>
</table>
billion debt portfolio would have been almost $12 million over six months, or about half of the FICB's reported net earnings for the year. During 1981, the Louisville district experienced an unprecedented level of charge-offs among its PCAs. While it is not possible in this study to determine the degree to which rising interest rates contributed to this problem, it does appear that hedging would have insulated the institution from any repayment problems stemming from mounting pressure on borrowers' cash flow positions caused by rising interest rates during the period of analysis.

Although the profits from the futures transactions resulted in substantially reduced lending rates, the benefits of the hedging strategies are not fully captured in Table 8. The profits, accrued monthly, are available for investment until the particular issue matures. This provides the institution with the opportunity to generate additional revenues. Another benefit of hedging not depicted in the table is its effect on the FICB's lending rate beyond the period of analysis. Most of the bonds issued under the hedges will remain in the portfolio for several months after December and will continue to reduce the average cost of debt until they mature.

Another interesting feature of Table 8 is the difference in trends among the three scenarios. While the actual lending rate increased through most of the period, the routine hedge rate remained quite stable and the rate under the weighted hedge strategy declined. These trends are not surprising given the effect of the hedging strategies on the monthly cost of bonds, but they are inconsistent with the analysis of rate movements between the cash and futures markets.
The results of the regression analysis suggested that rates on the cash instruments changed more rapidly than futures. This would imply that a routine hedge would only dampen changes in FCS bond rates and that the position would have to be weighted to fully offset the movements. Yet, the analysis of the two strategies obtained a very different result. The routine hedge was quite effective in stabilizing the institution's lending rate between July and November when the hedge was in place, while the weighted hedge overcompensated for rate changes and actually increased the variability of the lending rate.

However, it is interesting to note at this point the ratios of the actual rate change in FCS bonds and in December T-bill futures over the entire period. From July 1 to December 1 these ratios were 1.82 and 1.78 for six and nine month bonds respectively, consistent with the regression estimates for these instruments reported in Table 6. It would appear, then, that for the entire period the portfolio analysis estimates were quite accurate, but were less reliable in the short run.

Because the routine hedge strategy proved so effective over a period of predominantly rising rates suggests that the direction of rate movements affected the basis. To examine this possibility the difference between cash and futures yields (basis) were regressed on the futures yields. The results of these regressions suggest that as futures rates increase the basis strengthens and as rates fall the basis weakens. This implies that as rates rose from July through September the difference between the cash and futures yields would have become more positive (wider). Such circumstances would tend to reduce the effectiveness of a
routine hedge position because cash rates would be increasing faster than futures.

As Figure 6 illustrates, the basis did strengthen (become wider) from July to September as rates increased and weakened thereafter as rates fell. However, the basis with September T-bill futures strengthened very little. Further, because the hedge was instituted on the pricing day for the July FCS bond issue and a basis point gain was realized between June 23 and July 1, the slight strengthening of the basis was offset resulting in a very effective routine hedge.

After September 1, the December T-bill futures contract became the hedging vehicle. As the graph shows the futures position continued to gain basis points through the month of September while cash yields fell sharply. The divergence in the two markets accounts for the large reduction in October bond costs after hedging. The futures market then came back into line with cash yields during October. As discussed earlier, FCS bond yields were well below July levels in November, but futures were still exhibiting a basis point gain. At that point the hedge was lifted and cash yields further lowered.

It appears, then, that the particular set of circumstances in this period of analysis resulted in an effective routine hedge. However, this does not suggest that a routine hedging strategy would always be as effective as it was in this case. Furthermore, the decision to lift the hedge was also dependent on the particular situation that existed during the period. In general, the futures position would not still exhibit a profit when cash yields are well below the level at which the hedge was instituted.
Figure 6: Average Rates on FCS Bonds and T-Bill Futures, July-December 1981

Percent

FCS Bonds

Sep. Fut.

Dec. Fut.

Coupon Rates

July August September October November December
An important consideration in this analysis is the size of the futures position required to hedge the FICB's debt issues. Because of the number of contracts sold, both hedging strategies required very large margin deposits. Although the initial margins can be covered by government securities, any additional deposits required because of losses in the futures position must be made in cash. If interest rates had moved the opposite way during the period of analysis, the substantial profits reported in Tables 4 and 7 would have been losses requiring large cash deposits into the margin account. While losses on a large futures position can pose a liquidity problem, they can also limit the effectiveness of the hedge. A loss on a short futures position resulting from a drop in rates must be covered immediately, while the gain from a lower bond cost is not realized until the issue date. The foregone earnings on this cash can represent a considerable opportunity cost, particularly if the losses occur early in the hedge, and can affect the cost of the bonds.

Another critical consideration with regard to the size of the institution's futures position is the liquidity of the T-bill futures market. Under the routine hedging strategy the September futures position represented 13% of the market's open interest, while the December position was 20%. The FICB's positions became an even larger proportion of the market under the portfolio analysis determined hedge. Obviously, the futures markets were not capable of absorbing the large numbers of contracts used in the study. Moreover, this is only one of thirty-seven banks in a system with total outstanding bonds of about $70 billion.
However, this should not necessarily preclude the use of interest rate futures by the FCS. Hedging bond issues over a shorter period than six months would require substantially fewer contracts. Participating in long term issues, as other members of the system do, would allow the FICB to spread its position over additional futures instruments such as T-notes and T-bonds. In addition, they would probably hedge only a small portion of their debt issues to offset rate movements for a part of their loan portfolio. This would allow the FICB or other Farm Credit System lenders to use futures to expand the range of services it offers customers. By hedging a portion of its debt portfolio it could provide a choice between variable and fixed rate loans. This could prove very beneficial to borrowers who are less willing or able to absorb the risk associated with variable rate loans. Moreover, hedging a portion of their portfolio would be especially applicable for the Banks for Cooperatives because many of their credit lines are large enough to permit tailoring of a hedged loan plan to the needs of individual borrowers. As such, there are a number of opportunities for the FICB and other Farm Credit System lenders to utilize interest rate futures in a manner that would make the margin and market liquidity constraints less binding.
Although interest rate futures markets have existed for several years very few commercial banks participate in these markets. The major objectives of this analysis are to determine if hedging with interest rate futures instruments is a viable alternative for commercial banks to manage interest rate risk, and to identify factors that might be limiting the use of futures by banks. To address these objectives a case study of a commercial bank was undertaken.

Description of the Bank

The study focuses on a commercial bank located in northwestern Ohio. The institution has a sizable agricultural loan portfolio and is one of the major agricultural lenders in the region. It had assets in excess of $140 million through the period of analysis (July-December 1981).

The commercial and retail loan portfolios, along with the securities portfolio of the institution, are presented in Tables 9 to 11. The figures in these tables represent average monthly balances and the rates earned on the different assets comprising these portfolios from July through December 1981. As Table 9 shows the total commercial loan portfolio exhibited modest growth through the period. However, much of
Table 9: Case Bank Commercial Loan Portfolio

<table>
<thead>
<tr>
<th>Month</th>
<th>Real Estate</th>
<th>Agricultural</th>
<th>Collateral</th>
<th>Personal</th>
<th>Installment</th>
<th>Commercial</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount</td>
<td>Amount</td>
<td>Amount</td>
<td>Amount</td>
<td>Amount</td>
<td>Amount</td>
<td>Amount</td>
<td>Amount</td>
</tr>
<tr>
<td>July</td>
<td>$6,352</td>
<td>$4,264</td>
<td>$1,409</td>
<td>$1,520</td>
<td>$1,649</td>
<td>$21,206</td>
<td>$1,751</td>
<td>$38,151</td>
</tr>
<tr>
<td></td>
<td>(10.1%)</td>
<td>(19.2%)</td>
<td>(19.4%)</td>
<td>(17.6%)</td>
<td>(12.9%)</td>
<td>(17.7%)</td>
<td>(10.2%)</td>
<td>(16.1%)</td>
</tr>
<tr>
<td>August</td>
<td>6,332</td>
<td>5,133</td>
<td>1,409</td>
<td>1,532</td>
<td>1,614</td>
<td>20,882</td>
<td>1,880</td>
<td>38,782</td>
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<td>(12.9)</td>
<td>(18.0)</td>
<td>(8.3)</td>
<td>(16.3)</td>
</tr>
<tr>
<td>September</td>
<td>6,413</td>
<td>5,520</td>
<td>1,451</td>
<td>1,645</td>
<td>1,586</td>
<td>20,589</td>
<td>1,862</td>
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<td>(18.0)</td>
<td>(13.4)</td>
<td>(18.3)</td>
<td>(12.5)</td>
<td>(16.8)</td>
</tr>
<tr>
<td>October</td>
<td>6,361</td>
<td>5,973</td>
<td>1,405</td>
<td>1,636</td>
<td>1,534</td>
<td>20,307</td>
<td>1,899</td>
<td>39,115</td>
</tr>
<tr>
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<td>(10.0)</td>
<td>(19.7)</td>
<td>(20.0)</td>
<td>(18.0)</td>
<td>(13.2)</td>
<td>(17.6)</td>
<td>(10.9)</td>
<td>(16.3)</td>
</tr>
<tr>
<td>November</td>
<td>6,300</td>
<td>6,229</td>
<td>1,379</td>
<td>1,713</td>
<td>1,467</td>
<td>20,827</td>
<td>1,353</td>
<td>39,268</td>
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<td>(13.0)</td>
<td>(17.4)</td>
<td>(10.2)</td>
<td>(16.2)</td>
</tr>
<tr>
<td>December</td>
<td>6,371</td>
<td>6,557</td>
<td>1,383</td>
<td>1,778</td>
<td>1,401</td>
<td>20,857</td>
<td>1,206</td>
<td>39,554</td>
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<td>(10.2)</td>
<td>(18.4)</td>
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<td>(11.7)</td>
<td>(16.9)</td>
<td>(8.7)</td>
<td>(15.7)</td>
<td></td>
</tr>
</tbody>
</table>

1Amounts are in thousands of dollars.
this growth was accounted for by increases in agricultural loans. Another interesting feature of this table is that the rate earned on the commercial loan portfolio follows the basic trend of rates through the period of analysis. That is, first increasing from July through September and then declining thereafter.

A similar trend is exhibited for the retail loan portfolio in Table 10. Again, rates tend to follow the pattern for the period. However, the portfolio did experience more growth than commercial loans, and this growth was more widely distributed across loan categories.

The portfolio of the bank's management division is shown in Table 11. The table shows the amounts and rates for the various types of securities the bank holds as well as Federal Funds sold. As one can see, the level of activity in this portfolio was high relative to the others. Further, rather than following the period trend the rate of return on the portfolio tended to increase throughout the entire second half of 1981.

On the liability side of the balance sheet the bank's CD portfolio constitutes the largest proportion of deposits, and it is the proportion most susceptible to interest rate volatility. As Table 12 indicates, there was considerable growth in the bank's CD portfolio throughout the period. However, this increase was centered in large CD's, along with six- and thirty-month money market certificates. Together these accounts constitute the most interest sensitive portion of the portfolio. In addition, All Savers certificates were introduced in October 1981 and grew rapidly throughout the remainder of the period.
Table 10: Case Bank Retail Loan Portfolio
Amount\(^1\) and Yield

<table>
<thead>
<tr>
<th>Month</th>
<th>Credit Card</th>
<th>Overdraft</th>
<th>Real Estate</th>
<th>Collateral</th>
<th>Student</th>
<th>Personal</th>
<th>Installment</th>
<th>Commercial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$1,818</td>
<td>$387</td>
<td>$22,396</td>
<td>$100</td>
<td>$1,818</td>
<td>$1,577</td>
<td>$18,183</td>
<td>$955</td>
<td>$47,322</td>
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<tr>
<td></td>
<td>(15.7%)</td>
<td>(18.4%)</td>
<td>(10.1%)</td>
<td>(18.3%)</td>
<td>(24.8%)</td>
<td>(14.7%)</td>
<td>(14.7%)</td>
<td>(15.7%)</td>
<td>(13.0%)</td>
</tr>
<tr>
<td>August</td>
<td>1,883</td>
<td>414</td>
<td>22,593</td>
<td>157</td>
<td>2,039</td>
<td>1,823</td>
<td>18,306</td>
<td>901</td>
<td>48,116</td>
</tr>
<tr>
<td></td>
<td>(14.8%)</td>
<td>(20.3%)</td>
<td>(9.9%)</td>
<td>(22.2%)</td>
<td>(14.2%)</td>
<td>(14.6%)</td>
<td>(14.9%)</td>
<td>(12.9%)</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>1,913</td>
<td>430</td>
<td>22,965</td>
<td>197</td>
<td>2,157</td>
<td>1,711</td>
<td>18,454</td>
<td>822</td>
<td>48,649</td>
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<tr>
<td></td>
<td>(15.4%)</td>
<td>(17.0%)</td>
<td>(10.1%)</td>
<td>(18.8%)</td>
<td>(24.6%)</td>
<td>(14.9%)</td>
<td>(14.9%)</td>
<td>(13.4%)</td>
<td>(13.1%)</td>
</tr>
<tr>
<td>October</td>
<td>1,928</td>
<td>438</td>
<td>23,242</td>
<td>200</td>
<td>2,199</td>
<td>1,753</td>
<td>19,115</td>
<td>798</td>
<td>49,673</td>
</tr>
<tr>
<td></td>
<td>(16.3%)</td>
<td>(17.7%)</td>
<td>(10.0%)</td>
<td>(18.9%)</td>
<td>(24.7%)</td>
<td>(14.6%)</td>
<td>(14.9%)</td>
<td>(13.8%)</td>
<td>(13.1%)</td>
</tr>
<tr>
<td>November</td>
<td>1,820</td>
<td>452</td>
<td>23,462</td>
<td>194</td>
<td>2,211</td>
<td>1,715</td>
<td>19,198</td>
<td>778</td>
<td>49,830</td>
</tr>
<tr>
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<td>(15.2%)</td>
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<td>(10.2%)</td>
<td>(18.8%)</td>
<td>(26.4%)</td>
<td>(14.4%)</td>
<td>(14.7%)</td>
<td>(15.6%)</td>
<td>(13.2%)</td>
</tr>
<tr>
<td>December</td>
<td>1,843</td>
<td>455</td>
<td>23,516</td>
<td>190</td>
<td>2,195</td>
<td>1,806</td>
<td>19,168</td>
<td>774</td>
<td>50,007</td>
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<tr>
<td></td>
<td>(15.4%)</td>
<td>(20.5%)</td>
<td>(10.2%)</td>
<td>(18.2%)</td>
<td>(25.8%)</td>
<td>(13.9%)</td>
<td>(14.9%)</td>
<td>(15.2%)</td>
<td>(13.2%)</td>
</tr>
</tbody>
</table>

\(^1\) Amounts are in thousands of dollars.
Table 11: Case Bank Securities Portfolio

<table>
<thead>
<tr>
<th>Month</th>
<th>U.S. Government</th>
<th>Other Taxable</th>
<th>Municipal (tax. equiv.)</th>
<th>Total Securities</th>
<th>Fed. Funds Sold</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>July</td>
<td>$7,901</td>
<td>$3,622</td>
<td>$22,002</td>
<td>$33,525</td>
<td>$1,014</td>
<td>$34,599</td>
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<td>(17.0%)</td>
<td>(8.5%)</td>
<td>(15.4%)</td>
<td>(15.0%)</td>
<td>(18.4%)</td>
<td>(15.1%)</td>
</tr>
<tr>
<td>August</td>
<td>7,901</td>
<td>3,844</td>
<td>22,352</td>
<td>34,091</td>
<td>904</td>
<td>35,001</td>
</tr>
<tr>
<td></td>
<td>(17.0%)</td>
<td>(9.8%)</td>
<td>(16.0%)</td>
<td>(15.5%)</td>
<td>(17.3%)</td>
<td>(15.6%)</td>
</tr>
<tr>
<td>September</td>
<td>7,900</td>
<td>4,011</td>
<td>22,434</td>
<td>34,345</td>
<td>2,177</td>
<td>36,522</td>
</tr>
<tr>
<td></td>
<td>(16.4%)</td>
<td>(9.6%)</td>
<td>(16.4%)</td>
<td>(15.6%)</td>
<td>(16.1%)</td>
<td>(15.6%)</td>
</tr>
<tr>
<td>October</td>
<td>7,899</td>
<td>4,244</td>
<td>22,180</td>
<td>34,323</td>
<td>1,706</td>
<td>36,029</td>
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<tr>
<td></td>
<td>(16.9%)</td>
<td>(10.5%)</td>
<td>(17.0%)</td>
<td>(16.2%)</td>
<td>(15.4%)</td>
<td>(16.2%)</td>
</tr>
<tr>
<td>November</td>
<td>8,086</td>
<td>3,760</td>
<td>23,207</td>
<td>35,053</td>
<td>413</td>
<td>35,466</td>
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<tr>
<td></td>
<td>(16.3%)</td>
<td>(10.9%)</td>
<td>(17.2%)</td>
<td>(16.3%)</td>
<td>(13.9%)</td>
<td>(16.3%)</td>
</tr>
<tr>
<td>December</td>
<td>9,082</td>
<td>3,389</td>
<td>24,508</td>
<td>36,979</td>
<td>5,944</td>
<td>42,923</td>
</tr>
<tr>
<td></td>
<td>(16.7%)</td>
<td>(11.5%)</td>
<td>(17.6%)</td>
<td>(16.8%)</td>
<td>(12.6%)</td>
<td>(16.2%)</td>
</tr>
</tbody>
</table>

1Amounts are in thousands of dollars.
Table 12: Case Bank CD Portfolio Amount\(^1\) and Cost

<table>
<thead>
<tr>
<th>Month</th>
<th>Regular CDs</th>
<th>Variable Rate</th>
<th>Keogh &amp; IRA</th>
<th>Public Funds</th>
<th>Large CDs over $100,000</th>
<th>6 mo. Money Market</th>
<th>30 mo. Money Market</th>
<th>All Savers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$5,605</td>
<td>$263</td>
<td>$2,153</td>
<td>$2,370</td>
<td>$5,918</td>
<td>$31,629</td>
<td>$5,261</td>
<td>$31,629</td>
<td>$53,259</td>
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<td>(7.0%)</td>
<td>(8.9%)</td>
<td>(9.6%)</td>
<td>(15.6%)</td>
<td>(15.9%)</td>
<td>(14.3%)</td>
<td>(10.8%)</td>
<td>(13.3%)</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>5,129</td>
<td>260</td>
<td>2,145</td>
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<td>33,111</td>
<td>5,587</td>
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<td>(9.7)</td>
<td>(15.7)</td>
<td>(16.3)</td>
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<td>251</td>
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<td>2,991</td>
<td>6,064</td>
<td>33,844</td>
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<td>(15.0)</td>
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<td>(13.9)</td>
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<tr>
<td>October</td>
<td>4,415</td>
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<td>32,880</td>
<td>7,527</td>
<td>$1,290</td>
<td>57,798</td>
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<td>(9.8)</td>
<td>(14.7)</td>
<td>(14.7)</td>
<td>(15.5)</td>
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<tr>
<td>December</td>
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<td>229</td>
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<td>666</td>
<td>8,750</td>
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<td>(9.8)</td>
<td>(12.0)</td>
<td>(12.0)</td>
<td>(14.9)</td>
<td>(15.3)</td>
<td>(11.5)</td>
<td>(13.6)</td>
</tr>
</tbody>
</table>

\(^1\)Amounts are in thousands of dollars.
The remaining interest bearing deposits of the bank, N.O.W. accounts and other time deposits, remained fairly stable over the period. The average levels of these deposits are depicted in Table 13. As the table reveals, the N.O.W. account balances increased slightly over the period while the time deposits declined. Taken together, they represent a fairly constant level of deposits for the bank over the period at an interest rate of about 5 percent. The demand deposits of the bank remained fairly constant throughout the period at a level slightly in excess of $38 million.

As one can surmise, both the asset and liability portfolios of the bank are susceptible to changes in interest rates. However, the degree of rate variability as well as its timing differ among the portfolios. The result is a varying spread between the rates earned and paid on funds. The relationship for the period of analysis is shown in Table 14. While much of the variability in the spread is accounted for by varying rates of growth in the different portfolios, some portion is undoubtedly due to different rates of turnover of existing assets and liabilities. This difference in turnover gives rise to the notion of the gap, or the difference between rate sensitive assets and liabilities of the institution. In turn, the gap is central to identifying the bank's interest rate risk exposure.

**Interest Rate Risk Profile**

The first step in undertaking a hedging strategy for any institution is to identify the portions of the asset and liability portfolios that are rate sensitive over the planning horizon of the hedge. For
Table 13: Other Interest Bearing Deposits and Demand Deposits¹

<table>
<thead>
<tr>
<th></th>
<th>N.O.W. Accounts</th>
<th>Other Time</th>
<th>Demand Deposits</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$5,610</td>
<td>$25,906</td>
<td>$38,166</td>
<td>$69,682</td>
</tr>
<tr>
<td>August</td>
<td>5,879</td>
<td>24,781</td>
<td>38,768</td>
<td>69,418</td>
</tr>
<tr>
<td>September</td>
<td>6,087</td>
<td>24,312</td>
<td>38,094</td>
<td>68,493</td>
</tr>
<tr>
<td>October</td>
<td>5,982</td>
<td>24,097</td>
<td>37,495</td>
<td>67,574</td>
</tr>
<tr>
<td>November</td>
<td>6,140</td>
<td>23,290</td>
<td>38,806</td>
<td>68,236</td>
</tr>
<tr>
<td>December</td>
<td>6,361</td>
<td>23,283</td>
<td>38,079</td>
<td>67,723</td>
</tr>
</tbody>
</table>

¹Amount in thousands of dollars.
<table>
<thead>
<tr>
<th>Month</th>
<th>Interest Income</th>
<th>Interest Expense</th>
<th>Interest Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>12.34</td>
<td>6.48</td>
<td>5.86</td>
</tr>
<tr>
<td>August</td>
<td>12.57</td>
<td>6.58</td>
<td>5.99</td>
</tr>
<tr>
<td>September</td>
<td>12.94</td>
<td>6.84</td>
<td>6.10</td>
</tr>
<tr>
<td>October</td>
<td>12.84</td>
<td>7.15</td>
<td>5.69</td>
</tr>
<tr>
<td>November</td>
<td>12.83</td>
<td>7.05</td>
<td>5.78</td>
</tr>
<tr>
<td>December</td>
<td>12.99</td>
<td>6.95</td>
<td>6.04</td>
</tr>
</tbody>
</table>
the purposes of this study, the bank's planning horizon is assumed to be the six month period from July through December 1981. Given the levels of the case bank's assets and liabilities on June 30, 1981, estimates of the monthly turnover in the portfolios were determined to arrive at an interest rate risk profile for the institution (44). This profile, shown in Table 15, depicts the level of turnover in assets and liabilities and hence, the gap, for the case study institution in 30 day increments out to 180 days.

The first column on the asset side of the interest rate risk profile identifies securities that will mature over the period of analysis. These values were obtained from a listing of the case bank's securities portfolio by maturity date. While there was certainly more activity in the bank's securities portfolio, these amounts represent what the bank would have known with certainty to be turning over during the period.

The next column shows the amount of commercial loans coming due over the period as of June 30, 1981. These estimates were obtained from a random sample of the commercial loan customers of the bank conducted in December of 1982. A sample of 200 loan accounts representing 15 percent of the customers was drawn. Of this sample, 87 percent had active accounts during the period of analysis. From these account records, a profile of loans coming due from July to December 1981 was obtained. For the purposes of the analysis it was assumed that the total commercial loan portfolio would exhibit a proportional breakdown of amounts due similar to the sample.
Table 15: Case Bank Interest Rate Risk Profile June 30, 1981  
(in thousands of dollars)

<table>
<thead>
<tr>
<th>Month</th>
<th>Securities</th>
<th>Commercial Loans</th>
<th>Retail Loans</th>
<th>6 mo. %</th>
<th>30 mo. %</th>
<th>Large CDs over 100,000</th>
<th>Public Funds</th>
<th>Other CDs</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$1,000</td>
<td>$6,100</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$24</td>
<td>$4,000</td>
<td>$1,000</td>
<td>$330</td>
<td>+$1,745</td>
</tr>
<tr>
<td>August</td>
<td>250</td>
<td>6,950</td>
<td>2,000</td>
<td>2,300</td>
<td></td>
<td>4,000</td>
<td>1,230</td>
<td>330</td>
<td>+1,350</td>
</tr>
<tr>
<td>September</td>
<td>500</td>
<td>5,050</td>
<td>2,000</td>
<td>11,000</td>
<td>2,100</td>
<td>4,000</td>
<td>1,000</td>
<td>330</td>
<td>-10,880</td>
</tr>
<tr>
<td>October</td>
<td>3,160</td>
<td>2,000</td>
<td>3,600</td>
<td></td>
<td></td>
<td>4,000</td>
<td>1,230</td>
<td>330</td>
<td>-4,000</td>
</tr>
<tr>
<td>November</td>
<td>1,069</td>
<td>3,035</td>
<td>2,000</td>
<td>6,000</td>
<td></td>
<td>4,000</td>
<td>1,000</td>
<td>330</td>
<td>-5,225</td>
</tr>
<tr>
<td>December</td>
<td>1,195</td>
<td>5,850</td>
<td>2,000</td>
<td>6,000</td>
<td>18</td>
<td>4,000</td>
<td>1,230</td>
<td>330</td>
<td>-2,535</td>
</tr>
</tbody>
</table>

1 Rate sensitive assets minus rate sensitive liabilities.
In the case of the retail loan portfolio, obtaining a similar sample from which to estimate the turnover in loans was not possible. However, by assuming a constant rate of turnover and a typical term for the various types of retail loans an estimate was obtained. For instance, it was assumed that real estate loans had a constant rate of turnover and an average term of 12 years. Therefore the total real estate loans divided by the number of months in the average life of these loans (144 months) yielded an estimate of their monthly turnover. Similar calculations were performed on the other categories of retail loans to determine an estimate for the total portfolio. Interestingly, a similar exercise conducted for the commercial loan portfolio yielded an estimate quite close to that of the sampling technique for the full six month period. Of course, in both cases, this method lacked the precision of sampling because of the constant turnover assumption.

Given that N.O.W. accounts and time deposits other than CDs correspond to a fairly constant level of deposits at a stable rate, and that checking accounts also remain at approximately $38.25 million, the bulk of the case bank's interest sensitivity in liabilities rests in its CD portfolio. As such, the liability side of the institution's interest rate risk profile centers on its CDs. However, data concerning the volume of turnover in these deposits was not available. Hence, estimates of what the turnover must have been were constructed from the information available about the levels and rates of these deposits through the period of analysis.
As is evident from Table 15, the major proportion of the variability in CDs is accounted for by six month money market certificates (6MMMC) and Large CDs. In determining the volume of turnover in these as well as the other deposits a simple formula was employed. The amount for the previous month at its specified rate, plus any increase in the account, times the average rate for that month, plus an unknown volume of turnover multiplied by the difference between the rate on inflowing and outflowing deposits will equal the amount deposited in the month in question at its average rate. For example, on June 30 the bank had $30.8 million in 6MMMC at a rate of 14.32 percent. During July this amount increased by $1.6 million at an average rate of 14.56 percent. Hence, the original amount plus the increase, plus any deposits turning over and being reinvested at the new rate will equal the amount deposited at the end of July, $32.4 million, at the new rate of 14.35 percent. Stated mathematically in millions of dollars:

\[
$30.8 \times 14.32\% + $1.6 \times 14.56\% + X(14.56\%-14.52\%) = 32.4 \times 14.35\%\]  (11)

Solving the equation for \(X\) yields a turnover for the month of approximately $2 million. Similar calculations were performed on the different types of CDs to arrive at the amounts reported in Table 15. However, the CDs over $100,000 have, for the most part, maturities of less than two months. Therefore, it is assumed that the rate of turnover on these accounts would remain constant throughout the period of analysis. Finally, the column in the table for other CDs represents the average runoff in these deposits experienced through the period.

The difference between the rate sensitive assets and liabilities reported for each month results in a measure of the institution's rate
sensitivity gap. The gap, in turn, represents the level of interest rate risk exposure the case bank was faced with over the following six months. As noted in Table 15, neither the amount nor the direction of the bank's risk exposure is constant over time. During July and August the bank could have expected an excess of rate sensitive assets over liabilities, while during the remaining months of the year more liabilities than assets will be turning over. This type of detailed information on interest rate risk exposure is critical to the implementation of any hedging strategy.

The Case Bank's Interest Rate Risk and Hedging Objective

The objective of a hedging strategy is the removal of interest rate risk. Since this risk arises from a mismatch of maturities between assets and liabilities, hedging is essentially an exercise in maturity transformation. This is, identifying the nature of the institution's mismatch in maturities and then, through the use of futures, adjusting the maturity structure of either the asset or liability side of the balance sheet to create a match.

Based on the interest rate risk profile in Table 15, the case study bank had very limited exposure to interest rate risk on a month to month basis. However, the risk the bank was exposed to varied over the period under consideration. During July and August the institution had an excess of rate sensitive assets over liabilities. Hence, should interest rates fall the bank would have been repricing more of its assets than liabilities at a lower rate. On the other hand, if interest rates rose the bank was in the very favorable position of being
able to reprice more of its assets at the new rates and, thereby, increase its interest rate spread.

During the remaining months of the period the opposite situation holds. That is, the institution is rate sensitive on the liability side of its balance sheet. If rates fell the bank's spread would have increased and if they rose the bank would have been in a position of repricing more of its liabilities than assets at higher rates.

Recall from Chapter IV that the trend in interest rates through the period of analysis was one of increasing rates through the first two months and then a decline through mid-December when rates turned up again. Given this trend and the interest rate risk profile depicted in Table 15, the bank was in an ideal position in terms of its risk exposure throughout the period of analysis. With rates rising early in the period the bank was able to reprice more of its assets. Later, as rates fell, more liabilities were turning over.

Of course, the bank management probably knew neither the precise dimensions of its interest rate risk exposure nor the exact trend rates would follow during the period. Further, had the bank consciously assumed such a maturity mismatch it would have been speculating that rates would follow the trend they did. A different interest rate scenario might have placed considerable pressure on the institution's interest margin.

It is assumed that the bank's objective is to neutralize its interest rate risk exposure. This requires adjusting the rate sensitivity of the balance sheet to establish a gap of zero or a match in the rate sensitivity of the bank's assets and liabilities. Through sixty days
the bank has a positive gap. Hence, to achieve a position of zero exposure it must either fix the rate on some of its assets or increase the rate sensitivity of its liability portfolio. Because the bank experienced a positive gap, it had some flexibility in the manner it chooses to close the gap. These options included extending the maturity of some of its rate sensitive assets or selling them and investing in fixed rate assets. Another alternative would be to establish a futures position to extend the maturity of some of its maturing assets or one that would increase the rate sensitivity of its liability portfolio.

Because the asset portfolio of the bank was composed of a variety of loans and securities that earn a wide range of returns, it would have been quite difficult to execute a hedge that would accurately reflect the rate sensitivity of the portfolio with the contracts actively traded at that time. However, creating greater rate sensitivity on the liability side, particularly for the large certificates of deposit, might be more readily accomplished. To close the gap by this method would have entailed establishing a long position in futures that would allow an additional $3 million in certificates to become rate sensitive during July and August. Then as rates increased or decreased, the loss or profit from the futures position creates additional rate sensitivity on the liability side of the balance sheet to offset the positive gap.

As noted previously, the negative gap during the remaining months of the period would be beneficial if rates fell, but harmful if they rose. It would be quite costly for the institution to adjust its
balance sheet to a zero gap if this latter situation occurred without the use of interest rate futures. A short position in futures would decrease the rate sensitivity of the liability portfolio by locking in the rate paid on the amount of funds in excess of rate sensitive assets. This reduction in liability rate sensitivity would return the bank to a zero gap position during these months.

However, accomplishing the objective of closing the bank's rate sensitivity gap is not as simple as the above discussion might imply. A number of practical problems arise in attempting to implement such a hedging strategy. One problem is the degree of the institution's interest rate risk exposure (i.e., the size of the gap). For most of the period the gap, whether positive or negative, is quite small. This leads to a major problem in the timing of the futures transactions.

Given that the majority of the institution's rate sensitive liabilities are short term in nature, the preferred hedging vehicle would be the 90 day T-bill futures contract. This contract is denominated in units of $1 million. Hence, covering the bank's interest rate risk exposure would, in most months, require very few contracts. Because of the indivisibility of these contracts, each offsetting transaction would cover at least $1 million of the institution's exposure and would occur on a specific date during the month. On the other hand, the cash position being hedged by the bank represents a continuous flow of much smaller amounts throughout any given month. During the period of analysis, monthly swings in interest rates on T-bill futures ranged from 50 to 250 basis points in either direction. With this kind of interest rate volatility, timing the offsetting transaction of a hedge
to accurately reflect changes in the cash market position becomes problematic at best.

Further complicating the situation are the rates earned on assets and paid on liabilities turning over. By themselves, these flows can have major effects on the returns and costs of the institution. Very high or low rate loans coming due could lower or raise the return of the portfolio when reloansed at current rates. Similarly, deposits turning over with costs very different from prevailing rates would naturally change the bank's cost of funds. While most of the assets and liabilities turning would not fall into this category, it is quite likely that some would be older loans and deposits originated during a time of much lower rates. An example of this would be the large turnover in thirty month money market certificates during September. The important point here is that the bank must have some knowledge of these rates in order to fully specify the extent of its interest rate risk exposure.

Another difficulty involving the age of the assets and liabilities turning over during the period revolves around the starting date of the hedge. The assets and liabilities comprising the bank's interest rate risk profile existed prior to June 30, 1981. This means that only variability in interest rates occurring from that date forward can effectively be hedged.

The implications of this point can best be illustrated with an example. The interest rate risk profile of the bank indicates that substantial risk exposure exists during September. Furthermore, the very large turnover in six month money market certificates accounts for
a large proportion of this interest rate risk. If they were to short T-bill futures on July 1 to hedge the anticipated reissue of these deposits in September, it would be hedging only the rate variability occurring during the ninety day period of the hedge. The period from March, when these CDs were issued, until June 30 would not be hedged. In this particular case there was an 87 basis point increase from March to June in the average issue rate for these deposits that would not be hedged. Therefore, to fully hedge the rate sensitivity of these deposits would have required instituting the hedge when they were issued in March.

The Routine Hedge

The small positive gaps facing the bank during July and August would be difficult to hedge given the size and maturity of the available futures contracts, and an attempt to hedge could actually increase the bank's risk. In addition, the positive gap presents alternatives other than futures to deal with interest rate risk exposure. As suggested earlier, the bank might extend the maturity of some rate sensitive assets or sell them to invest in fixed rate assets if they wanted to close the gap. As such, it is assumed that it would not be in their interest to hedge their position with financial futures during these months.

The negative gap identified for the remainder of the period, however, presents fewer opportunities to offset the bank's risk exposure. During these months, with large and negative gaps, the bank might employ an interest rate futures hedging strategy to reduce its
exposure. In order to achieve this objective they should establish a short position in futures to lock in the cost of the excess of rate sensitive liabilities. Again, they must consider the face value of their hedged portfolio as well as its maturity structure to ensure dollar equivalence in the rate movement of the cash and futures positions.

The hedge was instituted on July 1, 1981. In order to hedge their exposure from September through November the bank sold 39 December 90 day T-bill futures. To hedge the $11 million in six month certificates coming due in September with the three month futures instrument required 22 contracts. Similarly, hedging their interest rate risk exposure in October and November required 7 and 10 contracts, respectively. All of these contracts were sold on the IMM on July 1 at the market index price of 87.07(12.93%). To hedge the December exposure, the bank sold 5 March 1982 T-bill futures contracts on July 1 at an index price of 87.5 (12.5%). This position was established to lock in the rate on $2.5 million of the $6 million in six month money market certificates coming due during December. The hedging vehicle was changed to the March contract to hedge December's exposure to avoid convergence and the potential liquidity problems of trading an expiring contract.

The futures position was then retired by systematically purchasing contracts as the certificates turned over. The precise timing of the turnover in deposits, however, was not known. It was assumed, therefore, that these certificates turned at a constant rate during the month in question. Hence, the offsetting transactions in the futures market were conducted at a constant rate through the month.
example, in September, which had 21 business days, one contract was bought each day with an additional offsetting transaction occurring on one of the days. In other months, with fewer contracts, the offsetting transactions were spaced a consistent number of days apart until the appropriate number of contracts had been purchased throughout the month.

The cash position being hedged along with the futures transactions to execute the hedge are depicted in Table 16. The total margin deposit required to place the hedge on July 1, assuming $2,000 for each of the 44 contracts, was $88,000. As profits or losses accrue over the life of the hedge, the margin account is adjusted accordingly. In September one 90 day T-bill future was purchased each day to accomplish the hedging objective. The average index price at which these trades took place over the month was 85.65(14.35%). Hence, the bank was able to purchase contracts to offset its futures position at an average of 142 basis points below the July selling rate. After deducting two points to account for transaction costs, the bank was left with a futures profit of $77,000. During October substantially fewer contracts were needed to hedge the excess of rate sensitive deposits. In simulating the hedge, one contract was purchased every three days through the month. The average index price for these purchases was 86.31(13.69%). Again, this represented a gain in the futures transaction of $12,950.

In November and December, however, the situation changed. Interest rates had been falling and the prices of the futures contracts had risen above July levels. Therefore, each basis point change reported in Table 16 represents a $25 loss on each contract of the futures
Table 16: The Routine Hedge

<table>
<thead>
<tr>
<th>Months</th>
<th>Cash Position Hedged</th>
<th>Contracts Purchased</th>
<th>Basis Point Changes</th>
<th>Profit (Col. 2x3x$25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>$11,000,000</td>
<td>22</td>
<td>140</td>
<td>$77,000</td>
</tr>
<tr>
<td>October</td>
<td>3,600,000</td>
<td>7</td>
<td>74</td>
<td>12,950</td>
</tr>
<tr>
<td>November</td>
<td>5,250,000</td>
<td>10</td>
<td>-188</td>
<td>-47,000</td>
</tr>
<tr>
<td>December</td>
<td>2,500,000</td>
<td>5</td>
<td>-101</td>
<td>-10,500</td>
</tr>
</tbody>
</table>
position. In November this loss, amounting to $47,000, was substantial. Moreover, had the bank withdrawn its initial margin deposit and profits from the previous two months positions, it would now be required to place additional margin to cover the futures loss. It must be remembered, however, that six month money market certificates in November were issued at a rate substantially below that prevailing in July. Hence, the futures position did act, as intended, to stabilize the cost of these deposits at July levels. Similarly, the December futures position experienced a loss, but the rate paid on deposits in the cash market declined correspondingly.

The effectiveness of the futures transactions in locking in July rates on the six month money market certificates issued during the hedge period is depicted in Table 17. The hedges for the first three months tended to overcompensate for changes in cash rates. That is, the profits from the futures transactions in September and October more than offset the increase in certificate rates. Similarly, the futures loss in November outweighed the drop in rates through that month. On the other hand, the December losses in the futures transactions were more than offset by a decline in cash market rates. Despite considerable month-to-month variation, the average rate on certificates that were hedged for the four months was, at 13.69 percent, close to the 13.87 percent rate the bank offered on six month money market certificates on July 1 when the hedge was instituted.

The basis risk apparent in the monthly variations is attributable to the cross hedge employed in the study and circumstances of the particular period. The maturity of the instrument underlying the
Table 17: The Effect of the Routine Hedge on Average Rates for Six Month Certificates

<table>
<thead>
<tr>
<th></th>
<th>Average Rate Offered on 6MMC</th>
<th>Average Rate on 6MMC Hedged</th>
<th>Average Rate After Hedge on 6MMC Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>15.25</td>
<td>13.85</td>
<td>13.85</td>
</tr>
<tr>
<td>October</td>
<td>14.23</td>
<td>13.49</td>
<td>13.49</td>
</tr>
<tr>
<td>November</td>
<td>12.83</td>
<td>14.71</td>
<td>14.40</td>
</tr>
<tr>
<td>December</td>
<td>11.68</td>
<td>12.69</td>
<td>12.10</td>
</tr>
</tbody>
</table>
futures contract, being different from the cash instrument hedged, would lead to some variability in rate changes between 90 day T-bill futures and the 26 week bills on which the rates for six month money market certificates are based. Indeed, there was considerable variability between rate movements for these instruments during September and October. While this basis variation continued in the following two months of the study period, a more important development occurred that further compromised the effectiveness of the hedge. On November 1, 1981 a regulatory change took place that affected the pricing of six month money market certificates. Prior to this date the ceiling on these deposits was set at .25 percent above the most recent 26 week Treasury Bill rate. The new regulation stipulated a ceiling of .25 percent above the higher of the most recent auction or the average rate on the previous four weekly auctions. During November the auction rate fell dramatically and the ceiling shifted to the four week average. Hence, the effectiveness of the hedge was compromised as the rate paid by the bank on these deposits became a function of a moving average of T-bill auction rates. The ceiling on six month money market certificates continued to be tied to the four week average until late December when rates rebounded. If deposit rates had instead followed the weekly auction rate, the average rate paid in November would have been almost 100 basis points lower.

Weighted Hedge

To reduce the basis risk apparent in the routine hedge case, the bank might employ a weighted hedge. Designing a hedge in accordance
with the historical relationship between the cash and futures instruments involved is one method the bank might use to reduce basis risk. In this study the optimum hedging ratio is defined as one that will minimize the overall variance of a portfolio of cash and futures instruments.

The hedging ratio is estimated by regressing the yield of the cash instrument on the futures yield. Because the rate on the six month money market certificates being hedged is tied to the Treasury Bill of the same maturity, weekly data on the 26-week U.S. Treasury Bill auction were collected. The futures data represented Friday settlement prices for 90-day Treasury Bill futures contracts for December 1981 and March 1982 delivery. Data on the rate movements for both the futures and cash instruments were collected for the period of March 21, 1980 to June 26, 1981. These dates were selected because both futures contracts were traded during this period.

The slope coefficients of the regressions suggest that the futures positions established under the routine hedge must be increased to reflect the differences in rate changes between the instruments. The position in December 90-day T-bill futures must be increased by a factor of 1.5, while the March futures position must be 1.6 times larger. Consequently, the futures position established at the start of the hedge consists of 59 December 90-day T-bill futures for the bank's net exposure from September through November, and 8 March 90-day T-bill futures to hedge December's exposure.

The results of the transactions to execute the weighted hedge are presented in Table 18. Rather than merely increasing the results of
Table 18: The Weighted Hedge

<table>
<thead>
<tr>
<th>Month</th>
<th>Cash Position Hedged (6MMC)</th>
<th>Contracts Purchased</th>
<th>Basic Point Change</th>
<th>Profit (Col. 2x3x$25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>$11,000,000</td>
<td>33</td>
<td>136</td>
<td>$112,200</td>
</tr>
<tr>
<td>October</td>
<td>3,600,000</td>
<td>11</td>
<td>63</td>
<td>17,325</td>
</tr>
<tr>
<td>November</td>
<td>5,250,000</td>
<td>15</td>
<td>-192</td>
<td>-72,000</td>
</tr>
<tr>
<td>December</td>
<td>2,500,000</td>
<td>8</td>
<td>-96</td>
<td>-19,200</td>
</tr>
</tbody>
</table>
the routine hedge by the appropriate factor determined in the regressions, transactions were spread out in a consistent manner over a wider number of days throughout the month. As a result, the basis point changes recorded for the weighted hedge differ from the changes reported under the routine hedge case. Moreover, the basis point changes shown in both Tables 16 and 18 are not unique. A wide range of possible basis point changes exist given the possible combinations of transactions in the course of the month. However, the transactions were undertaken in a consistent manner throughout the course of each month to simulate the a priori decisions the bank would have to make in such an instance. Further, the particular set of settlement prices employed in the analysis represent neither the best nor the worst possible combination regarding the profitability of the hedges.

The profits and losses from the futures transactions exceed the routine hedge case approximately in proportion to the weighting factors used. Again, differences emerge because some transactions are completed on a different set of days. The effect of these profits and losses on the average rate paid by the bank on its six month certificates through the period of the hedge is presented in Table 19. As the table indicates, the weighted hedge was quite effective in stabilizing the rate paid on new deposits. The only exception is the after hedge rate on six month certificates issued in November. Again, had the regulations concerning rate ceilings on these deposits not changed, the rate on these deposits would have averaged more than 100 basis points lower.
Table 19: The Effect of the Weighted Hedge on Average Rates for Six Month Certificates

<table>
<thead>
<tr>
<th></th>
<th>Average Rate Offered on 6MMC</th>
<th>Average Rate on 6MMC Hedged</th>
<th>Average Rate After Hedge on 6MMC Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>15.25</td>
<td>13.21</td>
<td>13.21</td>
</tr>
<tr>
<td>October</td>
<td>14.23</td>
<td>13.29</td>
<td>13.29</td>
</tr>
<tr>
<td>November</td>
<td>12.83</td>
<td>15.61</td>
<td>15.14</td>
</tr>
<tr>
<td>December</td>
<td>11.68</td>
<td>13.22</td>
<td>12.31</td>
</tr>
</tbody>
</table>
Comparison of Results

More important than the changes in the average rates paid on six month money market certificates is the effect the hedges had on the interest spread of the institution. In order to estimate these effects the average after hedge rate on each month's certificates was substituted for the actual rate. The overall interest expense of the bank was then recalculated to arrive at a new interest spread under both the routine and weighted hedge cases. Table 20 presents a comparison of the bank's actual interest expense and the expense under the alternative hedging strategies along with the resulting interest spreads.

Both the routine and weighted hedges had a substantial impact on the bank's interest expense and spread. Both hedges raised the average interest spread of the bank through the period of analysis and reduced the variability in the spread. The larger futures position under the weighted hedge case, despite large losses in some months, resulted in the highest average spread and the least variability.

Increases in the average spread for the six month period of 4 and 6.5 basis points under the routine and weighted hedges, respectively, translate into significant gains in the institution's profitability. Alternatively, the lower and more stable interest expense generated by the hedges might provide them with a competitive edge in their market. Moreover, to the extent that hedging reduced the bank's interest rate risk exposure, the institution is in a position to pass less interest rate risk to its borrowers, thereby improving its credit risk posture.

Although the hedges were effective in reducing the variability in the bank's interest spread, considerable variation persisted throughout
Table 20: The Effect of Hedging on the Case Bank's Interest Expense and Interest Spread

<table>
<thead>
<tr>
<th></th>
<th>Interest Income</th>
<th>Interest Expense Actual</th>
<th>Routine Hedge</th>
<th>Weighted Hedge</th>
<th>Interest Expense Actual</th>
<th>Routine Hedge</th>
<th>Weighted Hedge</th>
<th>Interest Spread Actual</th>
<th>Routine Hedge</th>
<th>Weighted Hedge</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>12.34%</td>
<td>6.48%</td>
<td>6.48%</td>
<td>6.48%</td>
<td>5.86%</td>
<td>5.86%</td>
<td>5.86%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>12.94</td>
<td>6.84</td>
<td>6.80</td>
<td>6.77</td>
<td>6.10</td>
<td>6.14</td>
<td>6.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>12.84</td>
<td>7.15</td>
<td>7.06</td>
<td>7.02</td>
<td>5.69</td>
<td>5.78</td>
<td>5.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>12.83</td>
<td>7.05</td>
<td>6.96</td>
<td>6.92</td>
<td>5.78</td>
<td>5.87</td>
<td>5.91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>12.99</td>
<td>6.95</td>
<td>6.91</td>
<td>6.89</td>
<td>6.04</td>
<td>6.08</td>
<td>6.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>12.75</td>
<td>6.84</td>
<td>6.80</td>
<td>6.78</td>
<td>5.91</td>
<td>5.95</td>
<td>5.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ave. Mo. Change</td>
<td>.17</td>
<td>.17</td>
<td>.15</td>
<td>.13</td>
<td>.20</td>
<td>.19</td>
<td>.19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the period. While some basis risk is inherent in the hedges employed, the effectiveness of the hedges in stabilizing the average rates paid on six month certificates suggests that basis variations alone would not account for the observed variability in the after hedge interest spreads. It appears, then, that the actual interest rate risk profile of the bank may have differed somewhat from the estimated risk profile. The estimation process used, particularly the constant turnover assumptions employed in determining the interest sensitivity of some asset and liability portfolios, undoubtedly resulted in some miscalculation of the precise interest rate risk exposure of the institution. This imprecision likely contributed to reducing the estimated effectiveness of the hedges.

In addition, changes in the institution's asset and liability portfolios during the six month period of analysis would affect the original estimate of interest rate risk exposure. The introduction of all saver's certificates in October, for instance, may have triggered a substantial realignment of funds within the institution as well as attracting additional deposits to the new, relatively high rate instruments. Furthermore, considerably more activity occurred in the institution's securities portfolio than the maturity structure indicated.

These considerations point to the complexity of the hedging process for a financial institution. Hedging demands a rigorous accounting system, one that is quite different from that typically employed by agricultural lenders, in order to identify sources of interest rate risk exposure. The process is further complicated by the ongoing changes that typify the behavior of an institution's asset and
liability portfolios over time. While the complexity of the hedging process is a formidable obstacle, it does not obviate the use of interest rate futures as a valuable tool in lender's efforts to reduce interest rate risk.
CHAPTER VI
SUMMARY AND CONCLUSIONS

The increasing importance of debt financing in agriculture along with higher and more volatile interest rates has exposed both borrowers and lenders to greater risks. The objective of this study was to examine the potential for agricultural lenders to alleviate a portion of this risk by using financial futures to hedge interest rate risk. The specific objectives of the study were: 1) to identify opportunities for hedging by a FCS lender and rural bank; 2) to examine the degree to which a portfolio analysis determined weighted hedge departs from a routine hedge position; 3) to compare the effects on cost and revenue of the two different hedging strategies with an unhedged position; and 4) to evaluate factors that may be limiting the effectiveness or use of financial futures hedging by agricultural lending institutions.

The study focuses on two financial institutions serving agricultural credit markets in Ohio, the FICB of Louisville and a rural commercial bank. Data on the asset and liability portfolios of these institutions were used to determine the extent of their interest rate risk exposure during the period of analysis. The period selected, the second half of 1981, was characterized by highly variable interest rates. After identifying the risk exposure of the institutions, two different hedging strategies were simulated and the effects on their
cost and revenue compared to their actual experience during the six month period of analysis.

The FICB of Louisville, which discounts PCA loans in Ohio, Indiana, Kentucky and Tennessee had an average volume of loans outstanding of about $3 billion during the second half of 1981. A generally rising level of interest rates increased the FICB's average cost of funds almost 2.5 percentage points from the previous year's level. However, rather than passing this entire increase on to its customers, the bank reduced its operating margin. The reduced margin contributed to a substantial decline in net income for the year.

The potential for the FICB to reduce the variability in its cost of funds by using interest rate futures was analyzed by simulating two hedging strategies. Prior to implementing the hedges, the institution's debt needs were estimated and the appropriate hedging instrument was determined. The participation of the bank in the system's bond issues during the study period was approximated as the debt portfolio maturing over that time, adjusted for the seasonal paydown typically experienced at the end of each year. The appropriate futures contract for hedging was selected by correlating the yields on T-bill, T-bond and GNMA futures with FCS six and nine month bonds. In addition, the standard deviations of the basis between FCS securities and the futures were analyzed. The T-bill futures contract, because of its similarity in maturity to FCS bonds, and because it exhibited the highest level of correlation and lowest standard deviation of the basis with FCS bonds, was selected as the best hedging instrument.
The routine hedge was established by selling 3,920 T-bill contracts, and then retired by purchasing the appropriate number of contracts to cover each month's bond issue. However, a number of occurrences during the hedge period, including a substantial decline in rates from their peak level, a November bond cost well below the July level, and continued profits on the futures, suggested that an actively managed hedge would have been lifted at the end of October.

The futures transactions proved quite profitable and substantially offset the rise in bond costs for the period. The average weighted cost of debt from July to November was reduced by 1.6 percentage points. However, overestimating the number of contracts sold to hedge the monthly bond issue and closing the position accounted for about 10 basis points of this gain.

The weighted hedge position magnified these results. Under this strategy the routine hedge position was increased to reflect the minimum risk hedging ratio estimated by minimizing the variance of a portfolio of FCS bonds and T-bill futures. The ratio indicated that the futures position under the routine hedge strategy should be increased approximately 1.6 times. Following the same pattern of transactions as for the routine hedge, the weighted hedge resulted in a reduction of 2.6 percentage points in the average weighted cost of bonds.

Although the profits from the futures transactions substantially lowered the cost of bonds issued during the hedge period, their effect on the average cost of all debt for the institution was much smaller. Under the routine hedge strategy the average cost of all debt was
reduced by .48 percentage points for the period from July to December, while the weighted hedge reduced costs by .77 percentage points. Moreover, the effects of the hedging strategies on the variability of the average cost of all funds were mixed. Over the full six month period the range of the average cost of funds actually increased, particularly under the weighted hedge. However, by lifting the hedge at the end of October, substantial losses in the futures market that would have raised the cost of bonds issued in December were avoided. If the period from July to November is considered, the routine hedge substantially lowered the range of the average cost of funds, while the weighted hedge left it essentially unchanged.

The commercial bank analyzed in the study was a major agricultural lender in its area and had total assets of about $140 million through the period of analysis. Estimates of the monthly turnover in the asset and liability portfolios were determined to establish the bank's interest rate sensitivity gap, the difference between the rate sensitive assets and liabilities. The case study bank had very limited interest rate risk exposure through the period. The interest rate risk that was apparent centered in the bank's six month money market certificates of deposit. The rate paid on these deposits is tied the rate on six month treasury bills. Therefore, the 90 day T-bill futures contract was selected as the hedging instrument.

Because the rate sensitivity gaps that faced the bank in July and August were so small that hedging might actually increase the bank's risk, the hedges were instituted only for the larger gaps identified for the remainder of the period. However, the short futures positions
were established on July 1 to hedge any changes in rates that might occur during the full six month period. The appropriate number of futures contracts were then purchased to offset rate changes on the deposits rolling over. Because of the continuous flow of deposits into and out of the bank each month, futures contracts were purchased continuously through the month rather than on one particular date as was the case for the FICB analysis.

Under the routine hedge strategy, the futures transactions in most months more than compensated for changes in certificate rates, while in December the losses in the futures position were more than offset by a decline in cash market rates. Despite the considerable month-to-month variation, the average rate on certificates that were hedged for the four months was, at 13.69 percent, close to the 13.87 percent rate the bank offered on six month money market certificates in July when the hedge was instituted.

The weighted hedge position was established to reflect the ratio determined by minimizing the variance of a portfolio of six month treasury bills and t-bill futures. The ratio indicated that the routine hedge position should be increased by a factor of 1.5. Rather than multiplying the results of the routine hedge by the appropriate factor, the weighted hedge transactions were spread out in a consistent manner over a greater number of days throughout each month in a further attempt to capture the effects of the continuous flow of deposits into and out of the bank. As a result, the basis point changes recorded for the weighted hedge differ from those of the routine hedge.
Despite offsetting the futures position on a different set of days, the profits and losses from the futures transactions exceeded the routine hedge case approximately in proportion to the weighting factor used. The weighted hedge was quite effective in stabilizing the rate paid on new deposits, but at rates well below both the actual and routine hedge cases.

The basis risk apparent in the monthly variations under both the routine and weighted hedge strategies was attributable to a number of factors. The cross-hedge employed, using different but related cash and futures instruments, contributed to some of the variability. However, a regulatory change affecting the pricing of six month money market certificates further compromised the effectiveness of the hedges late in the year. On November 1, 1981 the ceiling on these deposits was changed from .25 percent above the most recent six month bill rate to the higher of either the most recent rate or the average rate for the previous four weeks. During November rates fell sharply and the ceiling shifted to the four week average. Therefore, the effectiveness of the hedges was compromised as the bank rate become a function of a moving average of treasury bill rates through late December when rates rebounded.

In order to estimate the effects of the hedging strategies on the institution's interest spread, the average after hedge rates on each month's certificates was substituted for the actual rates. After recalculating the bank's interest expense, the average spread for the six month period was 4 and 6.5 basis points higher than the actual rate under the routine and weighted hedges, respectively. In addition, both
hedging strategies resulted in less variability in the bank's interest spread.

Conclusions

The analysis indicated that the case study institutions were exposed to interest rate risk during the period of analysis. Although their exposure was relatively small, particularly in the case of the commercial bank, hedging with financial futures did present an opportunity to alleviate this risk. Moreover, the study found that a routine hedge position, one that was opposite but equal in size to the cash market position, provided the most effective risk reduction. The portfolio analysis determined hedge, which weighted the routine hedge position to compensate for different rates of change in the yields of the cash and futures instruments, actually increased the interest rate risk exposure of the institutions by over-compensating for differences in rate changes.

The specific results of the analysis regarding the effect of hedging on the institutions' cost of funds would likely change given different portfolio distributions or a different time period. However, the analysis did indicate a number of factors that any lender must consider before implementing a hedging strategy. Moreover, the study showed that the practical problems associated with establishing and maintaining a hedging program are an obstacle to the use of financial futures by agricultural lenders.

Identifying an institution's interest rate risk exposure and managing that risk over time is a complex process. Many institutions,
particularly small agricultural banks, may lack the supporting infrastructure to monitor risk exposure and the personnel to effectively manage a hedge position. The difficulties encountered in determining the case bank's risk exposure would probably be common to many small institutions. While large lenders, such as the FCS banks, might be less constrained by these resource considerations, the process of managing their interest rate risk over time is no less complex.

Other problems faced by potential users of interest rate futures center on their degree of risk exposure and alternative means of managing it. The interest rate risk profile of the case bank, for instance, indicated a near matching of rate sensitive assets and liabilities, and required only limited hedging. However, the management of institutions maintaining such a position must recognize the potential trade-off of interest rate risk for credit risk in their loan portfolios. In addition, the study demonstrated the problems associated with hedging a small gap. Both the size of the futures contracts and the timing of the futures transactions reduced the effectiveness of hedging. For many institutions hedging may not be warranted because of these factors.

In the case of FCS lenders, the effects of variability on the marginal cost of funds are substantially reduced by their policy of average cost lending. While this policy provides FCS lenders with a competitive advantage when rates are rising rapidly, it also means they cannot adjust their lending rates as rapidly as others when interest rates decline. Interest rate futures may provide an effective tool for managing the effects of interest rate cycles on the system's average
debt costs. However, the size of the FCS debt portfolio in relation to the futures markets may prove to be a limiting factor in this regard.

The basis risk apparent in the study suggests another factor that may be limiting the use of interest rate futures. While basis variability during the period of analysis usually favored the short hedge positions established by the case study institutions, these results cannot be expected to hold under all situations. During a different time period basis variations might compromise rather than enhance the effectiveness of hedging. Moreover, attempts to control for basis risk by weighting the hedges to establish a risk minimizing portfolio of cash and futures did not prove highly effective, in some cases actually increasing variability. Although weighting the futures position tended to magnify the favorable rate and basis changes during the period, the same procedure at another time might substantially raise the cost and variability of funds.

Current regulations concerning the use of interest rate futures by financial institutions present another impediment to hedging. In the case of the FCS, the use of interest rate futures is limited to a pilot program that fixes rates on farm mortgages for a five year period. The regulations for banks, however, are less precise. Regulators have recognized that it is impossible to adequately cover all of the possible ways that banks might hedge their interest rate risk exposure (25). Therefore, the guidelines established for the use of futures are quite liberal, requiring only that futures positions must be established in accordance with safe and sound banking practice and allowing individual banks to administer their own programs. However,
regulations are also restrictive in requiring that banks account for futures transactions using a mark-to-market method.

Mark-to-market accounting results in daily profits and losses from a futures position being immediately reflected in a bank's financial statements. However, the cost-basis accounting used by banks for their cash position does not reflect the same variability. Gains (losses) in the cash market do not appear in the financial statement to offset losses (gains) in the futures market until the cash position is altered. The mark-to-market accounting requirement provides for a significant degree of market discipline in that most banks obviously want to avoid considerable variation in profits, which would be a source of concern among investors. However, this policy can also discourage legitimate hedging strategies (25).

These considerations highlight the difficulties associated with the complex process of hedging a financial institution's interest rate risk. While not insurmountable, they do represent significant barriers to the effective use of interest rate futures by lenders. Studies continue to indicate that few financial institutions employ hedging programs, but that many are considering their use (11, 73). The potential to reduce risk and perform the task of financial intermediation more effectively and efficiently will continue to provide an incentive for lenders to examine interest rate hedging strategies. However, the issues and problems identified in the study will delay their widespread use.
Suggestions for Further Research

This study identified a number of factors limiting the effectiveness and use of hedging strategies by agricultural lenders that warrant additional research. The difficulty of estimating the rate sensitive gap of the commercial bank suggests that alternative measures of interest rate risk exposure might be investigated. One such approach is duration analysis, which adjusts for the differing cash flows of various balance sheet items. An addition, research on hedging only a portion of a lender's portfolio would provide insights into the feasibility of establishing alternative products to the variable rate loans currently offered by most lenders.

The portfolio analysis approach to hedging employed in this study proved less effective than the routine hedge strategy. However, alternative measures of risk might provide a more effective method of dealing with the basis variability apparent in the study. In addition, a portfolio analysis approach to hedging that simultaneously determined the optimum cash and futures positions, rather than taking the cash position as given, might alleviate the interest rate risk passed on to borrowers when lenders match asset and liability maturities.

The regulatory environment in which financial institutions operate represents another area for further research. While current regulations are designed to prevent financial institutions from assuming high risk, they also present obstacles to the adoption of risk reducing hedging strategies. Identifying the extent to which current regulations create disincentives to hedging could lead to alternative regulations that would foster greater use of financial futures.
Interest Rate Futures Contracts

Financial futures markets emerged in the early 1970's in the midst of inflation, volatile interest rates, and floating exchange rates. Although the first contracts traded were in foreign currencies, interest rate futures contracts were not far behind. This section entails a description of more actively traded interest rate futures contracts which will form the focal point of the analysis.

The Government National Mortgage Association (GNMA) pass-through certificate was originated in 1970 to increase the flow of funds to the secondary mortgage market. This is the standard security for the GNMA futures contracts (52). There were two types of GNMA futures contracts traded at the time of the study, the collateralized Depository Receipts contract (CDR) and the Certificate Delivery contract (CD). The principal difference between these two contracts is that the delivery of a GNMA-CD futures contract involves actual GNMA certificates priced to provide an equivalent yield to GNMA 8% certificates while the GNMA CDR is backed by a pool of GNMA certificates equal to an equivalent principal balance of $100,000 of GNMA 8's. The GNMA-CDR, traded on the Chicago Board of Trade (CBT), is still actively traded, but the Certificate delivery contract is no longer in use.
The originator of the GNMA CDR deposits a minimum pool of $100,000 of GNMA 8% certificates, or their equivalent, with a bank. Upon delivery of the futures contract, the buyer receives a certified depository receipt for the $100,000 pool of GNMA 8% pass-through certificates or their equivalent (52). The equivalence aspect of the contract simply means that sellers who deliver GNMA pass-through certificates with coupons below (above) 8% must deliver more (less) than the $100,00 face value.

The CBT's GNMA CDR futures contracts are denominated in units of $100,000. The price of the instrument is quoted as a percentage of par with a minimum price fluctuation of 1/32 of a point ($31.25 per contract). The daily price limit is 64/32 above or below the previous day's settlement price. The CBT trades these contracts for March, June, September and December delivery up to three years hence.

The CBT also trades Treasury-Bond futures contracts. The contract is for U.S. Treasury bonds with a face value of $100,000 that mature in 15 years, or are not callable for 15 years from delivery. Again, the price is quoted as a percentage of par with a minimum price fluctuation of 1/32. The contracts are traded on the same quarterly cycle as the GNMA CDR and are traded for delivery up to 2 1/2 years into the future.

The International Monetary Market offers 90 day Treasury-Bill futures contracts. Each contract has a face value of $1,000,000 and the contract price is quoted in terms of the IMM index. The current discount rate offered for the futures contract is the difference between the index base of 100 and the contracts index price. Thus, if
the discount rate is 8.78%, the IMM index price would be 91.22. The minimum price fluctuation is one basis point (.01%) which is equivalent to $25 and the daily price limit is 60 basis points (.60%) or $1,500. IMM Treasury-Bill futures are traded for March, June, September and December delivery.

Domestic Certificate of Deposit (CD) futures began trading on the IMM during the period of analysis. This contract is for a three month Domestic Certificate of deposit of $1,000,000. The price of the contract is quoted in terms of the IMM index with a minimum fluctuation of one basis point. However, the daily price limit is 80 basis points above or below the previous day's settlement price. The CD futures contract differs from the other contracts discussed in that the price quotation is in terms of an add-on yield rather than a discount yield. That is, it represents the maturity value in excess of its initial $1,000,000 value. Therefore, a CD contract with a yield of 12% has a maturity value of $1,030,000. Contracts are traded for March, June, September and December delivery.

These four interest rate futures contracts were traded during the time of the study. While similar contracts were traded on other exchanges, these were the most actively traded instruments of their type and, therefore, constituted the most liquid contracts traded. Since the period of analysis in the study, interest rate futures contracts for Treasury-notes, Euro-CD's, commercial paper and stock indices have been traded. A more recent development has been the trading of options on futures. The CBT trades options on Treasury-Bond futures, giving
the buyer the right to require the seller (writer) of the option to buy or sell Treasury Bond futures at a specified price as stated in the contract.
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