FACTORS IN AND FEASIBILITY OF INTEREST RATE HEDGING BY FARMERS

by

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CHAPTER I

INTRODUCTION

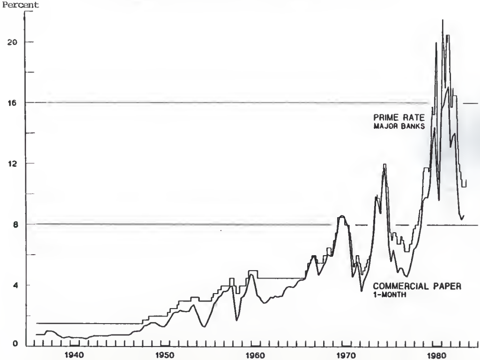
Problem Setting

In October 1979, the emphasis of the Federal Reserve monetary policy was changed from controlling the price of money and credit to controlling relatively more rigorously their supply. With this change in policy emphasis, the general level of interest rates, as well as interest rate volatility, increased substantially (Figure 1). The average level of interest rates almost doubled within a six month period. Interest rate volatility for the October 1979 through December 1983 period was greater than for any prior period [Hegde, p. 1]. With increased variability in interest rates, the risk of an unanticipated change is especially significant to traditionally heavy users of credit such as farmers.

For many years, agricultural lenders obtained loan funds through short-term deposits or borrowings and loaned the funds for both short and long term duration at fixed rates. The lenders sought a margin sufficient to cover operating costs, a profit, and risks associated with changing loan fund acquisition costs. This method of lending worked well in periods of relatively stable interest rates. However, with sharply higher and highly variable interest rates, many lenders found that they did not have a sufficient margin to cover the unexpected increased costs of loan funds. Loans made at a fixed rate had been funded with money that had, over time, higher costs than when the loans were made. As a result, lenders began to use strategies which allowed them to adjust interest rates on loans as

FIGURE 1

SHORT-TERM INTEREST RATES, PRIME RATE, EFFECTIVE DATE OF CHANGE;
COMMERCIAL PAPER, QUARTERLY AVERAGES, 1935 - 1983



[Board of Governors, 1983, p. 99]

the costs of funds changed [Solverson et al, p. 51].

Several methods can be used to pass changes in interest rates to the borrower. Shortened maturities on fixed rate loans provide a de facto method of making loan rates more variable. If the loan is renewed, changes in interest rates can be reflected in the new note. Loans with variable rate provisions are also used. A variable rate loan is generally based on some interest rate index, such as the prime rate, and neither the lender or the borrower knows the exact rate of interest to be charged over the life of the loan. The interest rate on the loan is the variable base rate plus a fixed margin. A third method used by lenders to pass their increased cost of funds to the borrower, is to incorporate a higher risk premium into the fixed loan interest rate. The higher risk premium will potentially offset increased loan fund acquisition costs that might occur.

There is evidence that financial intermediaries providing agricultural credit have acted to transfer a main portion of their increased interest rate risk to borrowers. Average maturities of all farm loans made by commercial banks fell from 8.3 months in 1978 to 6.4 months in 1982, while the number of commercial bank farm loans made with variable interest rates increased during the same period from 17 to 39 percent [Board of Governors 1983, p. 37-38]. In the 46 year period from 1933 through 1978, Federal Land Banks changed the interest rate charged to farmers only 24 times. In the 5 years following, 1979 through 1983, Federal Land Bank rates changed 14 times.

Agriculture is a capital-intensive industry. Debt for the average farm on January 1, 1982, was approximately $80,000, while large farmers (annual sales of over $100,000) had borrowings of over $336,000.

Approximately 28.5 percent of U.S. farms had debt levels above $112,000, however, these farms accounted for 87.4 percent of cash farm receipts [USDA, 1983(c), p. 15]. Relatively small variations in interest rates can translate into relatively large changes in total interest expense for the average farm borrower. Fluctuations in farm commodity or input prices, including interest costs, can easily eliminate the farmers profit margin even though he may be a very efficient producer.

Commodity futures markets have long offered the farmer the opportunity to minimize the risks of financial loss due to sharply rising or falling prices for many classes of crops and livestock. Only recently has the cost of money (interest rate) been viewed the same as other commodities. Prior to October 1975 there was no financial futures contract. Today the financial futures markets may offer the farmer a way to "lock-in" his interest costs, thereby allowing him to avoid unforeseen and potentially unfavorable fluctuations in his interest expenses.

Justification for Research

Recent literature has emphasized the potential for agricultural lenders to use the financial futures market to protect themselves from interest rate variability, and yet "price" loans to farmers at a fixed rate that does not pass interest rate risk to the farmer [Drabinstot and McDonely, Freeman, Moens, Solverson et al]. The problem is that agricultural lenders have generally been slow to adopt financial futures market technology as a tool for providing new loan options to farmers. A 1982 survey by the Federal Reserve Bank of Kansas City indicated that just 7 percent of responding commercial agricultural banks currently were using financial futures, while only an additional 15 percent of respondents indicated they would adopt their use in the future[1] [Drabinstot and McDonely, p. 22]. In a paper prepared for the Federal Reserve System Agriculture Committee, Alan R. Tubbs, an Iowa banker, states:

> "Some (rural banks) will investigate the possibility of utilizing the financial futures market to hedge money costs and eliminate interest rate risk for themselves and their customers. This will be a very small percentage of the rural banks. It is my opinion that most banks will not become involved in futures transactions . . ." [Tubbs, p. 9-10].

Although the lending institutions financing agriculture may have the experience and technical expertise available to protect themselves and the borrowers from interest rate risk, indications are that many agricultural lenders have not and will not make use of financial futures. Moens provides evidence that financial intermediaries have acted to transfer all or part of their increased interest rate risk to second parties [Moens, p. 33]. Hence, in many cases the farmer must either accept the increased interest rate volatility or make use of financial futures himself.

As previously indicated, those farms generating over 87 percent of cash farm receipts had debt levels above $112,000 in January 1982 and farm debt has continued to increase since 1982. Several financial futures instruments, including U.S. Treasury bonds and Certificate delivery GNMA's (Government National Mortgage Association mortgage-backed certificates) are traded on the Chicago Board of Trade with basic trading units of $100,000. The growing number of farmers facing debt loads greater than this amount

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[1]The survey sample consisted of the 100 largest commercial banks in agricultural lending volume and the top 10 percent in terms of farm loan volume as a percentage of total loan volume. An agricultural bank is defined by the American Bankers Association as a bank with at least $2.5 million in farm loans and/or 50 percent or more of its total loans in agricultural loans.

would suggest a number of potential users exists. The implication that many agricultural lenders will not make use of financial futures to reduce the effects of highly variable interest rates on farm loans, coupled with a potentially significant group of farmers able to effectively use financial futures as individuals suggested the need for this study.

Purpose of Study

The purpose of this study is to determine the feasibility of farmer use of the financial futures markets to "lock-in" interest rates. Specifically, the relationships between Federal Land Bank (FLB), Production Credit Association (PCA) and Kansas commercial bank interest rates and U.S. Treasury bond (T-bond) futures yields will be studied. Correlation and regression analysis as well as analysis of variance procedures will be used to examine farm interest rate hedging potential.

The specific objectives of this study are to:

1) Determine and evaluate variation in the basis for the following:
    a) T-bond futures yields and FLB interest rates.
    b) T-bond futures yields and PCA interest rates.
    c) T-bond futures yields and Kansas commercial bank interest rates.
2) Discern whether the basis between the cash interest rate and the futures yield is less variable than the cash interest rate.
3) Compare basis variability among the four T-bond futures contract months traded.
4) Establish guidelines for effective farmer use of interest rate hedging by:
    a) developing optimal hedging ratios.
    b) estimating the loan volume necessary for effective interest rate hedging.
    c) examining the effects of interest rate hedging on the interest costs of a hypothetical Kansas cattle feeder.

CHAPTER II

BACKGROUND AND LITERATURE REVIEW

Changing Farm Situation

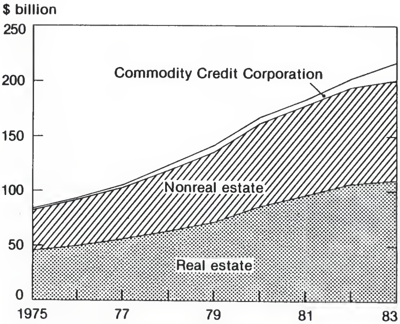
There has been continuing change in the U.S. farm sector. American farm labor productivity has increased to where each farmer fed 75 people in 1982, considerably above the 53 persons fed in 1972 [USDA, 1983(e) p. 58]. The size of the "average" U.S. farm increased from 240 acres in 1975 to 433 acres in 1982 while the number of U.S. farms fell to 2.4 million farms in 1983, down from 2.5 million farms in 1975 [USDA, 1983(b), p. 381].

But perhaps the most noted change has been the issue of increasing farm debt (Figure 2). In 1950, total U.S. farm debt was $13 billion. It rose to $53 billion in 1970, and then skyrocketed to $215 billion in 1983 [Production Credit Association, p. 13]. The Federal Reserve Board of Chicago has predicted that total farm debt could surpass a trillion dollars by the year 2000. Much could happen between now and the year 2000, but the general trend appears certain. Farm producers will be handling increasingly large sums of debt [Sabatka, p. 10].

Table 1 shows the "typical" U.S. farm's debt to asset ratio. This ratio rose from 16.2 in 1975 to 20.6 in 1983. Kansas Farm Management Association data permit a breakdown of loans to net worth ratios by farmer age (Table 2). This data show that loans to net worth have increased for all farmer age groups between 1976 and 1982, but most notably for the younger age groups. In 1982, farmers under the age 30 had an average ratio of over 1.4 as compared to 1.1 in 1976. Farmers between the ages of 31 and

FIGURE 2

FARM LOANS OUTSTANDING BY MAJOR USE CATAGORY, JANUARY 1, 1975 - 1983



[United States Department of Agriculture, Chart 9]

TABLE 1

DEBT TO ASSET RATIO U.S. FARMS,
JANUARY 1, 1975-1983

1975	16.2
1977	15.6
1979	16.1
1981	16.7
1982	18.5
1983	20.6

[USDA, 1983(e) p. 127-131]

TABLE 2

LOANS TO NET WORTH RATIO BY FARMER AGE CATEGORY, KANSAS FARM MANAGEMENT ASSOCIATION MEMBER FARMS, 1976-1982

	Age			
Year	Under 30	31-35	36-40	41-45
82	1.41	1.17	1.00	.84
81	1.25	1.05	.89	.77
80	1.10	.94	.75	.60
76	1.10	.83	.75	.60

	Age			
Year	46-50	51-55	56-60	Over 60
82	.58	.53	.41	.24
81	.59	.50	.33	.24
80	.48	.38	.30	.21
76	.54	.41		.25

[Kansas Cooperative Extension Service]

35 had an average ratio of 1.17 in 1982, up from .83 in 1976. Thus, data indicate that the farmer is operating under not only an increased debt load but also an increasingly leveraged position. Borrowed capital is becoming more and more important in the farm operation.

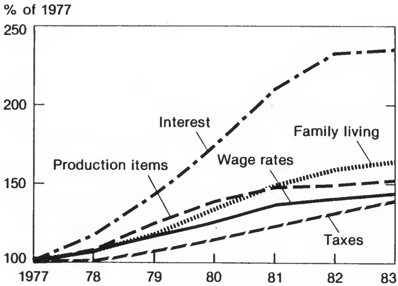
But increasing farm debt does not tell the whole story. Along with this increasing debt load, interest rates have risen dramatically. The relative importance of interest as a percentage of all cash expenses has almost doubled since the mid 1970's [USDA, 1983(c) p. 33]. Interest payable per acre of real estate debt has more than doubled in the period 1977 to 1983 (Figure 3). In 1982, farmers as a group spent more than 18 percent of their gross farm income on interest. This was more than their expenditures on seed, fertilizer, and pesticides combined [Production Credit Association, p. 15].

From "traditional" interest rates of less than 10 percent, the prime interest rate rose to 12 percent in 1974, fell to 6 percent in 1976, soared to an unprecedented 20 percent in April of 1980, only to begin a rapid decent a month later. By December 1980, the prime had climbed to a record breaking 21.5 percent [Chicago Board of Trade, 1980(a), p. 1]. In 36 years, from 1935 through 1970, the prime changed 39 times and ranged from 1.5 percent to 8.5 percent. In the 12 following years, from 1971 through 1982, the prime changed 202 times and ranged from 4.75 percent to 21.5 percent [Freeman, p. 90].

Table 3 provides documentation of the increased variability in interest rates paid by farm borrowers as measured by the coefficient of variation. The coefficients for the period 1978 to 1983 for Production Credit Associations, Federal Land Banks and all commercial banks are

FIGURE 3

PRICES PAID BY FARMERS FOR COMMODITIES, SERVICES, INTEREST, TAXES, AND WAGE RATES, PERCENT OF 1977 PRICE, 1977 - 1983



[United States Department of Agriculture, 1983(f), chart 24] significantly higher than the coefficients for either the 1960 through 1967 period or the 1968 through 1975 period.

TABLE 3

COEFFICIENT OF VARIATION FOR INTEREST RATES PAID BY BORROWERS

	Time Period		
Lender	1960-1967 [a]	1968-1975 [a]	1978-1983
Federal Land Bank	4	8	14.4[b]
Production Credit Association	6	11	17.8[b]
Commercial Banks	2	7	19.6[c]

[a]Moens et al

[b]Monthly data provided by Farm Credit Bank of Wichita

[c]From sample of Kansas commercial banks

Financial Futures Background

In 1975, the Chicago Board of Trade introduced the first interest rate futures contract, a contract in Government National Mortgage Association (GNMA) mortgage-backed certificates. In the first full year of trading, GNMA futures contracts equivalent to $15 billion were traded on the Chicago Board of Trade. Based on volume growth, GNMA futures contracts were one of the most successful new contracts ever introduced [Chicago Board of Trade, 1980(a) p. 3].

In response to the success of the GNMA contract and to provide other links to the cash financial markets, the Chicago Board of Trade introduced futures contracts based on U.S. Treasury bonds in August of 1977, ninety-day commercial paper in September of 1977, certificate delivery GNMA's in September of 1978, thirty-day commercial paper in May 1979, U.S. Treasury notes in June 1979, and domestic certificates of deposit in July 1981. Futures markets options on U.S. Treasury bonds were introduced in October 1982 [Chicago Board of Trade, 1980(a), p. 4].

Growth in the trading of these contracts has been phenomenal. Some 23.7 million financial futures contracts were traded in 1983 (Figure 4). Treasury bond futures were the most active financial futures contract, posting a volume of 19.6 million contracts in 1983 [Chicago Board of Trade, 1983, p. 1].

The Chicago Board of Trade defines a financial futures contract as follows:

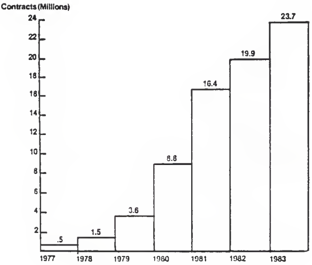
> "Financial futures, or interest rate futures, describes futures contracts based on financial instruments whose price fluctuates with changes in interest rates. As with all futures contracts, financial futures represent a firm committment to buy or sell a specific commodity or financial instrument, during a specified month, at a price established through open outcry in a central, regulated marketplace." [Chicago Board of Trade, 1980(a), p. 3]

Each futures contract is standardized. For example, U.S. Treasury bond futures contracts are based on a Treasury bond that has a $100,000 face value, is not redeemable for at least 15 years, and has an 8 percent coupon rate. Thus, when buying or selling a particular financial futures contract it is only necessary to look at one variable - price [Chicago Board of Trade, 1980(a), p. 3].

U.S. Treasury bonds are traded on the Chicago Board of Trade on points and 32nds of par. Par represents full face value of $100,000. If the price is below par, the bond is said to be selling at a discount. A price of 90-25 means that the bond is selling at 90 and 25/32 percent of its face

FIGURE 4

TOTAL CHICAGO BOARD OF TRADE FINANCIAL INSTRUMENT
CONTRACTS TRADED, 1977 TO 1983



[Chicago Board of Trade, 1983, p. 1]

value or $90,781.25. On the other hand, if the price is above par, the bond is said to be selling at premium. For example a price of 101-05 means the bond is selling at 101 and 5/32 percent of its face value.

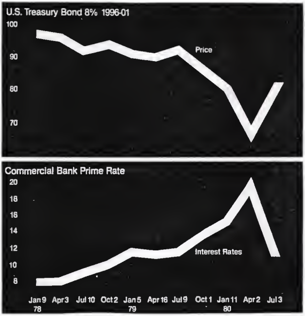
Bonds are referred to as "fixed income securities" because the term defines a fixed annual income stream. A bond issued with a 6 percent coupon pays 6 percent annually until maturity [Schwarz, p. 40]. It is important, however, to understand the inverse relationship between bond price and bond yield to understand how the financial futures market works. As market interest rates rise the price of previously issued fixed-income securities, such as bonds, falls (Figure 5). This is based on the principle that no one would buy a bond yielding 8 percent when he could buy a new issue of the same quality that would yield 9 percent. Bonds with an 8 percent coupon will continue to be bought and sold at a discount such that they also yield 9 percent [Chicago Board of Trade, 1980(a), p. 6].

By using calculations for yield to maturity, it is possible to determine what market price will bring the 8 percent coupon Treasury bond futures contract traded on the Chicago Board of Trade "into line" with yields on the cash market. Tables are available from the Chicago Board of Trade which easily translate bond futures prices into yield equivalents. Yield equivalents are intended as interest rate reference points only. Futures traders would not actually receive a bond yield unless they took delivery on the contract.

Treasury bond contracts are currently traded with delivery dates in March, June, September and December. It is possible to buy or sell a Treasury bond futures contract that will not become deliverable for over two years. For example, in July 1984 it was possible to have purchased or

FIGURE 5

INVERSE MOVEMENTS OF U.S. TREASURY BOND PRICE AND COMMERCIAL BANK PRIME RATE, JANUARY 9, 1978 TO JULY 3, 1980



[Chicago Board of Trade, 1980(a), p. 7]

sold a Treasury bond contract for any of the following delivery months:

September	1984	March	1986
December	1984	June	1986
March	1985	September	1986
June	1985	December	1986
September	1985	March	1987
December	1985		

Thus a user could have established a price over 2 years in advance of any actions that he planned to take in the cash market.

Hedging Background

The futures market has two primary functions. The first allows a user to reduce his risk exposure to significant price movements in the inputs or outputs of his business. This is referred to as hedging. A hedger either buys or sells futures contracts to protect a later cash market commitment. The second function of the futures market is to allow a user to accept price risk in return for profit. This is known as speculating. Speculators usually do not own nor intend to own the cash commodity. Their willingness to accept large amounts of risk while speculating on favorable future price movements helps provide a liquid market in which selling and buying can be accomplished with relative ease [Chicago Board of Trade, 1980(b), p. 8-9].

Interest rate hedging is the act of taking a position in the financial futures market that is intended as a temporary substitute for the sale or purchase of the actual financial instrument in the cash market. The two markets are expected to act in such a way that any loss realized in one market is offset by an equivalent gain in the other [Chicago Board of

Trade, 1982, p. 80]. The purpose of the hedging transaction is to shift the interest rate risk to others who are willing to bear this risk. If the hedge is successful, the hedger (borrower) would be relieved of price risk [Solverson et al, p. 52].

There are two basic types of hedges to be considered. The first, the short or sell hedge, is the sale of a futures contract today as a temporary substitute for the sale of the actual commodity at a future date. The second type of hedge is the long or buy hedge. The long hedge is the purchase of futures contracts today as a temporary substitute for the purchase of the actual commodity at a future date [Chicago Board of Trade, 1982, p. 79, 81]. The following examples of short and long hedges using financial futures clarify the nature of these transactions.

The Short Hedge. On October 1, a bond dealer is holding $1 million of twenty-year 8 3/4 percent Treasury bonds priced at 94-26 (yielding 9.25 percent). To protect current holdings from an expected rise in interest rates and therefore, a decline in portfolio value, a short hedge is executed. Ten December[2] Treasury bond futures contracts are sold at 86-28. Since each U.S. Treasury bond futures contract has a face value of $100,000, ten futures contracts are required to equal the $1,000,000 of current holdings to be protected.

By October 31, interest rates have risen and bond prices have dropped in response to the Federal Reserve Board of Governors' action. The bond dealer offsets the previous futures sale by purchasing ten December U.S.

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[2]Hedges are placed using the T-bond futures contract that will be the nearby contract when the hedge is offset. In this example the hedge was lifted in October. The December contract is the nearby contract.

Treasury bond futures contracts at 79-26. A gain of $7,062.50 is made on each contract, or $70,625.00 on the ten contracts.

Cash market bond prices have fallen to 86-16 (yielding 10.29 percent), making the dealer's inventory worth $83,125.00 less. But this loss is partially offset by the $70,625.00 gain in the futures market.[3] By hedging, the bond dealer reduced losses associated with holding the cash position from $83,125 to $12,500.

Cash Market	Futures Market
October 1 Holds $1 million 20-year 8 3/4% Treasury bonds priced at 94-26 (yield 9.25%) Value = $948,125.	Sells 10 Treasury bond futures contract at 86-28 Value = $868,750.
October 31 Prices for bonds fall to 86-16 (yield 10.29%) Value = $865,000.	Buys 10 U.S. Treasury bond futures at 79-26 Value = 798,125.
Loss: $83,125.00	Gain: $70,625.00

[Chicago Board of Trade, 1980(a), p. 43-44]

The Long Hedge. Consider an institutional investor in Treasury bonds. He may be the manager of a pension fund, trust fund or college endowment. On April 1, 1980, he expects that in three months (July) he will receive $1,000,000 - an amount which he plans to invest in Treasury bonds. Interest rates have been steadily rising but the manager suspects that rates are at or near their peak. Twenty-year 8 1/4 percent Treasury bonds are yielding 12.26 percent. The manager wants to take advantage of today's

[3]The cash loss was not perfectly offset by the futures market gain. This is due to changes in the basis, which will be discussed later.

higher yield level, in case it falls in the course of the next three months. His first step is to "go long" (buy) ten September T-bond futures contracts. He purchases the contracts at the current price of 68-10. By July 2, interest rates have dropped and, accordingly, the price of bonds has risen. He sells his ten futures contracts ("lifts his hedge") at 80-07, for a profit of $11,906.25 on each contract ($119,062.50 for the ten contracts). The price of Treasury bonds has increased from 68-14 to 82-13. This translates into an opportunity loss of $139,688.50 for the bond portfolio - but this loss is offset by a gain in the futures market of $119,062.50.

Cash Market	Futures Market
April 1 Wants to take advantage of today's higher yield level on 20-year 8 1/4% Treasury bonds at 68-14 Value = $684,375.	Buys 10 September bond futures contracts at 68-10 Value = $683,125.
July 2 Buys $1 million of 20-year 8 1/4% futures Treasury bonds at 82-13 (yielding 10.14) Value = $824,063.50	Sells 10 September bond contracts at 80-07 Value = $802,187.50
Loss: $139,688.50	Gain: $119,062.50

[Chicago Board of Trade, 1980(a), p. 42]

Cross-Hedging

Since financial futures contracts do not exist for loans and mortgages associated with agricultural lending, we must use a cross-hedge. Cross-hedging involves matching a loan at interest rates determined in the cash market with a financial futures contract at a price, and hence yield, determined in a different but related market. Such a hedge is based on the premise that, while the two instruments are not the same, their prices correlate. The protection gained by cross-hedging is better than having no protection from price risk in the cash position [Chicago Board of Trade, 1980(a), p. 45].

For cross-hedging to be effective, the movements of the cash market and the financial futures market must be highly correlated [Moens, p. 56]. Hedge argues that the growing trading volume in the financial futures markets, which resulted from increased level and volatility of cash market interest rates, has significantly strengthened the correlations between cash and futures prices. By comparing the R-squares for a period of relatively low level and volatility of interest rates (January 1979 to September 1979) with those from a period of relatively high level and volatility (October 1979 to June 1980), Hegde provides evidence that the hedging and cross-hedging effectiveness of financial futures markets improved with the generally rising level and volatility of cash market interest rates. R-squares rose significantly for both deliverable and non-deliverable cash securities [Hegde, p. 345, 348].

The following is an example of a short cross-hedge using Treasury bond futures to offset corporate bond price risk. A pension fund has a diversified portfolio of high-grade corporate bonds with a face value of $5 million, an average maturity of twenty years, and a current market value of $3,673,437.50 on January 2. The pension fund manager wants to protect the value of the portfolio from a possible rise in interest rates. There is no corporate bond futures market in which to hedge this risk, so he sells fifty June Treasury bond futures at 81-20 in the U.S. Treasury bond futures market.

By March 14, interest rates have risen, and the manager decides to sell the corporate bonds. He sells the bonds at $3,220,312.50, sustaining a $453,125.00 loss. He buys back fifty U.S. Treasury bond futures at 69-20 and gains $600,000.00.

Cash Market	Futures Market
January 2 Holds $5 million high-grade corporate bonds with a market value of $3,673,437.50 (a price of 73-15 per bond)	Sells 50 U.S. Treasury bond contracts at 81-20 Value = $4,081,250.
March 14 Value of bonds declines to $3,220,312.50 (a price of 64-13 per bond)	Buys 50 U.S. Treasury bond contracts at 69-20 Value = $3,481,250.
Loss: $453,125.00	Gain: $600,000.00

[Chicago Board of Trade, 1980(a), p. 45-46]

If, in the preceding examples, the price of the instrument being hedged had moved at the same rate as the price of the futures contract, the cash market losses (gains) would have been perfectly offset by futures market gains (losses). The perfect hedge would have resulted. The perfect hedge, however, occurs rarely in actual practice. Any change in the basis during the time the hedge is held will result in a gain or loss depending on the direction of the change. The basis is defined as the cash market interest rate minus the futures contract yield. Changes in the basis, resulting from differing rates of movement of the cash and futures instrument, result in imperfect hedges as observed in the preceding examples. To successfully hedge or cross-hedge, an understanding of the basis and basis risk is important.

Basis Background

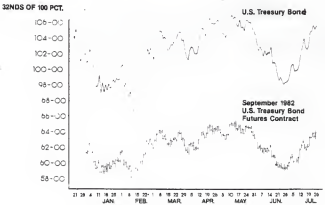
Cash and futures prices tend to move in the same direction, in roughly parallel patterns (Figure 6). These prices move in parallel because both are influenced by the same economic conditions and because the possibility of delivery exists in the futures market, but also because market participants engage in cash/futures arbitrage [Chicago Board of Trade, 1980(a), p. 38].

Arbitrage involves buying in one market and immediately selling in another market at a profit. In addition to allowing the arbitrageur to profit from distortions in usual price relationships, this action tends to bring prices back "into line". As a result of arbitrage, the futures price remains relatively close to the cash price. Wardrep and Buck assert that cash and futures prices do not always move exactly together but it is unusual for them to move in substantially different directions [Wardrep and Buck, p. 249].

Basis can be either positive or negative depending on relative cash/futures price magnitudes. Basis is said to weaken if it becomes less positive or more negative and to strengthen if it becomes more positive or less negative [Chicago Board of Trade, 1980(a), p. 40]. If the basis weakens on a short hedge (the futures yield advances relative to the cash market interest rate), a basis gain occurs. If the basis strengthens on a short hedge (the cash market rate advances relative to the futures yield), a basis loss occurs [Solverson et al, p. 52]. If the basis change is less than the change in spot (cash) prices, the futures markets are a useful tool for reducing the risk of holding that spot position [Wardrep et al, p. 249].

FIGURE 6

PARALLEL PATTERNS OF CASH MARKET U.S. TREASURY BOND PRICE AND FUTURES MARKET U.S. TREASURY BOND PRICES, JANUARY 1982 TO JULY 1982



[Chicago Board of Trade, 1984, p. 39]

Moens suggests examining the standard deviations in yields and basis to test the potential for cross hedging in a particular market and recommends that a "good" cross-hedge might be completed if the standard deviation of the basis is considerably less than the standard deviation of the yields. His research provides evidence that the standard deviations for basis between Federal Land Bank (FLB) bond yields and GNMA futures contracts are significantly lower than the standard deviations on the yields of FLB bonds [Moens, p. 76].

Optimal Hedging Ratio and Hedging Effectiveness

Basis variations imply different rates of price change for the cash interest rate and futures market yield. Hedging eliminates price risk, but leaves the hedger open to the risks associated with changes in basis. It is, however, possible to establish a hedge that will minimize basis risk. Using regression analysis, it is possible to determine if there is a relationship in price movements. This relationship tells the size of the futures market position needed to offset the variation in a cash position and is known as the optimal hedging ratio. Kuberek and Pefley suggest that the slope coefficient (Beta) from ordinary least squares regression (OLS) is a best-linear-unbiased estimator for the optimal hedge ratio and that the regression R-square statistic provides an estimate of hedging effectiveness; a perfect hedge would have an R-square of 1, while the R-square would equal zero if the hedge was completely ineffective [Kuberek and Pefley, p. 349-350]. Using the optimal hedging ratio will minimize basis risk [Leuck and Leuthold, p. 3].

Cross-Hedging Studies

In 1983 Kuberek and Pefley outlined a procedure for evaluating the cross-hedging effectiveness of interest rate futures and applied the procedure to the use of Treasury bond futures to hedge the interest rate risk of corporate debt [Kuberek and Pefley]. OLS regressions were performed on returns from corporate bond portfolios and T-bond futures contracts. The resulting sample coefficients of determination (regression R-square statistics) provided estimates of hedging effectiveness.

Kuberek and Pefley suggest that T-bond futures offer substantial protection from unexpected changes in corporate bond prices. The degree of hedging effectiveness, however, depends on both the quality of bonds being hedged and the maturity of the specific futures contract chosen in constructing the hedge. T-bond futures were found to be more effective in hedging high quality corporate debt (AAA of AA rated bonds) than lower-quality corporate debt (A rated bonds). Nearby futures contracts exhibited superior hedging effectiveness than more distant futures contracts regardless of the quality of debt being hedged.

Leuck and Luethold examined one sector of agriculture, grain storage, and analyzed the use of the financial futures markets in developing selective hedging strategies for reducing interest rate risk on variable rate elevator debt [Leuck and Luethold]. United States Treasury bill (T-bill) futures contracts were used to hedge the prime rate (private elevator debt) and Bank for Cooperative (BC) seasonal loan rate (cooperative elevator debt). Several hedging strategies were examined for four elevator size classes. The minimum size elevator that could effectively use T-bill futures contracts to hedge had a minimum annual grain volume of 2.7 million bushels and a minimum storage capacity of 2.0 million bushels. The benefits of hedging were greater for private elevators than for cooperative elevators. The results of this study indicate that hedging strategies can work to reduce interest rate risk on variable rate loans held by elevators and further, that this risk reduction can take place before or during the time debt is actually held.

Moens studied the potential for agricultural lenders to cross-hedge their loan fund costs on the financial futures using GNMA or T-bill futures contracts [Moens]. Correlation and regression analysis, and the comparison of standard deviations of yields on Farm Credit System bonds with the standard deviation of the basis between such bonds and futures market yields were used to analyze cross-hedging potential. Results of these tests indicated that GNMA futures contracts offered a better vehicle for cross-hedging agricultural lender fund costs than did T-bill futures contracts. Based on these results, actual cross-hedging examples using GNMA futures contracts were constructed for Federal Land Bank and Federal Intermediate Credit Bank bond issuances. Moens concluded that these cross-hedges provided a partial offset of opportunity losses incurred and suggested that the potential for agricultural lenders to cover interest rate volatility through the use of the financial futures does exist.

The preceding studies indicate that the use of the financial futures in establishing cross-hedges does offer potential interest rate risk reduction for several different institutions. However, very little research has been directed to the use of financial futures to reduce interest rate risk for primary agriculture i.e., the farm borrower.

CHAPTER III

FEASABILITY OF FARMER INTEREST RATE HEDGING

Hedging Instrument

The financial futures contract selected for the hedging of interest rate risk in this study is the United States Treasury bond (T-bond) futures contract as traded on the Chicago Board of Trade. Financial futures contracts are currently being traded on other markets such as the MidAmerica Commodity Exchange and the International Monetary Market (IMM) at the Chicago Mercantile Exchange. In this study it is the Chicago Board of Trade and the MidAmerica Commodity Exchange which provide the market mechanism for T-bond futures contracts.

The decision to use T-bond futures contracts was based on both the size of futures contracts and the liquidity of the markets in which they are traded. When considering the development of an interest rate hedging program for a farmer, it is necessary to match the farmers debt load with the futures contract size plus be sure there is sufficient market liquidity to facilitate timely buy and sell transactions.

As indicated in the preceding chapter, approximately 28.5 percent of U.S. farmers have debt loads of over $112,000, while the average farms debt on January 1, 1982 was about $80,000. There are some individual farmers with debt loads of over a million dollars. However, the use of the $1,000,000 U.S.Treasury bill futures contract or the $1,000,000 Domestic Certificate of Deposit futures contract is precluded from this study as being too large for use in establishing interest rate hedges for the majority of farmers. On the other hand, U.S. Treasury bond, U.S. Treasury Note, Certificate Delivery GNMA and CDR[4] GNMA futures contracts are all traded in $100,000 increments [Chicago Board of Trade 1980(a), p. 20, 26]. The $100,000 face value of these futures contracts more nearly matches the average farmers debt load than does the $1,000,000 face value of the larger futures contracts.

T-bond futures contracts were chosen from this group based on market liquidity. A liquid market is one where buying and selling can be done with ease, due to the presence of a large number of interested buyers and sellers willing and able to trade substantial quantities at small price differences [Chicago Board of Trade, 1982, p. 80]. T-bond futures are traded in a highly liquid market on the Chicago Board of Trade as evidenced by the 16 million T-bond futures contracts traded out of a total of 23.7 million financial futures contracts traded in 1983 [Chicago Board of Trade, 1983, p. 1]. In addition, T-bond futures can be purchased as $50,000 "mini" contracts on the MidAmerica Commodity Exchange. This potentially offers the smaller borrower, or borrowers who only want to "lock in" rates on part of their debt, an opportunity to hedge their interest rate risk.[5]

Cash Instruments

When developing a borrowing program, the agricultural producer has several options as to the interest rate structure and loan maturity that best fit his way of doing business. There also exist different sources of loan funds. The cash market instruments chosen for studying the potential

[4]Collateralized depository receipt

[5]Although there are minor discrepancies in T-bond futures prices between the Chicago Board of Trade and the MidAmerica Commodity Exchange, arbitrage would tend to keep these two markets parallel in price.

of interest rate hedging were commercial banks, Production Credit Associations (PCA) and Federal Land Banks (FLB). These lenders offer the farmer a wide range of options.

FLB's primarily offer long-term, variable rate, real estate loans. FLB loans to farmers are made for terms of 5 to 40 years. Most of these loans are amortized over the lending period.

PCA's make loans to farmers for almost any purpose, but limit loan maturity to a maximum of 7 years. Short-term operating loans are usually made with maturities that coincide with the normal marketing season of the enterprise being financed. The intermediate-term loan is usually amortized over the useful life of the item(s) being financed, but in special cases, intermediate-term loans with balloon payments at maturity may be arranged.

Commercial banks offer the farmer additional financing alternatives. The most important type of loan made to farmers by commercial banks (money center banks and rural banks) is production loans to provide funds for current farm operations.[6] Intermediate-term and real estate loans are also made. The maturity of farm loans made by commercial banks varies considerably with the purpose of the loan. Current operating loans are generally payable when the cash flow generated by the operation is received. Notes for intermediate-term loans may be written with 3 or 4 year maturities. Many intermediate-term loans, however, are written with maturities of one year or less, but with a mutual understanding between the lender and the borrower that the note will be extended at maturity [Nelson et al, p. 330].

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[6]Approximately 69 percent of the number of loans made by commercial banks in 1983 were for feeder livestock or current operating expenses [Board of Governors, 1983, Table 335.Q].

In 1983 the largest holders of agriculture's non-real estate debt were commercial banks. Commercial banks held 34 percent of non-real estate farm debt while PCA's supplied an additional 19 percent of the credit. FLB's financed the largest share of agriculture's real estate debt at 43 percent while commercial banks held 8 percent [USDA, 1984(a), p. 2, 3]. Figure 7 shows a historical breakdown of United States farm debt by holder.

The Data

Futures Yields. Monthly average Chicago Board of Trade T-bond futures contract prices were determined for the four nearby months for each of the four futures contract months currently being traded (March, June, September, and December contracts) with an overlap of one month. Figure 8 shows the time scheme under which T-bond price data were gathered. For example, the price for the June 1978 contract as it traded in March 1978, April 1978, May 1978 and the delivery month of June 1978 initiated the data set. Prices for the September 1978 contract as it traded in June, July, August and the delivery month of September 1978 were then determined. Similar data were obtained through the March 1984 T-bond contract. Averages were calculated using daily closing prices for the period 1978 through March 1984.[7] Yield equivalents were determined using tables based upon 8 percent 20 year bonds [Chicago Board of Trade, 1983].

During the study period, monthly average T-bond yields ranged from a low of 8.3 percent on the September 1978 contract in June 1978, to a high of 14.5 percent on the December contract in October 1981. Figure 9 shows nearby T-bond yields for the study period.

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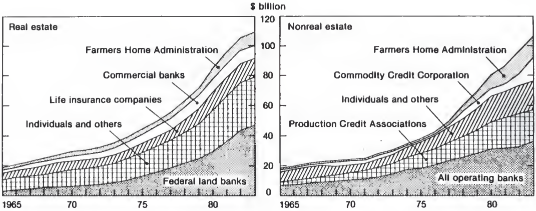
[7]Although T-bond futures trading was initiated in August 1977, it was not until trading of the June contract in March of 1978 that trading volume reached a level that insured market liquidity. 1,000 contracts in open interest was used as a measure of market liquidity.

FIGURE 7

TOTAL U.S. FARM REAL ESTATE AND NONREAL ESTATE
DEBT BY LENDER, 1964 - 1983



[United States Department of Agriculture, 1983(f), Chart 1]

FIGURE 8

TIME SCHEME FOR U.S. TREASURY BOND FUTURES PRICE COLLECTION

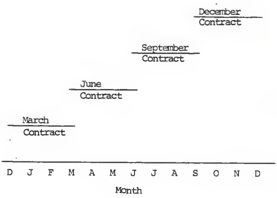
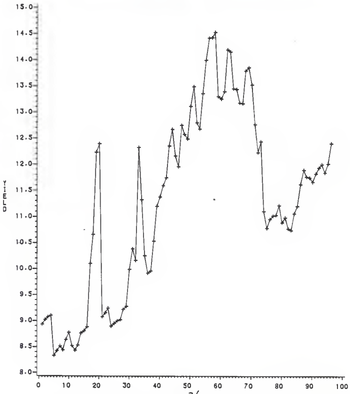


FIGURE 9

MONTHLY AVERAGE YIELDS OF NEARBY CHICAGO BOARD OF TRADE U.S. TREASURY BOND FUTURES CONTRACTS, MARCH 1978 TO MARCH 1984



[a] 1 = June 1978 contract in March 1978, 2 = June 1978 contract in April 1978, 3 = June 1978 contract in May 1978, 4 = June contract in June 1978, 5 = September 1978 contract in June 1978 and so on.

Cash Interest Rates. Federal Land Bank interest rates on farm real estate loans are uniform across all operating FLB's in the 9th Farm Credit District and are based on the average cost of loan funds.[8] The FLB's obtain loan funds through the sale of FLB bonds in the U.S. money investment market. FLB bonds are normally issued quarterly with different maturities and issue rates. For example on July 23, 1984, bonds maturing January 20 1987, January 20, 1989 and January 20, 1992 were issued. Yields were 13.20 percent, 13.70 percent, and 13.75 percent respectively. Variable rate loans with maturities of 5 to 40 years are made as well as 5 year fixed rate loans. The interest rate on a variable rate loan can change the first day of any month during the loan period and is based on the current average cost of funds for the District. The interest rate of the 5 year fixed rate loan is set based on the cost of funds from a special issue of FLB bonds. The size of the bond issue which provides funds for the 5 year fixed rate loan is made based on prior borrower committments. In other words, the borrower does not know his interest rate until after he is committed to the loan.

The PCA interest rate in this study is the base rate charged to each member PCA in the 9th Farm Credit District by the Federal Intermediate Credit Bank (FICB) of Wichita Kansas. This rate is the same for all member PCA's. Each separate PCA then charges its customers this base rate plus a given "operating" spread, which depends on the size and structure of the individual PCA. Operating spreads were between .75 and 3 percent. The base

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[8]This study does not include the impact on effective interest rate of stock purchase requirements or closing fees which, during the study period, could vary from one FLB to the next.

rate, and hence the borrower's interest rate, can change on the first day of any month during the loan period.

The FICB obtain funds principally through the sale of short-term bonds supplemented by the sale of some intermediate-term bonds and discount notes. Bond issues usually take place monthly with the majority of bonds issued with 9 month maturities. Figure 10 shows average monthly interest rates charged by FLB's and the average monthly PCA base rate from March 1978 through March 1984.

Commercial bank interest rate data are from selected Kansas agricultural banks.[9] The rate quoted is the base agricultural loan rate. Loan rates for individual customers are determined using the base rate and an incorporated risk factor. The risk factor is based on such things as the customer's past loan history, repayment capacity, financial position and purpose for which the funds will be used. The higher the perceived risk, the higher will be the loan rate. A banks "best" customers receive the loan at the base rate.

The banks agricultural base loan rate is usually a fixed margin above the individual bank's cost of funds. Commercial banks obtain loanable funds primarily though deposits. Hence bank rates tend to reflect competitive money market rates.

Agricultural loans made by commercial banks are set up with either fixed or variable rates depending on the bank and the nature of the loan. Fixed rate loans, as the name implies, are made with a guaranteed interest rate for the life of the loan. Loans which come due in 6 or 12 months, as

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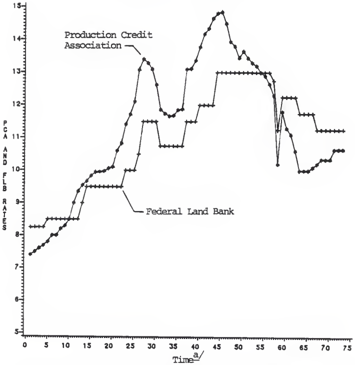
[9]Selection based on size and geographical region. Bank size ranged from $52.7 million to $1,464.1 million in assets as of June 30, 1982.

FIGURE 10

MONTHLY AVERAGE INTEREST RATES FOR FEDERAL LAND BANK AND PRODUCTION CREDIT ASSOCIATION FARM LOANS, MARCH 1978 TO MARCH 1984



Legend: Federal Land Bank = +, Production Credit Association = *

a/ 1 = March 1978, 2 = April 1978 and so on to 73 = March 1984.

well as longer term loans of 3-5 years are available at fixed rates at some commercial banks. Conversely, a variable rate loan is one in which the interest rate charged to the borrower can change during the life of the loan. Usually the variable loan rate follows the individual bank's base rate. This type of loan can be offered with the interest rate adjusted daily, weekly, monthly, quarterly, semi-annually or annually.

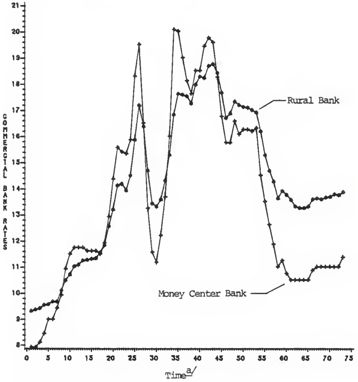
The commercial banks were separated into two catagories on the basis of interest rate volatility: commercial money center banks and commercial rural banks. Commercial money center banks are the larger, correspondent banks whose agricultural loan rates tend to more closely follow the national money market prime loan rate. The overall mean interest rate charged to agricultural producers by money centers was not significantly different from the mean interest rate charged to agricultural producers by the typically smaller rural banks. However, the standard deviation for the money center banks interest rate was 3.4 while rural banks interest rates exhibited a standard deviation of 2.6. Coefficient of variations were 25 and 18 respectively. Figure 11 shows the monthly average interest rate levels of commercial money center banks and commercial rural banks for the study period. Money center banks registered the highest monthly average rate of 20.08 percent in October 1981, while the rural banks highest monthly average rate of 18.75 percent was recorded in September 1981.

Correlation Analysis

According to Moens, correlation must be high between the cash and futures instruments movements for effective cross-hedging to take place [Moens, p. 56]. Correlation measures the closeness of a linear relationship between two variables. When the variables are highly

FIGURE 11

MONTHLY AVERAGE INTEREST RATES FOR MONEY CENTER BANK AND RURAL BANK FARM LOANS, MARCH 1978 TO MARCH 1984



Legend: Money center bank = +, rural bank = *

a/ 1 = March 1978, 2 = April 1978 and so on to 73 = March 1984 correlated, their points tend to fall on or near a line of fit. A perfect linear relationship is equivalent to a correlation of one. Table 4 gives Pearson product-moment correlation coefficients for each of the four cash instruments and T-bond yields.

TABLE 4

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENT MATRIX FOR STUDY VARIABLES (CASH MARKET INTEREST RATE AND U.S.TREASURY BOND FUTURES YIELD)

	FLB	PCA	Money Centers	Rural Banks	T-Bond Yield
FLB	1.000 (.0000)	0.823 (.0001)	0.418 (.0001)	0.767 (.0001)	0.819 (.0001)
PCA		1.000 (.0000)	0.779 (.0001)	0.932 (.0001)	0.850 (.0001)
Money Centers			1.000 (.0000)	0.889 (.0001)	0.719 (.0001)
Rural Banks				1.000 (.0000)	0.916 (.0001)
T-Bond Yield					1.000 (.0000)

Figures in parenthesis are significance probabilities. If the value is small, significance is indicated.

Correlation values range from a low correlation of .72 between T-bond yields and commercial money center rates to a high correlation of .92 between commercial rural bank rates and T-bond yields. Correlation coefficients between PCA rates and T-bond yields and FLB rates and T-bond yields are .85 and .82 respectively. Significance probabilities indicate that all correlation coefficients were highly significant. While no cash interest rate moves in perfect unison with T-bond futures yields, correlations are high. Each of these cash interest rates moves in a manner similar to T-bond futures yields.

Standard Deviation Cross-Hedge Test

Cross-hedging potential was evaluated by comparing the standard deviation of the cost paid to acquire cash funds (interest rates) to the standard deviation of basis between such cash costs and futures market yields. If the standard deviation of the basis is considerably less than the standard deviation of the cash interest rate, a good cross-hedge might be effected [Moens, p. 76]. In this study, the standard deviations of PCA, FLB, commercial money center bank and commercial rural bank rates are compared to the basis between these rates and T-bond futures yields. For a perfect cross-hedge, i.e. no basis risk, the standard deviation of the basis would be zero. As the cash market rates increase (decrease), T-bond yields would increase (decrease) by an identical amount.

Table 5 gives standard deviations for PCA, FLB, money center bank and rural bank interest rates and the basis between each of these four cash rates and T-bond futures yields. While no basis exhibits the standard deviation of zero necessary for a perfect hedge, the standard deviations of the basis are considerably lower than the standard deviations of cash instrument rates. Since the standard deviation of the basis between each of the cash instruments and T-bond yields is lower than the standard deviation of the cash instrument across all T-bond contracts, successful cross-hedging may be accomplished.

Table 6 lists interest rate coefficients of variation and means for the four cash instruments and their corresponding basis. It is evident that the relative variation in basis, as measured by the coefficient of variation (C.V.), is considerably higher for FLB's and PCA's than for commercial money center or rural banks. The C.V. may be useful for

TABLE 5

MEANS AND STANDARD DEVIATIONS IN BASIS AND CASH INTEREST RATES, FOR THE PERIOD MARCH 1978 TO MARCH 1984

FLB

	CASH RATE		BASIS	
Contract Month	Mean	Standard Deviation	Mean	Standard Deviation
March	11.01	1.51	- .59	1.06
June	10.85	1.67	- .09	1.04
September	10.98	1.57	- .12	0.90
December	10.93	1.63	- .29	1.09
All Months	10.94	1.57	- .29	1.03

PCA

	CASH RATE		BASIS	
Contract Month	Mean	Standard Deviation	Mean	Standard Deviation
March	11.46	1.55	- .14	0.79
June	11.25	2.26	.30	1.16
September	11.33	2.25	.21	1.27
December	11.31	2.06	.02	0.98
All Months	11.34	2.02	.10	1.07

MONEY CENTER BANKS

	CASH RATE		BASIS	
Contract Month	Mean	Standard Deviation	Mean	Standard Deviation
March	14.22	3.29	2.83	2.80
June	13.59	3.90	2.60	2.60
September	13.70	3.24	2.59	2.50
December	13.58	3.00	2.29	2.25
All Months	13.61	3.41	2.37	2.46

RURAL BANKS

	CASH RATE		BASIS	
Contract Month	Mean	Standard Deviation	Mean	Standard Deviation
March	14.60	2.23	3.01	1.65
June	14.16	3.20	3.21	1.57
September	14.30	2.66	3.18	1.35
December	14.15	2.41	2.86	1.00
All Months	14.21	2.69	2.97	1.28

TABLE 6

MEANS AND COEFFICIENTS OF VARIATION FOR BASIS AND CASH INTEREST RATES, FOR THE PERIOD MARCH 1978 TO MARCH 1984

	CASH RATE		BASIS	
FLB				
Contract Month	Mean	Coefficient of Variation	Mean	Coefficient of Variation
March	11.01	13.71	- .59	- 179.66
June	10.85	15.39	- .09	-1115.47
September	10.98	14.26	- .12	- 714.28
December	10.93	14.95	- .29	- 310.65
All Months	10.94	14.37	- .29	- 354.80
PCA				
Contract Month	Mean	Coefficient of Variation	Mean	Coefficient of Variation
March	11.46	13.53	- .14	- 576.47
June	11.25	20.12	.30	382.42
September	11.33	19.92	.21	587.87
December	11.31	18.24	.02	565.20
All Months	11.34	17.84	.10	1069.22
MONEY CENTER BANKS				
Contract Month	Mean	Coefficient of Variation	Mean	Coefficient of Variation
March	14.22	23.14	2.83	107.42
June	13.59	28.80	2.60	98.55
September	13.70	23.66	2.59	97.58
December	13.58	22.11	2.29	97.05
All Months	13.61	25.06	2.37	103.72
RURAL BANKS				
Contract Months	Mean	Coefficient of Variation	Mean	Coefficient of Variation
March	14.60	15.72	3.01	38.76
June	14.16	22.32	3.21	48.97
September	14.30	18.63	3.18	42.60
December	14.15	12.02	2.86	35.12
All Months	14.21	25.06	2.97	42.95

comparing the variability of the basis between contract months. For instance, the basis for the June contract under FLB's exhibits a considerably higher C.V. (-1115.47) than does the March contract under FLB's (-179.66). If proven statistically significant, this would imply less basis risk in FLB interest rate hedges using the March T-bond futures contract than in FLB hedges using the June T-bond futures contract.

Variability Differences in T-bond Contracts

Because this study encompasses the potential use of any of the four T-bond contract months currently being traded on the Chicago Board of Trade to hedge interest rate risk, the question of whether or not there is a "best" contract month to use in constructing the hedge is raised. Table 7 gives results of an analysis of variance procedure which compared the basis variability of the four T-bond futures contract months as measured by maximum changes within each year. The results show that there is no significant difference in basis variability between the T-bond futures contract months for FLB's, PCA's, money center banks or rural banks. This implies that it will be possible to use either the March, June, September, or December T-bond futures contract to construct interest rate hedges with similar effectiveness in hedging results being observed.

Basis Analysis

An effective job of hedging cannot be done without knowing the size and predictability of the basis. Cash and futures prices tend to move in the same direction in roughly parallel patterns, although not perfectly as shown in the correlation analysis discussed earlier in this chapter. Changes in the basis between cash interest rates and futures market yields tend to be more stable than either the cash interest rate or futures market

TABLE 7

ANALYSIS OF VARIANCE RESULTS FOR COMPARISON OF U.S. TREASURY BOND FUTURES CONTRACT MONTH BASIS VARIABILITY

FLB

Contract Month	Mean a/	Grouping b/
March	0.87	A
June	1.23	A
September	1.20	A
December	1.06	A

PCA

Contract Month	Mean a/	Grouping b/
March	1.05	A
June	1.23	A
September	1.04	A
December	0.80	A

MONEY CENTER BANKS

Contract Month	Mean a/	Grouping b/
March	1.20	A
June	1.31	A
September	1.84	A
December	2.33	A

RURAL BANKS

Contract Month	Mean a/	Grouping b/
March	0.86	A
June	0.93	A
September	1.21	A
December	0.89	A

a/ First difference means.

b/ Means with same grouping are not significantly different.

yield movements. Understanding basis relationships is the key to effective hedging [Chicago Board of Trade, 1980(a), p. 38].

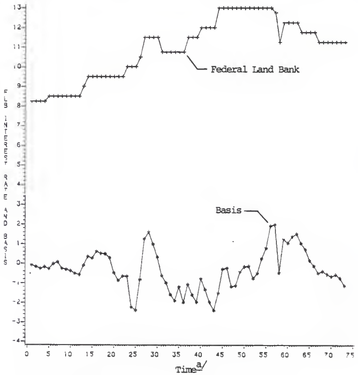
Figures 12 through 15 present cash interest rates along with the basis between the cash instrument interest rate and T-bond futures yields for PCA's, FLB's, commercial money center banks, and commercial rural banks respectively. It can be seen, that in general, the basis follows interest rate trends.

By regressing the basis between T-bond futures contract yield and cash interest rates against the cash interest rate, it is possible to determine the direction of basis movement as interest rates rise or fall. Regression results indicate that for money center banks, rural banks and PCA's, cash interest rate is a significant factor in determining the basis (Table 8). Slope coefficients are highly significant for money center banks, rural banks and PCA's at .62, .39 and .25 respectively for the all options catagories. R-squares were high for money center and rural banks with changes in the money center bank rate explaining 75 percent of the change in money center basis, while changes in rural bank rate explained 68 percent of the change in rural bank basis. The PCA's exhibited a considerably lower R-square of .22.

It can be seen from Table 8 that FLB interest rates are not a significant factor in determining the basis between T-bond futures yields and FLB interest rates. The low t-value of 1.08 indicates that the slope of the regression line is not significantly different from zero. This may be in part, due to the fact that the data used in this study does not reflect the effects of FLB stock purchase requirements or closing fees on effective FLB interest rates.

FIGURE 12

MONTHLY AVERAGE FEDERAL LAND BANK FARM INTEREST RATE AND BASIS BETWEEN FEDERAL LAND BANK INTEREST RATE AND U.S. TREASURY BOND FUTURES YIELD, MARCH 1978 TO MARCH 1984

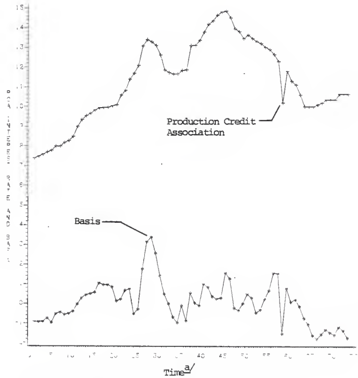


Legend: Federal Land Bank = +, Basis = *

a/ 1 = March 1978, 2 = April 1978 and so on to 73 = March 1984.

FIGURE 13

MONTHLY AVERAGE PRODUCTION CREDIT ASSOCIATION FARM INTEREST RATE AND BASIS BETWEEN PRODUCTION CREDIT ASSOCIATION INTEREST RATE AND U.S. TREASURY BOND FUTURES YIELD, MARCH 1978 TO MARCH 1984

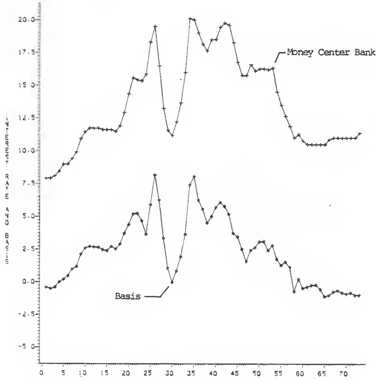


Legend: Production Credit Association = +, Basis = *

a/ 1 = March 1978, 2 = April 1978 and so on to 73 = March 1984.

FIGURE 14

MONTHLY AVERAGE MONEY CENTER BANK FARM INTEREST RATE AND BASIS BETWEEN MONEY CENTER BANK INTEREST RATE AND U.S. TREASURY BOND FUTURES YIELD, MARCH 1978 TO MARCH 1984



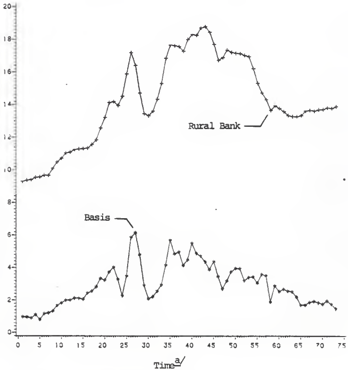
Time[a]

Legend: Money center bank = +, Basis = *

[a] 1 = March 1978, 2 = April 1978 and so on to 73 = March 1984.

FIGURE 15

MONTHLY AVERAGE RURAL BANK FARM INTEREST RATE AND BASIS BETWEEN RURAL BANK INTEREST RATE AND U.S. TREASURY BOND FUTURES YIELD, MARCH 1978 TO MARCH 1984



Legend: Rural bank = +, Basis = *

a/ 1 = March 1978, 2 = April 1978 and so on to 73 = March 1984.

TABLE 8

REGRESSION RESULTS OF THE BASIS BETWEEN U.S. TREASURY BOND YIELDS AND CASH INTEREST RATES ON CASH INTEREST RATES FOR VARIOUS FARM LENDING SOURCES

FLB

Contract Month	Intercept	Slope Coefficient	R-square a/
March	-3.00	0.22	.06
	(-1.9)	(1.54)	
June	-0.55	0.54	-.04
	(- .38)	(0.32)	
September	1.23	-0.12	.003
	(0.93)	(-1.0)	
December	-2.22	0.17	.02
	(-1.5)	(1.24)	
All Months	-1.08	.07	.002
	(-1.46)	(1.08)	

PCA

Contract Month	Intercept	Slope Coefficient	R-square a/
March	-1.65	0.13	.02
	(-1.4)	(1.25)	
June	-2.80	0.28	.26
	(-2.7)b/	(3.00)b/	
September	-2.94	0.28	.21
	(-2.4)b/	(2.66)b/	
December	-3.01	0.27	.28
	(-3.1)b/	(3.17)b/	
All Months	-2.74	0.25	.22
	(-5.0)b/	(5.25)b/	

Figures in parenthesis are t-values

a/ Adjusted R-square.

b/ Significant at the 99 percent confidence level.

TABLE 8—Continued

MONEY CENTER BANKS

Contract Month	Intercept	Slope Coefficient	R-square a/
March	-8.17 (-6.5) b/	0.76 (8.80) b/	.77
June	-5.54 (-6.5) b/	0.60 (10.0) b/	.81
September	-5.15 (-5.3) b/	0.54 (7.66) b/	.72
December	-6.01 (-4.8) b/	0.61 (6.84) b/	.67
All Months	-6.12 (-11.7) b/	0.62 (16.69) b/	.75

RURAL BANKS

Contract Month	Intercept	Slope Coefficient	R-square a/
March	-2.76 (-2.6) b/	0.39 (5.42) b/	.55
June	-3.04 (-4.3) b/	0.44 (9.04) b/	.78
September	-2.50 (-3.5) b/	0.38 (7.57) b/	.71
December	-1.85 (-2.4)	0.33 (6.22) b/	.62
All Months	-2.61 (-6.60) b/	0.39 (14.34) b/	.68

The way in which the basis is affected by rising or falling interest rates can be analyzed using graphical and numerical examples.

The regression equation for rural center banks for all options from Table 8 is:

Basis = -2.61 + .39 (x) + U

R-square = .68   t-value = 14.34

The dependent variable (basis) is the yield on the T-bond futures contract less the rural bank interest rate. The independent variable (x) is the FLB interest rate. Figure 16 shows this regression line.

The regression line illustrated suggests that as rural banks interest rates rise (fall) the basis will strengthen (weaken). If, for instance, at t = 0 the rural bank rate is 15 percent, the regression equation estimate of the basis between T-bond futures yields and rural bank rates would be: 3.24% = -2.61% + .39 (15%). This implies a corresponding T-bond futures yield of 11.76 percent. If at t = 1 the rural bank interest rate has risen to 16 percent, the new regression equation estimate of the basis would be: 3.63 = -2.61 + .39 (16%). The implied T-bond futures yield would thus be 12.37 percent. Likewise, if at t = 2 the rural bank interest rate fell to 14 percent, the regression equation estimate of the basis would be: 2.85% = -2.61 + .39 (14%). This implies a corresponding T-bond futures yield of 11.15 percent. Movements are shown in Figure 17.

With rising rural bank rates from 15 to 16 percent, the basis has strengthened from 3.24 percent to 3.63 percent. A producer making a short cross-hedge would have not been able to exactly offset his cash market risk by using an equal dollar amount of T-bond futures contracts due to this basis change. The following represents the hypothetical transactions which

FIGURE 16

EXAMPLE REGRESSION LINE, FIRST DIFFERENCES OF MONTHLY AVERAGE RURAL BANK INTEREST RATES ON FIRST DIFFERENCES OF MONTHLY AVERAGE U.S. TREASURY BOND FUTURES YIELDS FOR THE PERIOD MARCH 1978 TO MARCH 1984

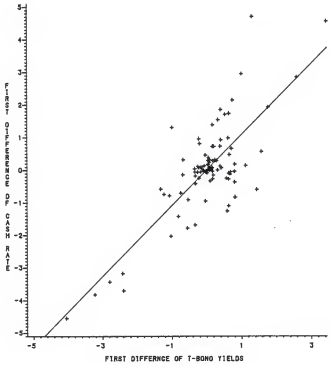
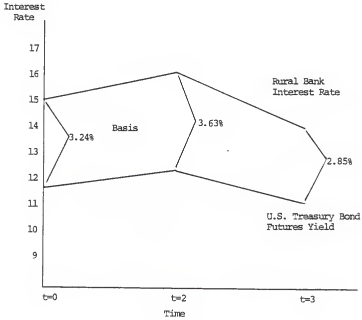


FIGURE 17

CHANGES IN BASIS BETWEEN U.S TREASURY BOND FUTURES YIELD AND RURAL BANK RATE AS RURAL BANK RATES RISE



would have taken place if a producer had implemented a short cross-hedge to "lock-in" a rural bank rate.

Cash Market	Futures Market	Basis
t=0 Borrower anticipates rising interest rates. Decides to "lock-in" current 15% rate because he feels interest rates will rise.	Sells 1 T-bond futures contract. Yield = 11.76%	3.24%
t=1 Borrower takes out loan. Interest rate is now 16%	Offsets futures position by buying back 1 T-bond contract. Yield is now 12.37%	3.63%
Opportunity loss = 1% Effective loan cost = 15.39%	Futures gain = .61%	

The hedger did not lock in a 15 percent interest rate but did manage to successfully offset a substantial portion of his increased cash cost by using a short cross-hedge. As rural bank rates rose by one percentage point, the basis between T-bond futures yields and rural bank rates rose by .39 percentage points. By using $1 of T-bond futures to hedge each dollar borrowed from a rural bank, the producer offset 61 percent of his increased cash borrowing costs.

The behavior of the basis with declining cash market interest rates could be analyzed in a similar manner, as could the regression results of each of the other cash instruments.

It is important to note that the basis movement for PCA's, commercial money center banks, and commercial rural banks with rising interest rates is unfavorable to the short cross-hedger. With the basis movement, the cash opportunity loss was not fully offset in the futures market. Conversely, with falling rates the projected basis change would be to the hedgers advantage. For instance, in the previous example, if cash interest rates fell to 14 percent instead of rising as anticipated by the borrower, the following transactions would have resulted.

Cash		Futures	Basis
t=0	Borrower anticipates rising interest rates. Decides to "lock-in" current 15% rate because he feels interest rates will rise before loan closing date	Sell 1 T-bond contract Yield = 11.76%	3.24%
t=1	Borrower takes out loan. Instead of rising rates as anticipated, rates have fallen. Interest rate is now 14%	Offsets futures position by buying back 1 T-bond contract. Yield is now 11.15%	2.85%
	Opportunity gain = 1% Effective loan cost = 14.61%	Futures loss = .61%	

The basis weakened as cash rates fell. The basis movement with falling cash rates offset part of the potential futures market loss. The direction in which the cash interest rates moves indicates the direction in which the basis will move.

Optimal Hedging Ratio

Information presented in the previous section indicates that while cash interest rates and T-bond futures yields move in the same direction, they do not move in a one-to-one relationship. This lack of parallel movement implies a variable basis which leaves a hedger open to basis risk. It is, however, possible to establish a hedge that will minimize this basis risk. Based on current research, Luethold recommends regressing the first differences of the cash market rate on to the first differences of the futures market yield to determine the relationship of the change in cash interest rate for each one percent change in T-bond futures yield [Luethold, 1984]. In this study the first differences of FLB, PCA, commercial money center banks and commercial rural bank rates, were regressed on to the first differences of T-bond futures yields.

The regression of the first differences gives a slope coefficient which indicates the size of the futures position needed to offset the variation in the cash position. This slope coefficient, or "optimal" hedging ratio, facilitates the minimization of basis risk for the hedger. For instance, when using the March T-bond contract to establish an interest rate hedge for a PCA loan, an optimal hedging ratio of .79 suggests that basis risk will be minimized by hedging each dollar of cash debt with .79 dollars of T-bond futures.

Regression results are listed in Table 9. Slope coefficients correspond to optimal hedging ratios. Optimal hedging ratios are given both by T-bond contract and for all contracts combined. Regressions for the All Months category are based on the continuum of 96 monthly average yields for successive nearby T-bond futures contracts and corresponding cash interest rates. Regressions for the March, June, September, and December T-bond futures options were calculated using only the monthly average yields for the nearby months in which that contract was traded and corresponding cash interest rates.

TABLE 9

OPTIMAL HEDGING RATIO COEFFICIENTS FOR U.S. TREASURY BOND FUTURES CONTRACTS AND VARIOUS FARM LOAN CASH INSTRUMENTS

FLB

Contract Month	Intercept	Slope Coefficient	R-Square a/
March	0.11 (1.06)	0.06 (0.44)	-.03
June	0.14 (1.63)	0.86 (1.15)	.02
September	0.04 (0.31)	0.58 (2.55)	.20
December	0.08 (0.68)	0.27 (1.64)	.07
All Months	0.02 (0.24)	0.42 (6.59) b/	.31

PCA

Contract Month	Intercept	Slope Coefficient	R-square a/
March	0.03 (0.24)	0.42 (2.54)	.20
June	0.07 (0.47)	0.40 (3.21) b/	.27
September	-.08 (-.04)	1.42 (4.23) b/	.43
December	0.00 (.005)	0.68 (2.84) b/	.24
All Months	0.00 (-.01)	0.65 (8.26) b/	.42

Figures in parenthesis are t-values

a/ Adjusted R-square.

b/ Significant at 99 percent confidence level.

TABLE 9—Continued

MONEY CENTER BANKS

Contract Month	Intercept	Slope Coefficient	R-square a/
March	-.16 (-.57)	1.05 (2.85)b/	.23
June	-.09 (-.33)	1.79 (7.06)b/	.69
September	-.22 (-.06)	2.42 (4.70)b/	.49
December	0.01 (0.36)	0.38 (0.79)	-.01
All Months	-.042 (-.28)	1.18 (7.78)b/	.39

RURAL BANKS

Contract Month	Intercept	Slope Coefficient	R-square a/
March	.018 (0.10)	.789 (3.40)b/	.32
June	.046 (0.26)	1.06 (6.74)b/	.67
September	-.06) (-.31)	1.78 (4.85)b/	.51
December	0.67 (0.43)	0.69 (3.08)b/	.29
All Months	0.00 (-.03)	1.08 (12.35)b/	.61

This study will emphasize the use of optimal hedging ratios determined in regressions using all contract months. Since there is no statistically significant difference in basis variability between T-bond futures contract months, equally effective hedges could be established regardless of the T-bond futures contract used. An additional reason for emphasizing the all contract months regression results is that the 96 observations used to calculate the All Months category gives highly significant values for the optimal hedging ratio, while the smaller data series used to calculate individual contract month regressions suggest considerably less significant hedging ratios. T-values for the All Months category for FLB, PCA, money center banks and rural banks indicate that values for the optimal hedging ratios (slope coefficients) are all highly statistically significant.

Although high t-values indicate that optimal hedging ratios for the All Months categories are highly significant, low R-squares imply that there is a considerable amount of variation in cash interest rates that is not explained by movements in T-bond futures yields. The regression equations show that cash interest rates should be thought of as having two independent components, one related to T-bond futures yields and the other a random component about which T-bond futures yields give no information [Krasker, p. 67]. Since T-bond futures yields give the borrower no information about the random component, the best the borrower can do is to sell T-bond futures to nuetralize the risk of changing cash interest rates related to changing T-bond futures yields.

The objective of the hedger is to structure a hedge such that there are equal dollar movements in the cash and futures positions even if the changes in cash interest rates and T-bond futures yields are not equal.

Using optimal hedging ratios from the regression results suggests the following:

Cash Instrument	Optimal Hedging Ratio	Dollars in cash position effectively hedged by one ($100,000) T-bond contract
FLB	.42	$238,100
PCA	.65	$153,850
Money Center Banks	1.18	$ 84,750
Rural Banks	1.08	$ 92,590

For example, to effectively hedge $100,000 borrowed at FLB rates would require .42 T-bond futures contracts. Restated, since it is not possible to buy or sell fractions of a futures contract, the gains or losses from interest rates variability incurred while holding a $238,100 FLB loan can be offset by cross-hedging with a $100,000 T-bond futures contract.[10]

It is important to note that the use of optimal hedging ratios in establishing hedges does not preclude the possibility of basis gains or losses. The low R-squares exhibited by the regressions of FLB's (.31), PCA's (.42) and commercial money center banks (.39) indicate that a large portion of the variability in these interest rates is caused by a random factor against which the optimal hedge does not provide protection. The considerably higher R-square shown by the regression of rural banks (.61) suggests a higher degree of efficiency should be attainable when establishing hedges using this cash instrument.

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[10]Loans for one half of the dollar cash position listed above could be effectively hedged using $50,000 "mini" T-bond contracts traded on the MidAmerica Commodity Exchange.

Dollar Equivalency

The optimal hedging ratio relates the movements between the cash and futures instruments and indicates the size of the T-bond futures position needed to offset the variation in the cash position. However, it is also necessary to take into account the length of time each of the instruments is held. Tailoring the hedge to fit the loan maturity requires the hedger to balance the gains (losses) from holding T-bond futures over time with the losses (gains) associated with the cash position over time.

A movement in a T-bond futures yield results from a change in the selling price of the T-bond contract. Hence, a futures yield increase or decrease implies an absolute change in the dollar value of the futures contract. That change in value is equal to the change in yield multiplied by the contract face value and is not dependent on a time factor.[11] A one percentage point change in futures yield is equivalent to a $1,000 change in the trading price of a Chicago Board of Trade T-bond futures contract. The dollar change is the same whether this movement took place over one month or one year.

The dollar value of a one percentage point change in the interest rate of an agricultural loan on the other hand is dependent on the time over which that change is in effect. A one percent interest rate change on a $100,000 loan for one year is equivalent to a $1,000 change in interest cost. If the loan were for six months however, interest cost would change only $500. Consequently, in addition to the optimal hedging ratio, it is

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[11]All T-bond futures contracts are standardized. For trading purposes the maturity date for a specific futures contract month is assumed to be the same regardless of when that T-bond futures contract is traded.

necessary to adjust the number of futures contracts traded to account for the maturity of the loan. The following formula can be used to determine the number of T-bond futures contracts required for dollar equivalency of the cash and futures positions.

$$X = \frac{\text{OHR} \times \text{LPB} \times \text{Maturity}/12}{\text{Face Value of Futures Contract}}$$

where:

X = number of T-bond futures contracts required to obtain dollar equivalency of cash market interest rate changes and T-bond yield changes.

OHR = Applicable optimal hedging ratio for lending institution.

LPB = Cash loan principal balance.

Maturity = Length of time in months that cash position is held.

Face Value of Futures Contract = $100,000 for Chicago Board of Trade T-bond futures contracts or $50,000 for MidAmerica Commodity Exchange "mini" T-bond futures contracts.

The following example illustrates the use of this formula.

A farmer plans on summer grazing 400 head of steers. The steers are projected to cost $450 per head. He plans to purchase the steers on May 1 and to hold them for 6 months. Loan funds for the purchase cost will be obtained from a rural bank and repaid when the steers are sold. It is now February 1 and interest rates are projected to rise. The farmer decides to hedge his projected loan needs of $180,000 (400 head x $450 per head) in order to "lock-in" the current rate. How many Chicago Board of Trade T-bond futures contracts should the farmer sell February 1 to implement the hedge?

$$.97 = \frac{1.08 \times 180{,}000 \times 6/12}{100{,}000}$$

Since it is not possible to purchase or sell fractions of a futures contract, the number of contracts required would be rounded to one. On February 1 the farmer would sell one T-bond futures contract to lock-in the current rural bank rate.

If in the above example the farmer decided to hold the steers for 9 months, 1.46 T-bond futures contracts would be needed. This is calculated as follows:

$$1.46 = \frac{1.08 \times 180{,}000 \times 9/12}{100{,}000}$$

If only one \$100,000 Chicago Board of Trade T-bond futures contract were used, a significant portion of the cash debt would be unprotected from interest rate risk. On the other hand, if two T-bond futures contracts were used the farmer would, in effect, be in a speculative position on .54 of a T-bond futures contract. In this case, the farmer could round the futures requirement to 1.5 T-bond contracts. He would sell one regular T-bond contract on the Chicago Board of Trade and one "mini" contract on the MidAmerica Commodity Exchange or sell three "mini" contracts.

T-bond futures contract requirements such as 2.78 or .67 require the hedger to make futures contract transaction decisions that will either leave a portion of the debt unhedged and thus unprotected from interest rate risk, or put the hedger in a speculative position. Speculators use the futures market to assume price risk in pursuit of potential profits. The hedger uses the futures market as a means of protection from unpredictable and potentially damaging price changes. [Chicago Board of Trade, 1980(a), p. 10]. By taking a speculative position, the hedger would assume a portion of the price risk he sought to avoid by hedging. Total risk may be minimized by rounding to the nearest purchaseable futures contract. The futures contract requirements of 2.78 and .67 could be rounded to 3.0 and .5 (one "mini" contract) respectively.

Summary

The discussion in this chapter explored the mechanics and the feasibility of farmer interest rate hedging. Several cross-hedging tests were used to examine the cross-hedging potential for agricultural loans from FLB's, PCA's and two classes of commercial banks. Interest rates on agriculture loans from these lenders were found to be highly correlated with T-bond futures yields. This implied that movements in agricultural loan interest rates and T-bond futures are responsive to similar underlying factors. The standard deviation of the basis between the cash loan rate and T-bond futures was found to be less than the standard deviation of the cash interest rates for each of the lenders considered. This suggests the possibility for successful hedging since the risk associated with changes in basis assumed while hedging is less than the risk associated with holding the unhedged cash position.

Having determined that the potential for successful interest rate hedging does exist, the basis was examined in more detail. For PCA's, money center banks and rural banks, the basis was found to strengthen as interest rates rose. FLB interest rates showed no predictable basis movement with changing interest rates.

Analysis of variance of basis suggested that no statistically significant difference in basis variability exists between contract months. Hence, any contract month can be used without significantly influencing hedging effectiveness.

Regression analysis helped to determine the combination cash/futures position necessary to minimize basis risk. The Beta coefficient from the regressions gave the risk minimizing optimal hedging ratio.

Finally, a method was developed for matching T-bond futures requirements with the cash loan maturity. This method involved the use of a dollar equivalency formula which takes into account the length of time each instrument is held plus the optimal hedging ratio and gives the number of T-bond futures contracts required to offset cash market interest rate risk.

The following chapter will utilize the information and evidence gathered in this chapter to construct actual cross-hedging examples.

CHAPTER 4

APPLICATIONS

There exists the potential for a farmer to cross-hedge interest rates in order to reduce risk associated with changing interest rates. Although the likelyhood of perfect hedge is small because of basis risk, the basis between T-bond futures and cash rate for FLB, PCA, money center and rural bank lenders is less variable than is the cash rate. In the long run, the farmer would gain from cross-hedging his agricultural loans with T-bond futures.

Cost of Hedging

When considering whether or not to hedge the farmer must understand both the mechanics of hedging as well as the costs associated with hedging. Two types of cost should be considered: execution costs and transaction costs.

Execution Costs. Execution costs are represented by basis risk. The agricultural producer should recognize that speculation exists in hedging. The hedger has, in essence, substituted basis risk for interest rate risk. Even though the basis risk associated with a hedged position is hypothesized to be less than the interest rate risk associated with holding the unhedged cash position, the basis is still variable. Hence the hedger is speculating on the basis.

The cross-hedger is in another sense also a speculator. If interest rates are expected to rise, then taking a short position in the futures market will be of benefit. But, if interest rates decline, the farmer will benefit by not taking a position in the futures market. Whether interest rates rise or fall, the agricultural producer is locked into an interest rate by hedging. While the hedged position insulates the user from increased interest costs associated with rising interest rates, it also prevents him from benefiting from cost reductions inherent to falling interest rates.

Transaction Costs. Transaction costs result from the actual implementation of the hedge. They are represented by the commission charged by the broker for placing the hedge and by the opportunity costs of the margin. A check with several Kansas brokers found commissions ranging from \$72 to \$90 for an overnight trade[12] on a \$100,000 Chicago Board of Trade T-bond futures contract. The commissions for an overnight trade on a \$50,000 mini T-bond contract traded on the MidAmerica Commodity Exchange ranged from \$45 to \$60.

Margins in commodity trading act as a performance bond or earnest money. There are two components of the margin account balance used in financial futures trading. The initial margin component is a security deposit guaranteeing performance and is the amount of money required to open a financial futures trading account with a registered broker on the commodity exchange. The maintenance margin component is an amount below which the initial margin is not allowed to float.

The margin account balance is computed by debiting or crediting the daily price movements of a contract to the initial margin. If the futures

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[12]An overnight trade involves both the initiation and liquidation of a futures market position which is held over time. This is contrasted with day trading which involves establishing and offsetting a position in the same day. Day trades incur significantly lower commissions.

contract price moves favorably to the contract holder, a surplus is built which can be withdrawn by the contract holder. Conversely, if the market moves against the contract holder, the margin account is reduced by the appropriate amount. If the account balance falls below the maintenance margin requirement, the contract holder receives a demand for additional margin money known as a margin call. The amount of the call equals the initial margin requirement less the account's balance [Buchanan et al, p. 2.4].

Margin requirements are subject to change with changing price variability. At the time of this study the initial margin per Chicago Board of Trade T-bond futures contract was $2,500 with a maintenance margin of $2,000. The cash balance necessary to maintain the margin account is not itself a hedging expense. However, the opportunity cost of using the money for margin purposes should be considered a cost. In this study the initial margin is assumed to be borrowed at the cash market interest rate prevailing when the hedge is established. This interest expense is considered a hedging cost. Margin calls are not considered.

Cross-hedging Examples

It is possible to "lock-in" the anticipated interest rate prior to the loan period (fixed rate loans) or to fix the interest rate during the time period in which the loan is held (variable rate loans). Hedging strategies for interest rate risk reduction will depend upon whether the hedger is trying to fix the interest rate before or during the loan period. The required strategy is tailored to the loan maturity through the use of the dollar equivalency concept.

To facilitate the evaluation of interest rate hedging, a hypothetical Kansas cattle feeder with lot capacity of 8,000 head was examined.[13] The hypothetical feeder was assumed to own the cattle being fed. One thousand thirty-three head of 600 pound steers were purchased each month, fed for six months, and sold at a market weight of 1,056 pounds. To isolate the effects of variability in interest rates, all prices, except interest rates, were held fixed at January 1984 levels. Table 10 lists the expenses considered and January 1984 price levels.

It was assumed that all funds required for the purchase, feeding and handling of the steers were borrowed on the day the steers were purchased. Actual monthly average cash interest rates and T-bond futures yields from the study period were used to construct the following cross-hedging examples.

Fixed Rate Loan Hedging Example. On December 1, 1979 the cattle feeder, in anticipation of rising interest rates on loans to purchase cattle during the next three months, decided to lock-in the current interest rate offered by his rural bank by cross-hedging with T-bond futures contracts. The current rural bank rate was 14.19 percent. A six month, fixed-rate note for $984,660 (1,333 head x $738.68/head) was executed on the day each group of cattle was purchased. Each loan was repaid six months later when the cattle were sold. Cattle purchases were made on January 1, 1980, February 1, 1980 and March 1, 1980.

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[13]Eight thousand head is the approximate average capacity of Kansas feedlots of over 1,000 head capacity [Kansas Crop & Livestock Reporting Service, p. 3].

TABLE 10

GREAT PLAINS CATTLE FEEDING BUDGET
[600 LBS. TO SLAUGHTER]

Costs and Returns	Per Head	Price
Non-feed Costs:		
600 lb Feeder Steer	$403.92	$67.32/cwt
Transportation to Feedlot (300 miles)	$ 3.96	$.22/cwt/100 miles
Commission	$ 3.00	$3.00/head
Vet Medicine	$ 3.00	$3.00/head
Death Loss	$ 5.60	1.5% of purchase
Total Non-feed Costs	$419.48	
Feed Costs:		
Milo (1,500 lb)	$ 80.10	$6.34/cwt
Corn (1,500 lb)	$ 93.30	$6.22/cwt
Alfalfa (800 lb)	$ 56.80	$142.00/ton
Cottonseed meal (400 lb)	$ 68.00	$17.00/cwt
Feed handling charge	$ 21.00	$10.00/ton
Total Feed Costs	$319.20	
Total Feed & Non Feed	$738.68	
Returns:		
1056 lb slaughter steer [a]	$733.81	$69.49/cwt

[USDA, 1984(b), p. 24]

[a]Steers were assumed to gain 500 pounds in 180 days at 2.8 pounds per day. Market weight = 1,100 pounds less 4 percent shrink.

Using the optimal hedging ratio of 1.08 for rural banks, the number of futures contracts required to offset the cash market interest rate risk for each six month fixed rate is:

$$5.32 = \frac{984,660 \times 1.08 \times 12/6}{100,000}$$

Since it is not possible to buy or sell fractions of a T-bond futures contact, five \$100,000 Chicago Board of Trade T-bond futures contacts were used to establish each of the three hedges.[14] To implement these hedges, the cattle feeder instructed his broker to sell 15 March, 1980 T-bond contracts (3 loans x 5 contracts per loan). Each contract required an initial margin of \$2,500. Margin money was borrowed at the interest rate prevailing at the time the hedge was implemented (14.19 percent). An \$80 commission was paid for executing each futures contract. Results of the hedging program were:

Cash Position	Futures Position	Basis
December 1, 1979 Decision made to lock in current rural bank interest rate of 14.19% on loans of \$984,6^0 to be made Jan. 1, Feb. 1 and March 1, 1980.	Sells 15 March 1980 T-bond futures contacts Yield = 10.10%	4.09%
January 1, 1980 Borrowers \$984,660 for cattle purchase. Interest rate = 13.94%	Buys 5 March 1980 T-bond futures contracts Yield = 10.66%	3.28%
Decreased interest = \$1,230.83	Futures gain = \$2,800.00	

[14]In this study, T-bond futures requirements will be rounded to the nearest \$100,000 Chicago Board of Trade T-bond Contract.

Net decreased interest costs	$4,030.83	
Less commission	$ 400.00	
Less opportunity cost of margin (5 contracts, $2,500 @ 14.19% for one month)	$ 147.81	
Net decreased costs	$3,483.02	
Effective interest rate = 13.48%		
February 1, 1980		
Borrows $984,660 for February cattle purchase. Interest rate = 14.50%	Buys 5 March 1980 T-bond futures contracts Yield = 12.20%	2.27%
Increased interest = $1,526.22	Futures gain = $10,500.00	
Net decreased interest cost	$8,973.78	
Less commission	$ 400.00	
Less opportunity cost of margin (5 contracts, $2,500 @ 14.19% for 2 months)	$ 295.62	
Net decreased cost	$8,278.16	
Effective interest rate = 12.51%		
March 1, 1980		
Borrows $984,660 for March cattle purchase Interest rate = 15.88%	Buys 5 March 1980 T-bond futures contracts Yield = 12.39%	3.49%
Increased interest = $8,320.38	Futures gain = $11,450.00	
Net decreased interest cost	$3,129.62	
Less commission	$ 400.00	
Less opportunity costs of margin (5 contracts, $2,500 @ 14.19% for 3 months)	$ 443.43	
Net decreased cost	$2,286.19	
Effective interest rate = 13.73%		

The January 1 transaction shows the effects of a change in basis. The basis weakened from 4.09 to 3.28 percent. T-bond futures yields advanced relative to cash interest rates. Instead of the feeder gaining in the cash market and losing in the futures market as expected, the feeder gained from the movements in both the cash and futures markets. A considerable change in the basis resulted in both a decrease in cash interest cost as well as a futures market gain.

The February transaction again indicates the effect of another favorable move in the basis. Although both cash interest rate and future contract yield increased, the weakening of the basis from 4.09 to 2.27 percent benefitted the cattle feeder with a basis gain of $9,100 (1.82% gain x 5 futures contracts x $100,000 per contract). This favorable basis change had a considerable influence on lowering the feeder's final effective interest rate.

In the March transaction, a favorable change in basis is once again observed. In addition to the increased cash market interest cost of $8,320.38 being totally offset by the futures gain, a profit of over $2,200 is made on the transaction. This profit is due to the weakening of the basis by .60 percentage points. The weakening of the basis in these examples was contrary to expectations of basis behavior as indicated by previous regression analysis. This is a further indicator of high basis variability.

The three preceding interest rate hedges produced results which were favorable to the cattle feeder. In each case his effective loan interest cost was reduced. Relatively large reductions in loan cost resulted from favorable basis changes. However, the possibility of adverse price and basis movements does exist. For example, assume the same cattle feeder on March 1, 1980 anticipates that interest rates will continue to rise instead of begin to fall as he previously had speculated. Being well pleased with the success of his previous interest rate hedges, the cattle feeder decides to "lock-in" the current rate for the cattle purchase he intends to make on

April 1. To implement the "lock-in" of the current rate of 15.88 percent, the cattle feeder instructs his broker to sell 5 June T-bond futures contracts.

Cash Position	Futures Position	Basis
March 1, 1980 In anticipation of continued interest rate increases, decision is made to lock-in current rate of 15.88%	Sells 5 June 1980 T-bond futures contracts Yield = 12.32%	3.56%
April 1, 1980 Borrows $984,660 for April cattle purchase Interest rate = 17.18%	Buys 5 June 1980 T-bond futures contacts Yield = 11.32%	5.86%
Increased interest = $6,400.29	Futures loss = $5,000.00	
Net increased interest cost	$11,400.29	
Less commission	$ 400.00	
Less opportunity cost of margin (5 contracts, $2,500 @ 15.88% for one month)	$ 165.42	
Net increased cost	$11,965.71	
Effective interest cost = 18.31%		

The hedge undertaken to fix the April 1, 1980 interest rate actually increased the cattle feeders interest costs. This was due to an unfavorable strengthening of the basis by 2.3 percent. The cash rate advanced relative to the futures yield. The cattle feeder experienced both increased interest cost in the cash market and a loss in the futures market.

These examples illustrate how at any one point in time the variability of the basis is a significant factor. However, over time hedging should be beneficial in reducing interest rate risk. A summary of the hedging results follows:

Loan Date	Decreased Interest	Interest Cost per Steer Hedged	Unhedged
January 1, 1980	$ 3,483.02	$ 49.79	$ 51.48
February 1, 1980	$ 8,278.16	$ 46.20	$ 53.55
March 1, 1980	$ 2,286.19	$ 50.71	$ 58.65
June 1, 1980	-$11,965.31	$ 67.62	$ 63.45
Total	$ 2,082.06		
Average Interest Cost per Steer		$ 53.58	$ 56.78

The cattle feeder reduced his interest cost an average of $3.20 per steer over the hedging period. This was equal to a 5.9 percent reduction in his interest cost on these four groups of steers over unhedged interest cost. In this case, the cattle feeder was successful in using the futures market to transfer a portion of his interest rate risk to other parties (speculators).

Variable Interest Rate Loan Hedging Example. Instead of a fixed rate loan, assume that on January 1, 1980 the cattle feeder obtained from a commercial money center bank a six month, variable rate loan for the purchase of 1,333 head of cattle he intended to feed for 6 months. The note was for $984,660 with a variable interest rate tied to the bank's base rate. The loan interest rate changed on the first day of each month to match changes which took place in the bank's base rate. The current money center bank rate was 15.34 percent. The cattle feeder felt interest rates would rise during the loan period, forcing him to pay higher interest charges. In order to "lock-in" and hold the current interest rate, the cattle feeder decided to hedge. His money cost was fixed for the first month at 15.34 percent. To "lock-in" this rate for the remainder of the 6-month loan the cattle feeder had to lock-in the rate for February, March, April, May and June. Each possible change in interest rate required a hedge. Hence, to "lock-in" the variable rate loan the cattle feeder established 5 hedges — one for each of the 5 months in which the loan rate could change. Using the optimal hedging ratio of 1.18 for money center banks and a maturity on each hedge of one month, one T-bond futures contract was required to offset cash risk for each hedge.

$$.97 = \frac{984,660 \times 1.18 \times 1/12}{100,000}$$

The cattle feeder instructed the broker to sell two March 1980 T-bond futures contracts and three June 1980 T-bond futures contracts.[15] Initial margin money of $2,500 and a commission of $80 per contract was charged. Hedge transactions were as follows:

Cash Position	Futures Position	Basis
January 1, 1980		
Borrows $984,660 on variable rate loan. Decides to lock-in	Sells 2 March 1980 T-bond contracts. Yield 10.66%	4.68%
current money center bank rate. Interest rate = 15.34%	Sells three June 1980 T-bond Contracts. Yield = 10.58%	4.76%
February 1, 1980		
Variable rate moves to 15.88% Increased interest cost = $443.10	Buys one March T-bond contract. Yield = 12.23% Futures gain = $1,570.00	3.28%

[15]The March contract is the nearby contract for hedges to be lifted in February and March while the June contract is nearby for T-bond futures contracts to be closed out in April, May, and June.

March 1, 1980 Variable rate moves to 18.38% Increased interest cost = $2,494.47	Buys one March T-bond contract. Yield = 12.39% Futures gain = $1,730.00	5.99%
April 1, 1980 Variable rate moves to 19.50% Increased interest costs = $3,413.49	Buys one June T-bond contract. Yield = 11.32% Futures gain = $740.00	8.18%
May 1, 1980 Variable rate moves to 16.50% Increased interest costs = $951.83	Buys one June T-bond contract. Yield = 10.25% Futures gain = $330.00	6.25%
June 1, 1980 Variable rates moves to 14.70% Increased interest cost = -$525.15	Buys one June T-bond contract. Yield = 9.91% Futures gain = -$670.00	3.34%
Total increased interest cost = $5587.94	Total futures gain = $3,040.00	
Net increased interest costs	$2,547.94	
Plus commission	$ 400.00	
Plus margin opportunity costs (5 contracts, $2,500 @ 15.34% for average 3 months)	$ 479.38	
Net increased costs with hedging	$3,427.32	
Net increased costs unhedged	$5,587.946	

Effective interest rate, hedged = 16.04%
Effective interest rate, unhedged = 16.47%

Through hedging, the cattle feeder, while not locking in his target rate of 15.34 percent, did manage to reduce his increased interest costs associated with the variable rate loan by $2,160.62.[16] The fact that cash market interest rate changes were not perfectly offset by futures changes is once again a reflection of basis variability.

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[16] The fact that the perfect hedge was not obtained is consistent with a low hedging effectiveness coefficient of .39 for money center banks (Table 9).

Similar examples could be developed for both fixed or variable rate loans of other maturities and for variable rate loans with rate changes taking place quarterly, semi-annually or annually. The longer the interval between possible rate changes on a variable rate loan, the fewer hedges which must be established. For instance, if quarterly interest rate changes had been specified in the preceding example, the number of times the loan rate could vary would fall from 5 to 1 (on April 1). Similarly, the shorter the interval between possible interest rate changes, the greater will be the number of offsetting hedges required to lock-in the initial interest rate. The benefits of interest rate risk reduction gained from hedging a variable rate loan with frequent potential interest rate changes, however, may be outwieghed by commission charges and opportunity costs of the margin associated with establishing the large number of required hedges.

Pre-fixing a Variable Rate Loan. It is possible to combine the methods used in the preceding examples to both "lock-in" the interest rate on a variable rate loan prior to borrowing and to hold that rate during the loan period. The following futures transaction would have been required if the cattle feeder had decided on December 1, 1979 to "lock-in" and hold the interest rate on his January 1, 1980 money center bank loan for cattle purchases.

December 1, 1979
  Sell 5 March T-bond futures contracts
  (Establish Hedge to lock-in December 1 interest rate)

January 1, 1980
  Buy 5 March T-bond futures contracts
  (Offset December 1 lock-in)
  Sell 2 March and 3 June T-bond futures contracts
  (Establish Hedges to lock-in initial January 1 loan rate
  for 5 possible rate changes)

February 1, 1980
Buy 1 March T-bond futures contract
(Offset February 1 interest rate change)

March 1, 1980
Buy 1 March T-bond futures contract
(Offset March 1 interest rate change)

April 1, 1980
Buy 1 June T-bond futures contract
(Offset April 1 interest rate change)

May 1, 1980
Buy 1 June T-bond futures contract
(Offset May 1 interest rate change)

June 1, 1980
Buy 1 June T-bond futures contract)
(Offset June 1 interest rate change)

In January, hedges were both established and offset. The gain from closing out the December 1 futures position offsets the increase in cash market interest rates which took place between December 1 and January 1. At this point, the cattle feeder had established a rate similar to the December 1 interest rate as the effective January 1 variable loan rate (basis variability prevents perfect lock-in). However, on February 1, the variable interest rate could change. To hold his effective interest rate at December 1 levels through the loan's maturity, the cattle feeder established hedges for each possible interest rate change. Without hedging, the cattle feeder's interest expenses would have increased by $6,433.11 over the December 1 to June 30 lock-in period. Through hedging, the effective interest rate of the variable rate loan was lowered to 15.68 percent from an unhedged level of 16.47 percent. While not perfectly locking-in the December 1 target rate of 15.41 percent, hedging reduced the cattle feeders exposure to changing interest rates.

FLB and PCA Interest Rate Hedges

Cross-hedges for FLB and PCA loans can also be constructed. These hedges will be effective in reducing interest rate risk since the standard deviation of the basis between the cash instrument and T-bond futures yields is less than the standard deviation of the cash instruments (Table 5). However, FLB hedges exhibit a low hedging effectiveness coefficient of .31 (Table 9). This implies that the use of FLB interest rate hedges will be less likely to completely offset the potential users' interest rate risk than hedges for PCA's, money center banks or rural banks.

In addition FLB loans are generally amortized. When developing interest rate hedges for these loans, the hedger should be aware that amortization will affect the dollar equivalency necessary to establish the hedge. FLB loans are amortized with either a decreasing payment plan or a level payment plan. The decreasing payment plan provides for fixed principal payments and declining interest payments on the outstanding principal balance. The level payment plan calls for equal payment each year with a larger proportion of each succeeding payment representing principal and a smaller amount representing interest. The outstanding principal balance, and hence the number of T-bond futures contracts, required to hedge, decreases over time with either type of amortization.

Hedging effectiveness coefficients for PCA's indicate that interest rate hedges for PCA's will be slightly more effective than interest rate hedges for commercial money centers. The hedging effectiveness coefficient for PCA's at .42 (Table 9) is considerably higher than the coefficient for FLB's. Neither FLB's or PCA's offer a hedging effectiveness coefficient as high as the .61 found for commercial rural banks.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Review of Study

The principal objective of this study was to determine the feasibility of farmer use of interest rate hedging. Farmers are not only borrowing more dollars, but are also financially leveraging their operations to a greater degree than in the past. They are, in addition, facing increased interest rate variability as monetary conditions change and as financial institutions structure loans to pass the changing cost of funds to the farm borrowers as those cost changes occur. Cross-hedging interest rates on agricultural loans made to farmers by Kansas Federal Land Banks (FLB's), Production Credit Associations (PCA's), commercial rural banks and money center banks using U.S. Government Treasury bond (T-bond) futures contracts was examined. These lenders are the major sources of short term operating funds, intermediate-term capital equipment funds and long term real estate financing for farmer borrowers. T-bond futures contracts were selected as the cross-hedging instrument because of their market liquidity and $100,000 face value.

Based on data from March 1978 through March 1984, study results indicated there is potential for successful cross-hedging of interest rates on agricultural loans by farmers. Cash interest rates of agricultural loans to farmers were found to be highly correlated with T-bond futures yields. Correlation coefficient values ranged from a low correlation of .72 between T-bond futures yields and money center bank interest rates to a high correlation of .92 between rural bank interest rates and T-bond futures yields. Correlation coefficients were .85 and .82 between PCA interest rates and T-bond futures yields and FLB interest rates and T-bond futures yields respectively. High correlations indicate that each of these cash market interest rates moves in a manner similar to T-bond futures yields. Hence cross-hedging potential does exist.

To further examine cross-hedging potential, the standard deviations of cash interest rates were compared to the standard deviations of the basis between cash interest rates and T-bond futures yields. The standard deviation of the basis is less, in all cases, than the standard deviation of the cash interest rate. For example, the standard deviation for PCA interest rates was 2.02, while the standard deviation of the basis between PCA interest rates and T-bond futures yields for the same period was 1.07. Risk associated with a change in basis is, therefore, less than the risk associated with changes in the cash interest rate. Hence, cross-hedging with T-bond futures should be effective in reducing the effects of interest rate changes. While the standard deviation of the basis is less than the standard deviation of the cash interest rates, it is not zero. Basis risk does exist.

Since this study encompassed the potential use of any of the four T-bond futures contract months currently being traded on the Chicago Board of Trade (March, June, September and December), variability differences in the basis between the four contract months were examined to determine if contract months differed. Although coefficients of variation for basis shows considerable differences in relative variation between contract months for FLB's (-179.66 for the March contract to -1115.47 for the June contract) and PCA's (382.42 for the June contract to 587.87 for the September contract), analysis of variance indicated no statistically significant difference in basis variability in contract months for any of the lenders. Any of the four contract months can be used to establish interest rate cross-hedges for loans from FLB's, PCA's, money center banks or rural banks with similar effectiveness.

Regression analysis was used to inspect the relationships between the interest rate level and the basis level. The regression of the basis between the cash instrument interest rate and the T-bond futures yield on the cash instrument indicated that as interest rates rise, the basis will strengthen (cash interest rate advances relative to the futures yield) for PCA's, money center banks and rural banks. Based on all contract months combined, as interest rose by 1 percentage point, basis strengthened by .25, .62 and .39 percentage points for PCA, money center and rural banks respectively. Regression results for FLB's showed no statistically significant correlations between basis movements and cash interest rate movement.

The Beta coefficient from the regression of the first differences of the cash interest rates on the first differences of T-bond futures yields gave the optimal hedging ratio for each of the lending institutions. The determination of optimal hedging ratios was necessary to equate dollar value movements in cash interest rates and T-bond contracts. Optimal hedging ratios were .42, .65, 1.18, and 1.08 for FLB's PCA's, commercial money center banks and commercial rural banks respectively. Ratios were statistically significant for each of the lenders considered. Regression R-squares indicated the highest hedging effectiveness was for commercial rural bank loan hedges at .61 with somewhat lower hedging effectiveness for the other cash instruments.

The optimal hedging ratio relates the movements between the cash and futures instruments and indicates the size of the T-bond futures position needed to offset the variation in the cash position. However, it is also necessary to take into account the length of time each of the instruments is held. A formula was developed which can be used to determine the number of T-bond futures contracts required for dollar equivalency of the cash and futures positions. The formula:

$$\text{Number of contracts} = \frac{\text{Optimal Hedging Ratio x (Loan Maturity/12)}}{\text{Face Value of T-bond Contract}}$$

incorporated the optimal hedging ratio, maturity of the farm loan (in months) and the face value of the T-bond contract ($100,000 for Chicago Board of Trade futures contracts or $50,000 for MidAmerica Commodity Exchange "mini" contracts).

Using the optimal hedging ratio and dollar equivalency formula, it was determined that the minimum dollar amount of a one year fixed rate rural bank loan which could be effectively hedged using a $100,000 Chicago Board of Trade T-bond futures contract was $92,500. An examination of farm debt showed that as of January 1, 1982, 28.5 percent of all U.S. farms had debts of over $112,000. These farms, however, constituted the major farm production sector. A significant number of potential users seems to exist.

Example interest rate hedges for a Kansas cattle feeder were developed. A fixed rate loan example was constructed using commercial rural bank interest rates. A variable rate loan example was developed using money center bank rates. By hedging the fixed rate loan, the cattle feeder reduced his interest costs 5.9 percent over unhedged interest costs for the period examined. The variable rate loan hedge example showed a reduction in the cattle feeders' effective interest rate from 16.47 percent to 16.04 percent for the period examined. Each of these cross-hedges provided a partial offset of interest costs incurred in the cash position and suggested it is feasible for farmers to offset increased interest rate volatility through use of the futures market. However, these examples also provided evidence of basis risk. Relatively large and unanticipated changes in the basis occured. Even though basis risk is less than interest rate risk, high basis variability may result in unanticipated futures gains or losses.

Limitations of Study and Additional Considerations

A limitation of this study is the use of monthly average interest rates and T-bond futures yields. Averaging dampens, to some extent, the actual variability of daily T-bond futures price changes and potential daily or weekly interest rate changes.

The lending institution data used in this study are somewhat location specific. Commercial bank interest rates are from commercial banks which primarily serve Kansas farm borrowers. FLB and PCA data were for the 9th Farm Credit District, which encompasses Kansas, Colorado, Oklahoma, and New Mexico. Therefore, coefficient results, such as the optimal hedging ratio, may not be applicable in other areas. However, if the money markets are efficient, and only the absolute level of cash interest rates differ, the optimal hedging ratios should remain applicable to other areas.

A consideration in the use of interest rate hedging is the lender's attitude toward hedging. If the farmer is dealing with a banker who does not understand hedging or has a negative attitude toward hedging, it is unlikely that the farmer will be able to hedge. Since survey's show that many bankers have elected not to use interest rate hedging themselves, this becomes a valid concern. The availability of knowledgeable brokers to assist the farmer in establishing interest rate hedges may also be limited since interest rate hedging is a relatively new field.

Production skills alone are no longer enough to guarantee a farmer financial success. Given today's more volatile money markets, financial management and marketing skills are extremely important. Interest rate hedging is only one tool to be considered in developing a total financial management program. The farmer must understand the underlying factors which influence the futures price movement as well as know how to structure cash loans to make the best use of the futures market.

Need for Further Study

This study suggests that it is feasible for farmers to use T-bond futures contracts in developing interest rate hedges but does not provide specific strategies for determining when it is optimal for the farmer to hedge. Further study is needed to determine hedging strategies to maximize potential farmer gains from interest rate hedging. For example, how much must interest rates be expected to increase before hedging becomes a profitable transaction? Are there interest rate patterns that farmers should use in developing a hedging strategy?

Costs incurred in the interest rate hedge should also be explored in greater depth. While this study does include commission costs and the opportunity costs of the margin, the opportunity costs of the farmer's time for initiating and managing the hedge should be further analyzed. The impact of margin calls will also affect the hedging strategy.

While it is not suggested that interest rate hedging can or should be used by all farmers, cross-hedging tests and example interest rate cross-hedges indicated that interest rate hedging using T-bond futures contracts can be a viable tool for reducing interest rate risk for farmers.

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FACTORS IN AND FEASIBILITY OF INTEREST RATE HEDGING BY FARMERS

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ABSTRACT

Agriculture is becoming an increasingly capital intensive industry. Farmers are borrowing more dollars as well as financially leveraging their operations to a greater degree than in the past. They are, in addition, facing increased interest rate variability as monetary conditions change and as financial institutions structure loans to pass the changing costs of funds to the farm borrower as those cost changes occur.

The primary objective of this study was to determine factors involved in and the feasibility of farmer use of interest rate hedging. More specifically, cross-hedging of interest rates on agricultural loans made to farmers by Kansas Federal Land Banks (FLB's), Production Credit Associations (PCA's), commercial money center banks and commercial rural banks using U.S. Treasury bond (T-bond) futures contracts was examined.

Statistical analysis of data from March 1978 to March 1984 indicated there is potential for successful cross-hedging of interest rates by farmers. Cash interest rates paid by farmers were found to be highly correlated with Chicago Board of Trade T-bond futures yields. The standard deviation of the basis between cash interest rates and T-bond futures contract yields was less for all lenders than the standard deviation of the cash interest rate.

A regression analysis of the first difference of cash interest rates on the first difference of T-bond futures contract yields gave the optimal hedging ratio for each of the lending institutions. Based on the optimal hedging ratio and loan maturity, a formula was developed to determine

the number of T-bond futures contracts required for dollar equivalency of the cash and futures position.

Using the optimal hedging ratio and dollar equivalency formula, example interest rate hedges for a Kansas cattle feeder were developed. Even though basis risk remained, each of the example cross-hedges provided a partial offset of interest costs incurred in the cash position and suggested it is feasible for farmers to offset increased interest rate risk through use of the futures market.