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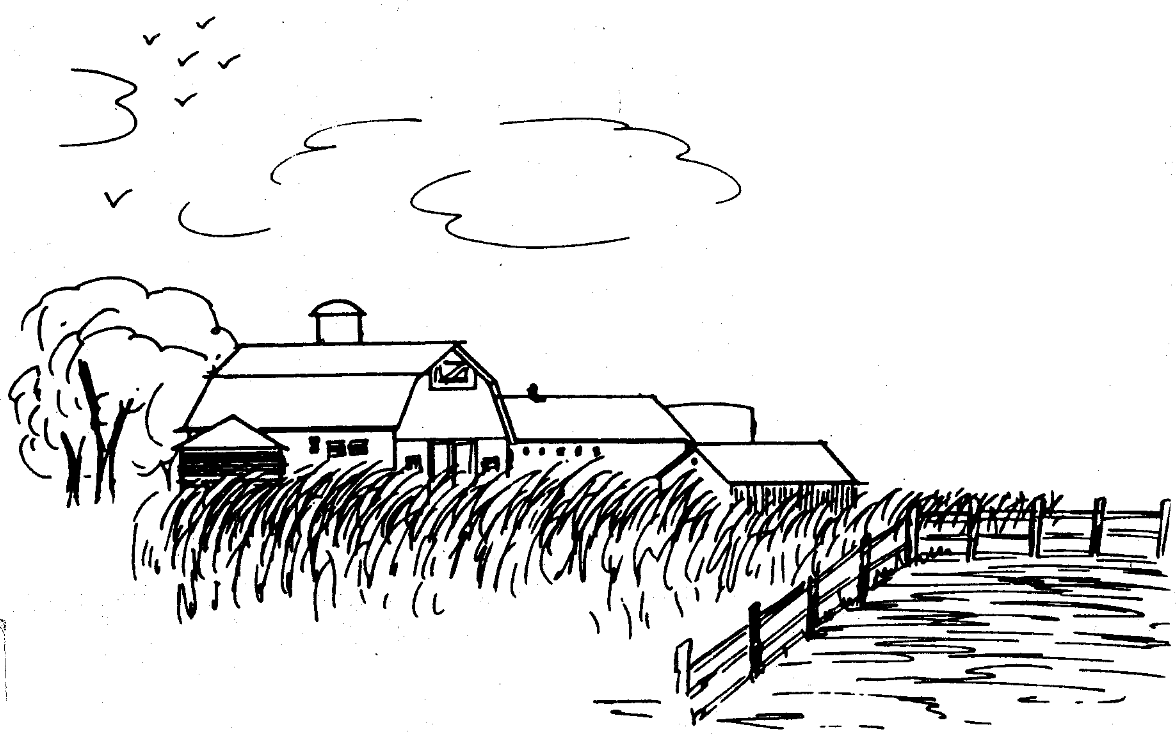

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PREFACE

This publication contains papers presented at the annual meeting of Regional Research Project NC-161, "Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues," at McLean, Virginia, October 1988. The papers represent topics which are part of the on-going research activities of participating universities and agencies and contribute to the objectives of the research committee. The focus of the meeting was on current management and policy issues in agricultural finance including: emerging issues facing agricultural lenders; policy/management of financial institutions; interest rates and risk factors; and farmer responses to new government programs.

The program was organized by a subcommittee composed of David Leatham (Chairman), Warren Lee, and Charles Moss and consisted of outside speakers, subcommittee reports, and selected papers.

The Committee extends its appreciation to Ed Harshbarger of the Farm Credit Administration for assisting with local arrangements and to Lucy Radke for her assistance in preparing mailings, compiling this proceedings publication, and handling committee correspondence.

Cole Gustafson
1988 Chairman
NC-161 Research Committee

Marvin R. Duncan

Emerging Issues for the Farm Credit System

Farm Credit Administration
McLean, Virginia

Following are the remarks of Marvin R. Duncan, Member of the Farm Credit Administration Board at the meeting of the NC-161 Research Committee on Financing Agriculture in a Changing Environment: Macro, Market, Policy and Management Issues held at the McLean Hilton Hotel, McLean, VA on October 4, 1988.

There are a number of emerging issues facing the institutions that comprise the Farm Credit System. They range from the role of directors, managers, and even stockholders of the borrower-owned institutions to credit standards, credit administration, internal controls, implementation of borrower rights, and the policy direction and management oversight provided by the directorate.

For our purposes here today, I have identified four emerging issues that I think merit our attention. Although they must all be faced in the near future, each has far longer term implications for the Farm Credit institutions and their borrowers. The four issues are:

- the structure of the Farm Credit System and its credit delivery mechanism;
- funding and loan pricing;
- capitalization and profitability; and
- renewing the spirit of entrepreneurship.

Even though these issues are somewhat interrelated, I would like to address each separately.

Structure & Credit Delivery

A History of Change

The Farm Credit System is currently undergoing marked structural change. However, change is nothing new to these institutions. The changes began soon after the old National Farm Loan Associations, later to become Federal Land Bank Associations (FLBAs), were chartered and continued after charters were issued to Production Credit Associations (PCAs).

In the 1930s, there were nearly 5,000 National Farm Loan Associations. If 10 farmers could qualify for a total of $20,000 in loans, they could apply for a National Farm Loan Association charter. The number of FLBAs was reduced to 1,216 by 1950 and to 553 by 1975. The number of Production Credit Associations peaked in 1945 at 511.

Now there are 225 Federal Land Bank Associations and 137 Production Credit Associations, with a wide mixture of common or separate boards, as well as common or separate managements at various levels. There are also 711 branch offices.

To add further diversity, the Columbia and Omaha districts each have one district-wide PCA. The Jackson and Spokane districts each have two PCAs, which amounts to a district-wide association with one hold-out association. The St. Louis district is down to four PCAs; Louisville is down to six, and Spokane has a district-wide Federal Land Bank Association.

Mergers of Banks

As you know, the Agricultural Credit Act of 1987, mandated the merger of the Federal Land Bank and Federal Intermediate Credit Bank in each district. This was achieved on July 6, 1988. The exception was Jackson where the land bank is being liquidated. In addition, eight district Banks for Cooperatives have voted to merge into a National Bank for Cooperatives effective January 1, 1989.

The stockholders of two of the remaining district banks -- Jackson and Spokane -- will reconsider their previous decisions not to merge and vote again. If they join the national bank, only Springfield and St. Paul will remain independent. Interestingly enough, like the national bank, they will be authorized to make loans in all territories served by the Farm Credit System.

Mergers of Associations

The next step in these structural changes is a vote by the stockholders of Federal Land Bank Associations and Production Credit Associations serving substantially the same territories to merge their associations. If they do, the resulting association would become a direct lender. Currently, the PCAs are primary lenders, but the FLBAs are agents of the land banks.

This could also become interesting. In Omaha, for example, there are 31 FLBAs and one PCA. If only one FLBA merged with the PCA, the resulting association could make direct long-term loans across the entire territory of the former PCA -- thus competing head on with the other FLBAs.

However, it doesn't stop there. Associations also have an opportunity to reorganize earlier mergers, disband, and/or seek reassignment to an adjoining district. Finally, discussions are currently underway that could result in shifts of associations affecting the territories of six Farm Credit Banks.

Local control now has real meaning to associations and their stockholders.

Fewer Districts

Let us continue with the final step. A systemwide committee is to come up with a plan to reduce the number of Farm Credit Districts, and hence Farm Credit Banks, down to no fewer than six. None of this precludes other kinds of mergers. Since the Banks for Cooperatives in Springfield and St. Paul apparently will not become part of the National Bank for Cooperatives, there is, for example, nothing to prevent them from merging with their respective Farm Credit Banks.

The Position of the Farm Credit Administration

I want to go clearly on record as saying that the Farm Credit Administration takes no position on any of the mergers that have taken place or that will be proposed. What will happen is strictly up to the stockholders.

Among the Farm Credit Administration's chief concerns are that the letter and intent of the law is carried out and that stockholders receive full financial disclosure and any other information necessary to help them make informed decisions on the merger proposals.

The statute states that the Farm Credit System:

> "be designed to accomplish the objective of improving the income and well-being of American farmers and ranchers by furnishing sound, adequate and constructive credit and closely related services to them, their

cooperatives, and to selected farm-related businesses necessary for efficient farm operations."

So, another concern of the Farm Credit Administration is that the structural design that the stockholders of the various institutions decide upon will accomplish that objective.

Bigger ≠ Better

From a professional standpoint, I think that whether there are the 11 Farm Credit Banks as currently configured or only six, the configuration will have limited bearing on cost effectiveness. In fact, Frederic Scherer, a noted structural economist, after years of meticulous study, observed: "On average, mergers decrease efficiency." Indeed, if after achieving whatever economies of scale are the norm for a given business, one could ask if bigger has ever been more efficient or if bigger has ever been more innovative.

In the case of the non-merged, jointly managed institutions, experience has shown that distress and hardship can result for the joint employees of these commonly managed, but corporately separate, institutions if one should fail.

In the commercial banking industry in 1987, banks with assets of $100 million to $500 million did better in both return on assets and return on equity than banks with assets of $500 million to $1 billion and substantially better than those with assets in excess of $1 billion.

By the same token, with the exception of whatever plusses may be perceived from having local control of a smaller institution, I doubt that it will make much difference if a district has one Farm Credit Association making direct loans of all kinds through branch offices or if a district has several independent associations making those loans.

Again, assuming the achievement of economies of scale, I believe it would be easy to over emphasize the advantages of mergers.

One might , however, ask whether in the longer term, the Farm Credit System needs both banks and associations. Perhaps, in time, one or the other will prove more efficient than a system composed of both.

Positioning for the Future

What will make a big difference for the Farm Credit institutions is how credit and related services are developed, packaged, priced, and delivered. In considering this area of structure, I concur wholeheartedly with the conclusions of Tom Peters in his recent book, Thriving on Chaos: Handbook for a Management Revolution.

After reviewing the evidence and experience of a number of companies, Peters gave this picture of the successful firm in the 1990s and beyond.

"It will be flatter - have fewer layers of organizational structure.

"It will be populated by more autonomous units - have fewer central-staff second guessers, more local authority to introduce and price products.

"It will be oriented toward differentiation, producing higher value-added goods and services, creating market niches.

"It will be quality conscious, service conscious, more responsive, and much faster at innovation.

"And it will be a user of highly trained, flexible people as the principal means of adding value."

Peters' first two points speak to organization. In the Farm Credit System, there are both banks and associations. Is it really critical how many banks or what kind of associations there are as long as there exists a reasonably flat structure with ample local autonomy and authority? Wouldn't eliminating management layers and streamlining the decision process improve the performance of banks and associations?

Remember, that non-interest costs for Farm Credit institutions are frequently marked by higher per dollar of loan volume than for other lenders with whom they compete. Fortunately, recent advances in information technology offer these institutions some innovative opportunities to improve the cost effectiveness of their credit delivery systems.

One might also question what value these layers add to the process? It could be argued that instead of adding value, they may often simply add unnecessary bureaucracy. But let's also recognize that management layering is a two-edged sword. Wouldn't eliminating those layers and having a high degree of local autonomy also help prevent the institutions from using one another as an excuse for taking an action, for not taking an action, or for simply dragging their feet? Putting responsibility and accountability where credit decisions are made and loans serviced will improve the performance of Farm Credit institutions.

Peters' second two points speak to products and services -- how they are developed, and how they are packaged, priced, and delivered to market segments. Farm Credit institutions can no longer afford to be stodgy, bureaucratic, political and traditional. Instead, they must become innovative, decisive, customer-driven, and profitable. These are the key elements to success.

The degree to which success is often achieved is found in Peters' last point. Success depends on people who are trained to do their jobs and given the ways and means of doing them well. It goes without saying that such people must be held accountable for the results. And if you have the right people with the right training, they will welcome that accountability. People want to excel and will do so for a firm that rewards excellence and achievement.

The legislation opens the doors for Farm Credit institutions to possibilities that have been talked about for years. But the efficiency and effectiveness of Farm Credit institutions will not be primarily dictated by their structure. It will, however, also be dictated by how well that structure is made to work. It will depend on the credit products and services to be offered to varying segments of the market and the mechanism to deliver those products.

Former Assistant Secretary of the Treasury, Charles O. Sethness, who was the Administration's point man on Farm Credit through all three legislative initiatives, commented recently on the future of the Farm Credit System. He said, "System institutions are going to have to figure out how to deliver customer-responsive services at competitive costs, and I think it is going to require some very sharp attention to the costs of the credit delivery system." An issue of primary importance then is how can credit best be delivered?

He added that another problem facing the system is "chewing through that backlog of high-cost debt." And that leads directly to my second issue -- funding and pricing.

Funding and Pricing

Funding

This issue involves how the Farm Credit institutions obtain their loan funds and how they price their loan products. The Farm Credit banks obtain their loan funds primarily through the sale of securities -- bonds and discount notes -- to investors in the Nation's money markets. Because their securities are sold in the "agency market," the Farm Credit banks have had a cost of funds advantage over their competitors.

Let me digress here and say that I don't think the agency market will be as big an advantage in the future as it has been in the past. This is true because financial markets have become much more efficient at intermediating credit. Recently, high quality commercial paper has commanded lower interest rates than have the discount notes of the Farm Credit banks. Innovations in agricultural credit, such as the securitization of debt, should further improve the efficiency of these credit markets and further erode the historic pricing advantage of Farm Credit institutions.

Pricing Their Products

Pricing their loans on the average cost of funds rather than on their marginal cost contributed to the Farm Credit institutions recent stress. This method of pricing their loan products put them at a distinct competitive advantage during periods of rising rates, but it also assured that the Farm Credit institutions were at a competitive disadvantage when rates were dropping because they had to live with high cost outstanding bonds that had no call provisions. For example, the banks still have some outstanding bonds that were issued in 1982 on which they are paying 15.2%. These bonds don't mature until 1992.

Farm Credit institutions introduced variable interest rates that helped them cope with mild swings in the market. However, when those interest rate swings became severe, this shifting of these interest rate risks to their borrowers created more problems than it solved. Interest rate risks transferred to borrowers came back to the banks and associations as credit risks when borrowers could no longer comfortably pay the higher debt service costs. Moreover, credit-worthy borrowers went elsewhere for lower cost loans, as competitors' interest rates began to fall.

Farm Credit institutions tried to counter this run-off of offering differential interest rates, giving cash-flowing, high-equity borrowers preferred rates. This method of loan pricing based the price of the loan on the risk a borrower brought to the other stockholders of the cooperative. While this principal has been accepted for many years in other farm cooperatives, many Farm Credit borrowers were angered by differential interest rates, probably because they did not understand the need to maintain the financial stability of their credit cooperatives. Distressed borrowers, on the other hand, argued that they should get lower rates to help their cash flow.

Other things being equal, the PCAs and Banks for Cooperatives should not have been caught in this interest rate bind, and for the most part, they weren't. PCA problems stemmed from inadequate credit standards, poor credit administration, and a lack of internal controls. The BCs haven't had many problems to speak of. For years, the PCAs obtained their loan funds chiefly through 9-month bonds, and the BCs obtained theirs through 6-month issues. In effect, the loan term matched the bond term -- the asset matched the liability. The BCs generally managed their credit business well, and as a result did not experience the depth of problems PCAs and Federal Land Banks faced.

The Federal Land Banks, in addition to the same management shortfalls of the PCAs, had not undertaken appropriate asset/liability management programs, and they experienced the most trouble. Farm Credit institutions -- particularly those making long-term loans -- simply must do a better job managing the liability side of their balance sheets. They must attain a better match between assets and liabilities.

For the future, this will mean more matched funding -- tying an interest rate to a bond rate for three to five years. It will mean adopting the kind of adjustable rate mortgages (ARMs) used by home lenders with caps on interest rate movements. And it may mean having callable debt instruments and prepayment penalties as a means of providing some measure of protection against being saddled with outstanding debt after the loans supported by that debt have been repaid.

Capitalization & Profitability

Profit a Necessity, Not a Luxury

Profit is essential for a credit cooperative, just as for any other business. The co-op traditionalists may prefer to call it earnings or even savings. But by any name, profit is necessary if a financial institution is to cover its operating expenses and cost of loan funds, maintain necessary reserves and allowance for loan losses, and capitalize itself to support loan growth. If the profits are beyond what is needed for these purposes, they can be distributed to borrower/stockholder through stock dividends and patronage refunds.

From a regulatory perspective, the Farm Credit Administration is interested in the safety and soundness of the institutions under our jurisdiction. In the examination process, the Farm Credit Administration looks at profitability indicators -- return on average assets, net interest margin, return on equity capital, and net operating income to average earning assets. These are important indicators for evaluating the operational soundness of the institutions. They are the same indicators investors look at when analyzing the institutions' financial statements and making decisions about their securities.

Capitalizing Farm Credit Institutions

The issue of capitalization is more complex. Before the Agricultural Credit Act of 1987, Farm Credit institutions were capitalized, in large part, through investments made by borrowers as a condition to obtaining loans. Borrowers from the Federal Land Banks and Production Credit Associations invested in the capital stock of the associations in amounts ranging from 5 to 10% of their loans. This was often a paper transaction because the borrowers usually financed their stock purchase with the same Farm Credit institution they were borrowing from.

The associations made similar investments in the banks. The stock was retired at par value when the loans were repaid. In essence, borrowers' capitalized their own loans. Borrowers from the Banks for Cooperatives also purchased stock on an equitable basis to help capitalize those institutions.

As a minimum requirement, farmers will now purchase stock of $1,000 or 2% of the loan, whichever is less. An institution, however, may choose to require higher levels of capital stock to be purchased. And its retirement will be at the discretion of the board of directors.

Capital Standards

But more important is what is going on right now. Capital standards for Farm Credit institutions now require that the institutions achieve a specified minimum capital base to support their risk adjusted asset base. Now, institutions are being capitalized rather than individual loans. Moreover, capital will now have a cost to banks and associations just as is true for commercial banks and thrift institutions

On September 28, the Farm Credit Administration Board approved final regulations governing capital standards for the Farm Credit institutions. Farm Credit institutions will be required to maintain a 7% risk adjusted capital ratio net of loan loss reserves. The capital will be in the form of at risk stock investment and retained earnings. The level of capitalization required by the regulations is, in fact, somewhat lower than many Farm Credit institutions maintained prior to the recent period of financial adversity.

The risk based capital standards conform very closely to standards adopted by other federal financial regulators for commercial banks and thrift institutions. These standards are all closely patterned after the Basle agreement, a pattern for financial institution capitalization agreed to by 12 industrialized countries in late 1987.

A majority of Farm Credit institutions are expected to achieve the risk-based capital requirements within the required 5-year phase-in period. The ongoing process of restructuring should permit many of the weaker units to achieve the standard over a somewhat longer period.

A stronger capital base will make the Farm Credit institutions more resilient and better able to weather the stressful periods and will provide a basis for sustaining their growth. It will also provide incentives for management policies that promote safety and soundness. Finally, a better capitalized system will provide assurances to stockholders and investors about the institution's viability.

Capital adequacy is measured by two major indicators:

- permanent capital to average assets,
- adversely classified assets as a percentage of risk funds.

The first, permanent capital to average assets indicates the amount of capital available to support growth. The second, adversely classified assets as a percentage of risk funds, compares the risk in the loan portfolio to the institution's capital base plus its allowance for loan losses. It also measures the threat to the institution's capital base presented by the problems in its assets. Again, the Farm Credit Administration, as a Federal regulator, and the investors in Farm Credit securities both look at these measurements.

Of course, down the road, the Farm Credit institutions will have the Farm Credit System Insurance Corporation and the Farm Credit Insurance Fund to insure the timely payment of principal and interest on notes, bonds, debentures, and other obligations of eligible and participating institutions. An interesting question is the level of reserves the insurance fund will require to protect Farm Credit institutions, investors, and taxpayers from the impact of financial adversity in Farm Credit institutions.

The Farm Credit Act of 1971, as amended provides the Farm Credit institutions with the tools and the mechanisms they need to deal with structure, credit delivery, funding, pricing, and capitalization and to realize the profitability necessary to be a viable competitor in the agricultural credit marketplace.

Let me paraphrase Peters once again in that perhaps I should not have said "to be" a viable competitor, because "to be" implies stasis and there is no place to stand anymore. The only excellent firms are those that are effectively evolving to meet the demands of a rapidly changing environment. For Farm Credit institutions that means continually striving to improve their products, their pricing, and their delivery.

A final issue relates to entrepreneurship and ownership.

Renewing the Spirit of Entrepreneurship & Pride of Ownership

If the Farm Credit institutions are to return to financial viability and prosper in the years ahead, their leadership and their borrower/stockholders must avoid succumbing to a Government program mentality and pursue with renewed vigor the spirit of entrepreneurship and pride of ownership that characterized their earlier years.

Though supporting the Farm Credit Act Amendments of 1985, the Farm Credit institutions were successful at negating the self-help provisions in those amendments, eliminating the chance for Federal financial assistance under that statute. The Farm Credit institutions were successful again when the Farm Credit Amendments Act of 1986 permitted Farm Credit institutions to use regulatory accounting practices that allowed some of them to operate at capital levels that otherwise would have resulted in their liquidation. And the Farm Credit institutions were successful when they came back a third time in 1987 with legislation that has made it possible for financial assistance to be provided. Some Farm Credit institutions are now fighting the provision calling for a one-time assessment that would require them to provide a modicum of that assistance themselves and reducing the level of taxpayer assistance required. Despite these actions, the Farm Credit institutions should not be lulled into believing that Congress will continue to step-in to solve their business problems. If it happens again, the cost in operating freedom and independence may well escalate.

By the same token, the Farm Credit borrowers should not think they have a right to have their loans restructured regardless of how that restructuring might affect the financial condition of the institution or the burden it may place on the other borrower-owners of the institution who have worked hard to keep their loans current. The Farm Credit institutions are required to restructure loans only if restructuring is less costly than foreclosure. They are borrower-owned, private sector, credit cooperatives, not Government programs.

The borrower ownership and cooperative features of the Farm Credit institutions have been among their greatest strengths resulting in what once was one of the largest and most successful agricultural credit organizations in the world.

Because these institutions were directed by boards whose members were also borrowers, Farm Credit institutions were attuned to the needs of those borrowers and were innovative in meeting those needs. However, while Farm Credit institutions were concerned about filling the credit requirements of borrowers, directors also recognized the need of having financially stable, earnings oriented institutions that would serve future generations. These directors established policies that would fulfill both requirements and held hired management accountable for carrying out those policies.

Borrowers, also, played an active role in the conduct of their institutions and watched with a critical eye what those institutions achieved. They chose their directors with care, often in highly contested elections. News releases proudly and justifiably boasted of stockholder attendance at annual meetings. Directors took pride in what they were able to report at those meetings. In short, Farm Credit institutions were cooperatives in every sense of the word. But somewhere, somehow, something went very wrong.

The Future is Now

It serves no useful purpose to point fingers and place blame. There is plenty to go around. We know what happened and we pretty much know why. What must be ensured is that the same mistakes are not made again.

The Agricultural Credit Act of 1987 provides both the tools and the opportunity for borrower/stockholder of Farm Credit institutions to once again take control over the future of their credit cooperatives. The challenge for these borrower/stockholders is to responsibly balance their legitimate interests as borrowers with the financial stability requirements imposed by ownership of their credit cooperatives.

There are substantive business considerations emerging for the Farm Credit institutions. The issues are clear. The prospects are present. They require immediate attention. The degree of effectiveness with which they are addressed will determine the future of the Farm Credit institutions. If that degree of effectiveness is high, the Farm Credit institutions can be assured their brightest successes are on the horizon.

In the final analysis, it's up to the borrower/stockholders who own the Farm Credit institutions. They must decide what is best for their institutions. Once decided, they must elect directors who will carry those views forward and who will exercise sound judgement giving direction to the credit cooperatives.

The directors must establish policies that reflect the views of the borrowers and hold management accountable for carrying out those policies. However, the directors must also realize that it is they and not management who borrowers hold responsible for the results.

It would be very constructive if the analytical and management expertise in this room could play a role in helping the directors, managers, and borrower/stockholders of the Farm Credit institutions to recognize the full range of these issues and their respective roles in successfully dealing with them.

METHODOLOGY IN ALLOWANCE FOR LOAN LOSS DETERMINATION

Martin Fischer and Glenn Pederson*

Generally accepted accounting principles (GAAP) require that an allowance for losses be established when (a) it is probable that an asset has been impaired, and (b) the amount of loss can be reasonably estimated. Concerning loan loss allowances for banks and other lenders, the 1983 Industry Audit Guide **Audits of Banks** states:

> A bank should maintain a reasonable allowance for loan losses applicable to all categories of loans through periodic charges to operating expenses. The amount of the provision can be considered reasonable when the allowance for loan losses, including the current provision, is considered by management to be adequate to cover estimated losses inherent in the loan portfolio [1, p.2].

Methods for estimating "losses inherent in the loan portfolio" are of great practical importance to lenders. A major challenge for the Farm Credit System (FCS) during the mid 1980s was to establish allowances in an environment where history and experience offered little useful evidence concerning the future level of loan losses. Elsewhere in the financial community, similar problems arose in connection with loans to developing countries and to energy-related sectors [2].

This paper addresses methodology in allowance for loan loss determination. Background issues relating to provision and allowance for losses in the FCS are reviewed, and impacts of FASB-15 accounting for restructured loans are discussed. A model of future loan losses of a Federal Land Bank (FLB) is developed. The model views future loan losses as a random variable, and yields estimates of the mean and variance of the distribution of future loan losses. The estimated mean of the probability distribution is presumably a reasonable estimate of "losses inherent in the loan portfolio." However, recognizing the uncertainty surrounding future losses, and in deference to the accounting principle of conservatism, management may prefer to establish an allowance in excess of the expected value of future losses. We propose that the allowance should be considered adequate if the probability that losses will exceed the allowance is acceptable (i.e., "small enough" for the comfort of management and auditors).

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Provision and Allowance Issues In the Farm Credit System 1/

The FCS has had considerable experience establishing allowances for losses in recent years. In 1985 and 1986, FCS incurred combined provisions for losses of $3.253 billion and $2.031 billion, respectively. These expenses were among the most visible factors underlying FCS net losses of $2.689 billion and $1.913 billion in those years. The flow of red ink stopped in 1987, as $184 million of prior years' provision expense was **reversed** (added back to income), and the FCS essentially broke even. The System has reversed $341 million of allowance through midyear 1988, and posted net income of $336 million. Provision for loss expense in the St. Paul District of the Farm Credit System paralleled the nationwide experience of FCS. The St. Paul District provision totalled $629 million in 1985 and $429 million in 1986, but in 1987 an $80 million reversal of provision expense occurred. Reversal of provision expenses continued in the St. Paul District in 1988, with reversals of $65 million taken through June 30.

The timing and magnitude of provision for loss has materially influenced the financial positions of system entities. Under Capital Preservation Agreements which existed prior to the third quarter of 1986, healthy System banks paid direct financial assistance to banks whose capital stock or participation certificates would otherwise have been impaired. Intra-system financial assistance accrued to $1.108 billion under these agreements between fourth quarter 1985 and third quarter 1986. Accrued assistance through the second quarter of 1986 was essentially cashed out by December 31, 1987. Financial assistance accrued in the third quarter of 1986 became the subject of several legal actions between contributing and receiving banks. One issue was that the financial viability of contributing banks could be jeopardized by providing assistance. Another issue was the "reasonableness" of provision for loss expenses accrued by recipients. Contributing banks did not wish to contribute if the provision expenses of recipient banks were excessive.

Ultimately, the Agricultural Credit Act of 1987 resolved the dispute over third quarter 1986 financial assistance: $415 million of payables accrued under the Capital Preservation Agreements in the third quarter of 1986 were assumed by the Financial Assistance Corporation (FAC). A $179 million assistance receivable accrued by the St. Paul Federal Land Bank in the latter half of 1986 was not cashed out by the FAC until July of 1988. If the St. Paul FLB had accrued its 1986 provision expenses in the first half of 1986 rather than the second half, it might have avoided contributing $70.8 million of assistance to other districts. It might also have received its assistance in cash at an earlier date. Clearly, the timing of provision expenses was important -- especially in 1986.

1/ This section is based on references [3] through [6].

Another issue relating to amounts paid under Capital Preservation Agreements is the treatment of negative provisions for loan losses (reversals) by receiving banks. Negative provisions could result in receiving banks being required to refund certain amounts previously received.

Allowances for loan losses are of interest to FCS banks and associations contemplating mergers. Depending on the particulars of the merger agreement, allowances for losses could influence the ownership interests -- and claims against future earnings or losses -- of banks and associations involved in mergers. One can envision a scenario in which overallowed bank "A" merges with bank "B" which is not overallowed. Future reversals of provision expense in the merged entity could benefit the former owners of bank B. Likewise, merger of an underallowed bank with another bank that is not underallowed could ulimately harm the stockholders of the latter bank.

Some FCS entities entered the era of "at risk stock" in a position of high leverage. Members of these entities may be concerned about the adequacy of existing allowances for loan losses, because loan losses in excess of existing allowances could result in loss of members' capital stock.

The FAC presumably takes an interest in allowances for loan losses when it evaluates requests for financial assistance. The amount of financial assistance provided to a recipient would likely depend on expected future charge-offs, provision expenses, and reversals -- in short, on the adequacy of the allowance for loan losses.

Allowance for loan losses was $2.567 billion or 4.8 percent of loan volume for the System on June 30, 1988. The St. Paul District had $453 million of allowance for loan loss or 6.9 percent of loan volume. Whether these allowances were inadequate, adequate, or excessive is of interest to borrowers, bondholders, the Financial Assistance Corporation, and management.

Impact of FASB-15

It is commonly understood that an allowance for loan losses is a reserve against future charge-offs of loan principal. However, in the present accounting and regulatory environment, FCS loan losses are more likely to be realized in the form of reduced future interest income than as charge-offs. This is especially true of restructured loans, which are accounted for under FASB-15, Standard No. 15 of the Financial Accounting Standards Board [8, Section 40].

Under FASB-15, a charge-off on a restructured loan would not be taken if the total of anticipated future cash receipts under the terms of the restructure agreement equals or exceeds the principal balance of the loan (provided that future cash receipts are probable and reasonably estimable). A charge-off would be taken if anticipated future cash receipts are less than the principal balance.

Interest income on FASB-15 restructured loans is recognized at an effective rate which equates the present value of future cash receipts to the recorded (pre-restructure) principal. The effective rate is usually below market rates. For example, in the most common loan restructure circumstances in the St. Paul District, the borrower receives an interest rate concession and/or foregiveness of principal. Anticipated future payments under the terms of the restructure typically exceed the pre-restructure principal balance, so zero charge-offs are taken. The effective interest rate, however, is commonly reduced to between 8 and 9 percent, which is 2 or 3 percentage points less than normal lending rates.

The loss of future interest income on restructured loans is clearly a "loan loss" in an economic sense. Likewise, the value of a restructured loan is clearly impaired when its effective yield is reduced below market interest rates. The following issue needs to be debated and resolved: What should be included in management's estimate of "losses inherent in the loan portfolio?" Should allowance for loan losses cover only anticipated charge-offs, or, should reductions in future interest revenue below market levels on restructured loans also be covered?

The Agricultural Credit Act of 1987 requires the FCS to restructure loans when restructuring is less costly than foreclosure. Regulations of the Farm Credit Administration require FCS to use FASB-15 on restructured loans. Charge-offs within the FCS could therefore be considerably smaller than was anticipated when existing allowances were established. Resolution of the allowance cum FASB-15 issue would seem imperative if consistent allowance for loss methods and interpretations are to be achieved among FCS entities.

Existing Allowance Methods

Existing allowance methods used by FCS entities are compatible with methods described in a study by the AICPA, **Auditing the Allowance for Credit Losses of Banks** [1]. While non-authoritative, the study offers practical advice on establishing allowances. Allowances are comprised of two parts: (1) A specific portion, which covers losses on specific loans, pools, or categories of loans, and (2) a general portion, to cover losses inherent in the portfolio which are not specifically identified or allowed for.

In the St. Paul FLB, specific allowances have been established loan-by-loan on all loans classified nonaccrual, vulnerable, or loss. The specific allowance is determined as follows:2/

$$\text{(1) Specific allowance} = \text{loan amount} - \left[\text{collateral value} - \text{selling costs}\right]$$

$$\text{if} > 0, \text{ otherwise} = 0$$

In essence, this procedure assumes a probability of loss equal to 1.0 on all nonaccrual, vulnerable, and loss loans, and a probability of loss equal to zero on other classes of loans. Furthermore, the procedure values collateral at its current value, so no consideration is given to the probability of alternative collateral value scenarios.

Besides the specific allowance, a general allowance is maintained against such contingencies as land value decreases, portfolio quality deterioration, and other risks theoretically not covered by the specific allowance.

If specific allowance understates the needed total allowance, this can be "corrected" by increasing general allowance. However, the reverse is not true: Too large of a specific allowance cannot be offset by a negative general allowance. In any case, one cannot know what "corrections" to the specific allowance are needed without first knowing how large the total allowance needs to be. In this regard, the ongoing debate about what constitutes a specific versus general allowance seems rather pedantic, and the effort devoted to "general" versus "specific" allowance for loss determination may be excessive. The real issue remains: How large should the total allowance be?

Model

The model presented here was developed and applied to the St. Paul FLB using December 1987 data. At that time the allowance was interpreted as covering future charge-offs only. Accordingly, "loan losses" are interpreted as charge-offs.

2/ Subsequent changes in the credit classification system necessitated changes in the procedure. Nevertheless, essentially all loans that were nonaccrual, vulnerable, or loss at the time of conversion to the new credit classification system had a specific allowance calculated as in (1) as of December 31, 1987. During 1987, a feature was added which permitted loan officers to assign a "factor" between zero and one to a loan for purposes of establishing specific allowances. Assigning a factor of 0.5, for example, causes the allowance to be established at half the amount given by (1). Allowance factors have been left at zero or one on nearly all loans.

Commodity market conditions, government policies, weather, management decisions of the FLB (restructure versus foreclosure), accounting rules, and the quality of the loan portfolio will influence future loan losses of an FLB. Many of these factors are interrelated, so the underlying process through which loan losses are generated is complex. Our model provides a simplified representation of this complex process. We view loan losses as dependent on future land values, credit quality, and loss exposure.

We assume that loan losses will depend on farmland values, which are an indicator of (and proxy for) general economic conditions in the farm sector. Losses depend on land values in two ways. First, the FLB's "loss exposure" (defined below) depends directly upon land values. Second, because of the presumed relationship between land values and farm sector economic conditions, the probability of a loss occuring (or, "loss rate") on loans of a particular quality depends on land values. For example, a strong farm economy with higher land values may result in a lower probability of loss, but a weak farm economy with lower land values will likely result in a higher probability of loss.

Changes in farmland values vary regionally, reflecting differences in commodity mix and nonfarm influences. For example, the St. Paul District has different views of the outlook for dairy land versus corn/soybean land. Future land values in each of the 23 service centers (territories) of the St. Paul District are underlying random variables in the model.

Credit quality of the existing portfolio is expected to influence future loan losses. The model assumes that the probability that a particular loan will fail depends on its current classification, and on future conditions in the farm economy (as manifested in land values). The probability of a loss is lower on better quality loans. For loans of a particular current quality, the probability of a loss increases if land values decrease.

The St. Paul FLB portfolio consists of a large number of loans, so it is neither practical nor desirable to identify probabilities of default on a loan-by-loan basis. Instead, loans are grouped into 12 discrete credit quality categories. The conditional probability of loan failure given land values is assumed identical for all loans within each category. The credit quality categories are as follows:3/

3/ Penetration refers to the ratio of loan amount to collateral value. Accruing loans are either performing, restructured, or high risk. A high risk accruing loan is one that is either delinquent or highly penetrated, or for which the borrower is current but has questionable repayment capacity.

1) Accruing Performing ≤100% penetrated
2) Accruing Performing >100% penetrated
3) Accruing Restructured ≤100% penetrated
4) Accruing Restructured >100% penetrated
5) Accruing High Risk ≤100% penetrated
6) Accruing High Risk >100% penetrated
7) Nonaccruing Unrestructured ≤100% penetrated
8) Nonaccruing Unrestructured >100% penetrated
9) Nonaccruing Restructured ≤100% penetrated
10) Nonaccruing Restructured >100% penetrated
11) Nonaccruing Unrestructured Cash Flag ≤100% penetrated
12) Nonaccruing Unrestructured Cash Flag >100% penetrated

Loss exposure (z) on a loan is defined as the loss that would be incurred under default, foreclosure, and acquisition and disposal of collateral by the FLB. It is calculated as follows:

$$(2)\ z = \text{loan amount} - (\text{collateral value} - \text{selling costs}) \quad \text{if} > 0, \text{ otherwise} = 0$$

Loss exposure is computed loan-by-loan for eight alternative land value scenarios by valuing collateral at 80, 85, 90, ... 115 percent of current value. Selling costs are estimated at 10 percent of collateral value. This yields a conservative measure of loss exposure for given land values.

Table 1 shows estimated loss exposure for the St. Paul FLB as of December 31, 1987. Aggregate loss exposure (Z) is shown for 8 land value scenarios and for 12 loan categories. Total loss exposure ranges from $978.6 million if collateral is valued at 80 percent of current value to $332.3 million if collateral is

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A loan is placed in nonaccrual status if any portion of the loan is believed not fully collectible with respect to principal and/or interest according to its original or restructured terms. Nonaccrual unrestructured cash flag loans are loans on which payments unexpectedly continued after the loan was placed in nonaccrual status, and a reassessment shows the loan is likely to be collected. This is a temporary status.

valued at 115 percent of current value. When collateral is valued at (100 percent of) December 1987 value, loss exposure is $521.3 million. Of this loss exposure, $208 million is on highly penetrated performing accruing loans, and $138 million is on highly penetrated high risk accruing loans.

Conditional expected loss for a loan in a particular quality category, given land values, is simply the conditional probability of loss for loans in that category, multiplied by the loss exposure on the loan under the particular land value scenario.

$$(3) \quad E(loss_i|v) = PL_{c|v} \cdot z_{iv} \qquad i \varepsilon c$$

where $E(loss_i|v)$ = expected loss on loan i given land value scenario v.

$PL_{c|v}$ = probability of a loss occurring on category c loans given land value scenario v.

z_{iv} = loss exposure on loan i under land value scenario v.

The expected loss on the loan is the weighted sum of conditional expected losses across land value scenarios (the weights being the probabilities of the various land value scenarios):

$$(4) \quad E(loss_i) = \Sigma_v \; P_v \; \cdot \; E(loss_i|v)$$

where $E(loss_i)$ is unconditional expected loss on loan i and P_v is probability of land value scenario v.4/

In estimating expected losses for the St. Paul FLB, subjective conditional probabilities of loss were provided by the Vice Presidents of Audit and Reviews, and by the Director of Special Assets, resulting in three sets of conditional probabilities. In the interest of conservatism in estimating expected losses, the largest conditional probability (of the three probabilities provided for each category and land value scenario) was used for estimation.

Managing appraisers provided subjective probability distributions for land values three years into the future for 23 territories in the St. Paul District. Another set of territory specific land value probability distributions was

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4/ Expected losses can be summed by category or territory to determine expected losses for any category or territory.

provided by the district senior appraisers. The land value distribution having the lowest mean value was used in subsequent estimations in the interest of conservatism. The district-wide volume-weighted expected change in land values was -1.99 percent. The volume-weighted subjective probability of a negative change in land values was .401.

District-wide loan losses are the sum of losses in each territory. The variance of loan losses for the entire district is

$$(5) \qquad VAR(L) = \Sigma_i \Sigma_j \; r_{ij} \; SD(loss_i) \; SD(loss_j)$$

where i and j are subscripts for territories, r is correlation between loan losses in territories i and j, and SD(loss) is standard deviation of loss. Because of joint dependence of losses in each territory on similar underlying economic phenomenon (government policy, commodity prices, exchange rates, etc.), the correlation of loan losses between territories is expected to be high. However, differences in commodity concentration and other portfolio characteristics between territories would result in less than perfect correlation in losses between territories. A correlation of .75 was assumed in the St. Paul application.

Estimates of standard deviations of losses within territories were obtained by assuming that conditional losses (losses in given land value scenarios) for service centers are known, i.e., have zero variance. Under the assumptions of the model, the only variability in conditional losses would be due to different specific loans failing. Simulations in which different loans were randomly chosen to fail showed minor variability due to different specific loans failing. The number of loans is large enough -- 65,000 -- that conditional loan loss has a tight distribution.

The assumption of zero variance in conditional losses is expected to have a minor impact on the estimate of variance. The assumption implies the following:

$$VAR(L_t) = \Sigma_v P_{vt} \cdot [Loss_{tv} - E(Loss_t)]^2$$

where t is a subscript for territory and P_{vt} is probability of land value scenario v in territory t.

Application of Chebyshev's Theorem

Using the estimated mean and variance from the probability distribution of future loan losses, Chebyshev's Theorem may be invoked to provide upper bound estimates of the probabilities of losses exceeding various amounts. Chebyshev's Theorem states:

If μ and σ are, respectively, the mean and the standard deviation of the distribution of the random variable x, then for any positive constant k the probability that x will take on a value which is at most $\mu - k\sigma$ or at least $\mu + k\sigma$ is less than or equal to $1/k^2$ [7, p. 149].

If the probability of losses exceeding the existing allowance is "too large" ("too small"), then the FLB may be considered underallowed (overallowed).

Summary and Conclusions

In recent years, the size and timing of provisions for loan losses have dramatically affected the financial performance of FCS entities. Substantial allowances remain as a reserve against future loan losses. Whether these allowances are adequate, inadequate, or excessive is of concern to regulators, borrowers, bondholders, the Financial Assistance Corporation, and management.

In large measure, the adequacy of existing allowances depends on how FASB-15 is interpreted and applied. FASB-15 changes the way losses are realized on restructured loans. Instead of taking losses immediately in the form of charge-offs when the loss is known, FASB-15 allows losses on restructured loans to be spread over the life of the loan and realized in the form of reduced interest income. Should the allowance for loan losses cover only charge-offs, or should the losses of interest income on restructured loans be covered as well? The principle of conservatism in stating assets on the balance sheet would seem to argue for allowances covering future losses of interest income on restructured loans, because the value of these assets is impaired. Common understanding, however, is that the allowance should cover only future charge-offs.

Besides FASB-15, future losses of the FCS will depend on economic conditions in the farm sector, the quality of existing loans, and collateral values. A model was developed for characterizing the probability distribution of future losses of an FLB. The model yields estimates of the mean and variance of the distribution of losses. Using Chebyshev's Theorem, upper-bound estimates of the probability that losses will exceed the allowance are derived.

The model requires probabilities of loss, and of future land value scenarios. These are necessarily subjective and leave results open to challenges regarding these parameters. However, any allowance method uses parameters which are subjective and open to the same criticism. We believe that by relying on credit, review, and appraisal experts to provide these probabilities and using the most conservative probabilities provided, the method generated reasonable estimates of expected loss, the variance of loss, and the probability of losses in excess of the St. Paul FLB's allowance.

We conclude with a plea for adoption of consistent methods for setting allowances for losses. Consistency in allowance methods is imperative if interested parties are to have confidence that allowances of System entities have a similar interpretation.

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Table 1 - Loss Exposure - Z Value - With Collateral Valued at 80 to 115 Percent of Current Value in Increments of 5 Percent, St. Paul Federal Land Bank

December 31, 1987

*** Key for Loan Categories *** a/

1 = Accruing Performing < 100% Penetrated
2 = Accruing Performing => 100% Penetrated
3 = Accruing Restuctured < 100% Penetrated
4 = Accruing Restructured => 100% Penetrated
5 = Accruing High Risk < 100% Penetrated
6 = Accruing High Risk => 100% Penetrated
7 = Nonaccruing Unrestructured < 100% Penetrated
8 = Nonaccruing Unrestructured => 100% Penetrated
9 = Nonaccruing Restructured < 100% Penetrated
10 = Nonaccruing Restructured => 100% Penetrated
11 = Nonaccruing Cash Flag < 100% Penetrated
12 = Nonaccruing Cash Flag => 100% Penetrated

Category	Z80	Z85	Z90	Z95	Z100	Z105	Z110	Z115
				(Million Dollars)				
01	119.8	79.5	48.5	26.4	11.6	3.2	0.0	0.0
02	284.6	265.5	246.3	227.2	208.0	188.9	169.7	151.8
03	31.5	22.6	15.0	8.7	3.9	1.1	0.0	0.0
04	83.6	76.7	69.9	63.1	56.3	49.5	42.6	36.2
05	55.4	39.1	25.3	14.5	6.6	1.8	0.0	0.0
06	205.6	188.9	172.1	155.4	138.7	121.9	105.2	89.2
07	35.9	26.4	18.1	11.1	5.5	1.7	0.0	0.0
08	62.8	57.1	51.5	45.8	40.2	34.5	28.9	23.8
09	26.8	18.6	11.8	6.6	3.0	0.9	0.0	0.0
10	58.0	53.4	48.9	44.4	39.9	35.4	30.9	26.7
11	4.5	3.0	1.9	1.0	0.5	0.1	0.0	0.0
12	10.3	9.5	8.7	7.9	7.1	6.3	5.5	4.8
	978.7	840.5	718.1	612.1	521.3	445.4	383.1	332.3

a/ Penetration equals loan amount/collateral value

SELECTING TAX ALTERNATIVES UNDER THE TAX REFORM ACT

by
Tammy Mickey
David Lins

The Tax Reform Act of 1986 (TRA) resulted in dramatic changes in tax laws for agricultural producers. Under the TRA farmers do, however, have a number of alternatives which influence the amount of taxes paid. The objectives of this paper are to review tax alternatives available to farmers and to determine under what conditions which alternatives should be selected in order to maximize after-tax income.

Tax Alternatives Available

Standard Deduction vs. Itemization: Under the TRA, taxpayers must choose between claiming the standard deduction or itemizing deductions. Since this is an annual election, the choice criterion is simple: choose the alternative which provides the largest deduction. Given the simplicity of this choice we will ignore it in further discussion.

Expensing vs. Nonexpensing: Under the Tax Reform Act, taxpayers who purchase new or used property for business purposes may elect to take an immediate deduction, rather than depreciate, up to $10,000 of the property's cost. However, if the annual investment in qualifying property exceeds $200,000 then the allowance decreases such that each dollar of investment over $200,000 results in a one dollar reduction of the maximum $10,000 allowance. If the current expense allowance exceeds total income earned from a business or trade, the unused portion may be carried forward as a deduction for future years.

The current expensing allowance may offset only active sources of income. Furthermore, if the property is not used for business purposes at least 50 percent of the time during the first two years of its life, the allowance is subject to recapture provisions. The Tax Reform Act stipulates a recapture period equal to the whole recovery life of the property.

Assuming positive income, the immediate deduction provided by the current expense allowance should reduce the tax burden in the year of purchase. However, claiming the current expense allowance also requires the taxpayer to reduce the property's depreciable basis by the total allowance earned, whether or not it can be completely deducted the first year. A smaller basis means smaller

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depreciation deductions in the future, and taxpayers should be aware of the implications for later tax years when considering the current expense election.

Cash Versus Accrual Accounting: The Tax Reform Act continues to allow most farmers to use the cash method of accounting, but new regulations have been incorporated to prevent abuse. The allowable deduction for prepaid expenses is now limited to 50 percent of the total farm expenses for the year. However, a taxpayer who lives on the farm and whose principal occupation is farming will not be subject to the new limitation if 1) the prepayment limitation has been met for the 3 preceding tax years, or 2) the excess prepayment is due to a business operations change caused by extraordinary circumstances (p. 3 Durst).

Most farmers prefer to use the cash method of accounting, and even under the new tax code, only large farms (specifically C corporations or partnerships that have a C corporation partner) which earn over $5,000,000 in annual gross receipts are required to use accrual accounting (p. 319 RIA Analysis). The tax liability may vary according to the accounting method used for preparing tax returns. For example, interest is a large expense for many operations, but under the cash accounting method farmers cannot claim deductions for accrued interest. They must pay off the accrued amount before that portion of the interest expense may be deducted. In choosing between cash and accrual accounting, farmers must determine whether the tax savings realized from income deferral and deductions for prepaid expenses exceed the lost deductions for accrued expenses. The difference in taxes between the two methods will depend upon the size and timing of business earnings and expenses.

Depreciation Method: The Tax Reform Act provides three alternative depreciation systems: the modified ACRS accelerated depreciation (MACRS), the Alternative Depreciation System (ADS), and a straight-line (SL) method. Like the old ACRS method, MACRS generates larger depreciation deductions in the early years of an asset's useful life. The Act continues the convention of pre-assigning property to a specific recovery class, but many types of property have been reassigned to classes with longer recovery periods. The Act creates new 7 and 20 year classes for personal property and extends the recovery period for real property and fixed improvements.

Longer recovery periods mean smaller annual deductions for some types of property, but the MACRS system now calls for double declining balance depreciation on all classes of personal property with recovery periods of 10 years or less. The remaining classes of personal property will continue to be depreciated according to the 150 percent declining balance method. To ensure maximum annual deductions, taxpayers will be permitted to switch to straight-line depreciation when the annual straight-line deduction exceeds the deduction under the declining balance method.

The ADS is an alternative to the MACRS form of depreciation. In general, the ADS calls for straight-line depreciation over longer recovery periods (p 209 RIA Analysis). Regulations require use of the ADS in calculating the depreciation allowance for the alternative minimum tax, certain tax-exempt properties, luxury assets, and properties held outside the U.S. However, the ADS may be elected for any property which also qualifies for MACRS depreciation. The ADS election is an annual election, but in any one year, such an election must hold for an entire recovery class of personal property (p. 209 RIA Analysis). However, the election for real property may be made on a property-by-property basis (p. 209 RIA Analysis).

Taxpayers who elect the straight-line method must either use the recovery periods assigned to the ADS or the recovery periods assigned to the MACRS recovery classes.

The tax code does not allow taxpayers to claim a full year's depreciation on new property placed into service during the tax year. Therefore, the tax code incorporates special mid-month, half-year, and mid-quarter conventions for calculating the depreciation allowance during the first and last years of service. Each of the depreciation methods mentioned above is subject to these conventions.

Farmers need to consider the interrelationship between depreciation and the other provisions in the tax code. For example, taxpayers who elect to use MACRS depreciation must calculate ADS deductions in order to determine the alternative minimum tax. In choosing one depreciation method over another, farmers should pick the method which maximizes the after-tax income over the long-run.

Looking at the tax options available; expensing versus nonexpensing, cash versus accrual, and three depreciation options; we find a total of 12 (2 x 2 x 3) possible selections. How can a farmer choose among these alternatives to maximize after-tax income? The answer of course is: "it depends." We move next to the identification of factors which are likely to influence the choice.

FACTORS AFFECTING TAX CHOICES

There are likely numerous factors which influence the appropriate choice of tax options. A priori, some of the more important are thought to be:

- Size of Farm
- Type of Farm
- Debt/Equity Position
- Future Price Directions
- Replacement Pattern for Capital Assets

    - constant replacement
    - early replacement
    - late replacement

- Stage of Growth

    - no growth
    - expansion
    - contraction

In this paper, we will look at the influence of size, debt/equity position, future price directions, and the replacement pattern for capital assets on the best choice of tax options available under the TRA. This paper will not address the issue of type of farm or stage of growth although both are likely to influence the choice of tax options.

Methodology

To assess the relative effects of the discretionary tax provisions, three interrelated models were used. A brief description of each follows.

Firm Simulation Model: The farm simulation model (FSM) constructed for this study has the capability to stimulate four years' financial statements for cash grain (corn/beans), beef cow-calf, and farrow-to-finish hog operations. The model itself is comprised of six components: the input sections, the debt schedule, the depreciation schedule, the cash flow statements, the inventory and accrual schedules, and the income statements.

The FSM starts with information taken from the 1986 FBFM data bank. Projecting future annual production and financial performance requires adjusting the base year inputs with adjustment factors. The adjustment factors are actually indices which create variations to the base year's production, price, and expense inputs throughout the four-year projection horizon. The model can simulate outcomes for a wide variety of economic scenarios.

The Aardvark Professional Tax Planner: The Aardvark Professional Tax Planner is the software package used to calculate the tax liability for the farm scenarios simulated by the FSM. The Professional Tax Planner is distributed by the CYMA/McGraw Hill Publishing Company. The equipment needed to run the program consists of an IBM-compatible personal computer with 512K of memory and two floppy disk drives as well as several 5-1/4 inch formatted diskettes on which to save the individual tax plan worksheets.

The tax planning software performs comprehensive tax calculations needed to accurately evaluate the tax alternatives of the Tax Reform Act of 1986 (p. ix, <u>Operator's Guide to the Professional Tax Planner</u>). The program allows the user to generate up to five years of tax return projections according to the rules and regulations contained in the current tax code.

The Net Present Value Model: To evaluate how various tax alternatives affect financial outcomes, a net present value (NPV) model was developed to compare simulated after-tax incomes. The NPV model calculates discounted values for the four years of projected income and for the future tax benefits the farmer derives from unused current expense credits and depreciation beyond the four-year projection horizon.

The discounted after-tax cash flows from the four-year projection consist of: net cash farm income plus depreciation, off-farm income, and interest income, less total taxes paid (the federal income tax, self employment taxes, and any additional tax owed from the alternative minimum tax). Although accrual income almost always differs from cash income, the model utilizes cash income because the net present value framework calls for the discounting of cash flows, not accrual adjustments. Therefore, the differences in after-tax cash flows between accrual and cash accounting are created by the difference in taxes paid.

The model calculates the future benefits from depreciation by multiplying the annual depreciation expense beyond year four by the average annual tax rate over the four-year projection horizon. The model follows the same format for calculating the value of any unused current expense credits. However, it is assumed that all unused current expense credits occur in year five.

Simulation Results

The models developed for this study can be used to simulate a wide variety of farm scenarios. A limited number of those scenarios are reported here.

Table 1 identifies the net present value of after-tax income and carryover tax credits for a small (547 acre) grain farm. This table demonstrates the various outcomes for all possible tax alternative combinations assuming constant capital replacement. Results of each of the 12 possible tax alternatives are reported, first under a scenario of constant prices and next under a scenario of generally increasing but variable prices. Results show some differences among the various tax alternatives.

Table 2 provides evidence of the best and worst tax alternatives, given various price scenarios and replacement patterns for machinery. Several points are evident from Table 1 and 2. First, the best and worst tax strategy varies from one price scenario to the next. In addition, the difference in the best and worst strategy may vary by more than $6,000 over a four year period. Consequently, the choice of strategy to follow can create a rather sizeable difference in financial outcomes. Not surprisingly, the current expensing alternative always showed up in the best strategy. However in a somewhat surprising result,

Table 1. Net Present Values of After-Tax Cash Flows for Various Tax Strategies, Small Grain Farms, Initial D/A Ratio = 20 Percent, Constant Replacement Scenario

Price Scenario	Cash vs. Accrual	Current Expensing vs. No Expensing	Depreciation Method MACRS	ADS	SL
			-- dollars --		
Constant	Accrual	NCE	148,131	146,593	147,312
Constant	Cash	NCE	147,733	146,200	146,913
Constant	Accrual	CE	151,438	150,967	151,177
Constant	Cash	CE	151,043	150,571	150,781
Rising	Accrual	NCE	186,902	187,358	186,101
Rising	Cash	NCE	190,060	188,529	189,451
Rising	Accrual	CE	188,663	188,097	188,380
Rising	Cash	CE	189,971	190,983	189,685

Table 2. Best and Worst Tax Strategies for Various Price and Replacement Patterns, Small Grain Farm Initial D/A Ratio = 20 Percent

Price Scenario	Replacement Pattern	Best Strategy	Worst Strategy	Difference in NPV
Constant	Constant	Accrual MACRS CE	Cash ADS NCE	$5,238
Rising	Constant	Cash ADS CE	Accrual SL NCE	$4,882
Constant	Early	Accrual MACRS CE	Cash ADS NCE	$3,948
Rising	Early	Cash SL CE	Accrual ADS NCE	$6,969
Constant	Late	Accrual MACRS CE	Cash ADS CE	$2,799
Rising	Late	Cash SL CE	Accrual ADS NCE	$5,414

current expensing also showed up among the worst strategies for the constant price-late replacement scenario. Thus one can not conclude that current expensing is always best irrespective of the other tax alternatives selected.

Table 3 identifies the best and worst strategies for a small grain farmer with an initial D/A ratio of 50 percent. A comparison of Table 2 and 3 reveals that for the rising price and early replacement pattern scenario, the best and worst tax strategies for the farmer with an initial D/A ratio of 50 percent are different than for a farmer with an initial D/A ratio of 20 percent. Thus financial position of the farmer can affect optimal tax strategy. Note also that the difference between the best and worst tax strategy is often higher for the farmer with the higher D/A ratio despite the fact that taxable income is much lower.

Table 4 and 5 identify the best and worst tax strategies for large (1,565 acres) grain farms under various price and replacement pattern scenarios. As was the case for small grain farms, the best strategy varies depending upon the initial D/A ratio. However, for large grain farmers, the worst tax strategy was the same regardless of the D/A ratio, except in constant price-early replacement scenario.

By comparing Tables 2 and 4 and Tables 3 and 5 we can determine if the best and worst tax strategies change by size of farm, given the same price and replacement pattern scenarios. Results of these comparisons indicate differences by size of farm do exist for both the best and worst strategies. Thus size of farm is shown to influence the optimal tax management strategy. Comparisons by type of farm have not yet been completed. However, preliminary evidence seems to suggest differences will also exist by type of farm.

SUMMARY:

The Tax Reform Act of 1986 offers farmers a number of tax alternatives including cash versus accrual accounting, expensing versus nonexpensing and three possible methods of depreciation. Simulation results suggest that the best choice for these alternative depends upon the size of farm, the level of debt, future price directions, and the replacement pattern for capital assets.

Simulation results also suggest that the magnitude of difference in net present value of after-tax cash flows between the best and worst choices for the various tax alternatives is substantial. Therefore, knowledge of the best tax strategy to follow can improve the financial position of farm firms.

Table 3. Best and Worst Tax Strategies for Various Price and Replacement Patterns, Small Grain Farms, Initial D/A Ratio = 50 Percent

Price Scenario	Replacement Pattern	Best Strategy	Worst Strategy	Difference in NPV
Constant	Constant	Accrual MACRS CE	Cash ADS NCE	$6,010
Rising	Constant	Accrual ADS CE	Cash SL NCE	$5,752
Constant	Early	Accrual MACRS CE	Cash ADS NCE	$6,488
Rising	Early	Cash MACRS CE	Cash ADS NCE	$4,137
Constant	Late	Accrual MACRS CE	Cash ADS NCE	$5,504
Rising	Late	Cash SL CE	Accrual ADS NCE	$3,038

Table 4. Best and Worst Tax Strategies for Various Price and Replacement Patterns, Large Grain Farms, Initial D/A Ratio = 20 Percent

Price Scenario	Replacement Pattern	Best Strategy	Worst Strategy	Difference in NPV
Constant	Constant	Accrual SL CE	Cash ADS NCE	$9,110
Rising	Constant	Cash MACRS CE	Accrual ADS NCE	$12,805
Constant	Early	Accrual MACRS CE	Cash ADS CE	$4,707
Rising	Early	Cash MACRS CE	Accrual ADS NCE	$9,523
Constant	Late	Accrual MACRS NCE	Cash ADS NCE	$5,949
Rising	Late	Cash MACRS CE	Accrual ADS NCE	$9,772

Table 5. Best and Worst Tax Strategies of Various Price and Replacement Patterns, Large Grain Farms, Initial D/A Ratio = 50 Percent

Price Scenario	Replacement Pattern	Best Strategy	Worst Strategy	Difference in NPV
Constant	Constant	Accrual MACRS CE	Cash ADS NCE	$8,546
Rising	Constant	Cash MACRS CE	Accrual ADS NCE	$11,015
Constant	Early	Accrual SL NCE	Cash ADS NCE	$6,137
Rising	Early	Cash SL CE	Accrual ADS NCE	$13,231
Constant	Late	Accrual MACRS CE	Cash ADS NCE	$7,563
Rising	Late	Cash SL CE	Accrual ADS NCE	$10,410

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FACTORS INFLUENCING FARM INVESTMENT BEHAVIOR

Eddy L. LaDue, *Lynn H. Miller* and *Joseph H. Kwiatkowski**

A knowledge of the investment behavior of farmers should allow policy makers to improve their estimates of farmer response to changing investment stimuli and increase their ability to influence investment through appropriate changes in policy variables. Such knowledge may also allow farm suppliers to influence demand for their products by addressing those factors that influence investment in their product or in items that use their product. For example, an electric company may be able to limit the need to expand generating capacity by encouraging investment in energy saving equipment or facilities.

What we are reporting today is a small part of a study on the Future Directions for the Upstate New York Agricultural Economy with Special Reference to the Potential for Electrical Energy Conservation. The study group conducting this research has five separate tasks, one of which is an investigation of the investment behavior of farmers. We will be discussing: (1) some of the results of our literature review, (2) the data collected, (3) some basic relationships we have found in the data, and (4) two models we have developed relative to investment in specific equipment items.

The Literature

To initiate this study, a comprehensive review of the literature was conducted (Brase and LaDue). The literature identifies a large number of variables as determinants of investment behavior. A partial list appears in the left column of Table 1. When you think about each of these factors individually, there is some economic logic for each of the factors. However, the basic question that is not answered by the literature is which factors are really important, or the most important. Or, there may be a more basic question as to whether there are a limited number of basic underlying forces which influence investment behavior that the variables listed in the literature are attempting to represent. If so, a number of the factors identified may reflect the same basic force.

One approach to this question is to start with a firm level neoclassical model of optimal capital accumulation (Jorgenson) where net worth (N) of the firm is given by:

$$(1) \quad N = \int_0^\infty e^{-rt} [P(t)Q(t) - w(t)L(t) - q(t)I(t)]$$

where:
P = Price of production (output)
Q = Quantity of output produced
w = Price of variable inputs
L = Quantity of inputs used
q = Price of capital
I = Investment in durable goods

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Table 1 *Variables Identified in Prior Research as Proxies for Factors Directly Affecting Investment*

	Input Prices	Product Prices	Input/ Output Relation	Discount Rate	Effective Planning Horizon	Utility of Expected Income
Age	N	N	I	N	D	I
Farming Experience	N	N	I	N	I	N
Education	N	N	I	N	N	N
Innovation Index	N	N	I	N	N	N
Legal Ownership	N	N	N	N	I	N
Farm Size	N	N	I	N	N	N
Farm Type	N	N	I	N	N	N
Distance to City of 20,000	N	N	N	N	I	N
Village Proximity	N	N	N	N	I	N
Risk Averseness	N	N	N	N	N	I
Interest Rate	N	N	N	D	N	N
Goals	N	N	N	N	I	I
Cash Flow	I	N	N	N	N	N
Income Expectations	I	I	N	N	N	N
Dairy Buyout Program	N	N	N	N	I	N
Management Index	N	N	I	N	N	N
Off-Farm Work	N	N	N	N	N	N
Regional Dummies	I	I	I	N	N	N
Percent Debt	N	N	N	I	N	N
Soil Quality	N	N	I	N	N	N
Decision Analysis	N	N	N	N	N	N
Tax Effects	N	N	N	I	N	N

D: Direct Proxy. I: Indirect Proxy. N: Not a Proxy

From this model it is clear that investment is a function of the prices of output, inputs and capital, the production function which establishes the level of output as a function of the amount of inputs and capital used and the time value of money or discount rate. Since optimal investment at any point in time is a function of future values of these variables, investment is determined by their expected value. Recognizing the lack of correspondence between the sale price of a used asset and the remaining flow of services from the asset implies a finite horizon and makes investment a function of the planning horizon. This lack of correspondence is particularly evident for buildings which often suffer a high level of capital loss upon construction, and new machinery which suffers a large decline in market value upon delivery at the farm.

Since investment is based on expected future income streams which are not known with certainty, expected income is probabilistic in nature. To reflect the fact that operators may value nonuniform probabilistic income streams differently, the model must be placed in a utility framework. Thus, the utility of expected income becomes a basic factor which may influence investment.

If the variables identified from the model represent the basic forces influencing investment, most of the variables identified by the literature as influencing investment are proxies for one or more of the basic forces. Some are more direct proxies than others but few could be called direct proxies for the basic forces influencing investment. Table 1 presents a categorization of the degree to which we believe the variables identified by the literature are proxies for the basic forces influencing investment. In general, studies of investment behavior have not had access to direct measures of the basic forces.

In developing models in this framework, we tried to avoid including more than one proxy for the same basic force in a model unless there was good reason to believe that the proxies would be complementary in reflecting the basic force rather duplicative. In selecting our models we considered: (1) appropriate proxy sets, (2) prior research results, and (3) the specific characteristics of the investment.

The Data

The data used in this study were collected as part of a survey of a random sample of Upstate New York farm businesses. Counties on Long Island and adjacent to New York city were excluded. One survey was used to obtain information to meet the objectives of five different groups of people. Thus, even though a personal interview was used and the survey was long, we were not able to obtain all of the information that may have been obtainable with an instrument that focused solely on investment behavior.

Data on over 1100 farms were obtained. However, some farms refused to provide the more sensitive data on such items as income or investment, which reduced the number of farms with sufficient data for inclusion in a model. The results reported in this paper include only the data on farms for which nearly complete information were obtained.

The data set is cross sectional and was collected at one point in time. The limited number of investment behavior questions that could be asked and the normal problems with respondent recall limited the amount of historical data that could be obtained. The cross sectional nature of the data set prohibits the use of many of the time series analysis procedures frequently used in investment analysis.

Basic Relationships

To obtain a basic idea of some of the general relationships that appear in the data, tables were developed for each of the variables identified in the literature as influencing investment behavior.

An example of those tables is presented in Tables 2 and 3 where investment is related to operator age. The life cycle theory of farm investment indicates that investment would be relatively modest for young farmers because they have few assets for loan security and modest borrowing capacity. Investments increase as the farm operator expands the business with growing income and improved borrowing capacity. As the operator approaches retirement investment declines and in some cases disinvestment takes place. This theory implies that investment should increase with age up to that age where farmers start to consider retirement in their planning and then investment could decline.

The amount of investment made by age group (Table 2) is consistent with life cycle theory although maximum investment occurs at a relatively early age, implying that their ability to invest is apparently important in limiting investment only during early age. Also, farmers may reach an acceptable business size relatively early in life (35-44 years of age). Thus, the lower level of investment for the 45-54 year age group may be the result of less desire to expand further rather than the incorporation of expected retirement in the planning decision process.

Table 2 *Relationship of 1985-86 Investment to Age of Farm Operator Upstate New York*

Age of Operator	Average Investment[a/] Expansion	Replacement	Total	1986 Rate of Expansion[a/]
				--Percent--
25-34	$ 2,900	$11,100	$14,000	2.9
35-44	4,400	14,000	18,400	0.7
45-54	3,400	8,800	12,200	1.1
55-64	2,000	8,500	10,500	0.8
65 plus	4,200	6,900	11,100	1.1
All Farms	$ 3,400	$10,100	$13,500	1.2

[a/] For all farms.
Source: 1987 Farm Management and Energy Survey.

Investment by young farmers is clearly restricted, likely by limited income and borrowing capacity. A higher proportion of the young (25-34) expanded their businesses (Table 3) and their rate of expansion (percent increase in assets) was far above that for other age groups (Table 2). However, the amount of investment per farm was less and the size of individual expansions was smaller than that for farmers who were somewhat older.

Table 3 *Relationship of 1980-86 Expansion Investment to Farm Operator Age Upstate New York*

Age of Operator	Percent of All Farms	Percent Expanding Once or more	Percent Expanding Twice or More	Average Expansion[a/]
25-34	14	47	20	$ 55,200
35-44	24	44	13	120,000
45-54	29	40	16	68,900
55-64	21	30	11	65,800
65 plus	12	23	15	70,800
All Farms	100	38	15	$ 80,400

a/ For farms that expanded. Most recent expansion only.
Source: 1987 Farm Management and Energy Survey.

Education is expected to be positively correlated to investment. The theory is that those with greater education will have better management ability, either because of what they have learned, for those who finish high school or go to a college of agriculture or business, or because of the higher level of intellectual ability required to enter other B.S. or graduate level programs. Economically, higher levels of management ability would be expected to require more other resources to reach an optimum combination of inputs. Operationally, we would expect better managers to have higher incomes making greater investment possible, and to have the ability to plan expansion of, and effectively manage, larger businesses.

The data indicate a clear positive relationship between education and investment, particularly expansion investment (Table 4). Those with more education expanded more frequently and the average size of expansion was larger (Table 5).

We do not have time today to discuss the results obtained for all of the variables investigated. Many of the variables did not have a strong enough relationship to investment to show that relationship through simple categorical tables. The variables for which relationships could be observed through this process were: (1) age, (2) education, (3) risk tolerance, (4) management, (5) size, (6) type of ownership, and (7) region of the state.

Table 4

Relationship of 1985-86 Investment to Farm Operator Education Upstate New York

Operator Education	Average Investment[a]			1986 Rate of Expansion[a]
	Expansion	Replacement	Total	
				--Percent--
No High School	$ 1,200	$ 7,200	$ 8,400	0.7
High School	2,700	9,600	12,300	1.0
Some College	3,300	10,300	13,600	0.7
College B.S.	7,600	15,800	23,400	3.2
Graduate	17,200	13,800	31,000	1.5
All Farms	$ 3,400	$10,100	$13,500	1.2

[a] For all farms.
Source: 1987 Farm Management and Energy Survey.

Table 5

Relationship of 1980-86 Expansion Investment to Farm Operator Education Upstate New York

Operator Education	Percent of All Farms	Percent Expanding		Average Expansion[a]
		Once or more	Twice or More	
No High School	20	30	11	$ 47,300
High School	50	38	13	54,000
Some College	15	44	14	81,900
College	14	42	23	99,000
Graduate	1	79	64	546,300
All Farms	100	38	15	$ 80,400

[a] For farms that expanded, most recent expansion only.
Source: 1987 Farm Management and Energy Survey.

Models of Investment Behavior

The two models of investment behavior that we are reporting on today have to do with two items of technology. These are energy (electricity) conserving technologies that have been developed during the last several years for use in the dairy industry.

The first is referred to as a heat recovery system. This is a system technology that uses the heat removed from the milk at the bulk tank to preheat water going to the water heater. Heated refrigerant from the bulk tank is used to heat the water which cools the refrigerant before it is cycled back to the bulk tank. Since dairy farms must cool all milk from animal body temperature to 32-40 degrees and use large amounts of hot water in the milking and cleaning process, large amounts of energy are used in these heating and cooling processes.

The second technology is a precooler which uses cold well water to cool milk down while it is being piped from the milking operation to the bulk tank. The milk passes through small tubes or channels that are surrounded by a counterflow of cold water. The water used in this process is frequently used for washing or animal consumption.

Both of these investments reduce energy use and, thus, cost. For most farms of any size, both are profitable investments when viewed in a net present value context.

The models used in this analysis are logit and probit models. Thus, we are dealing with the probability of investment. In reality we are looking at the probability that the farmer has invested in this technology at some point in time since its development.

Heat Recovery Model

The heat recovery model is a binomial logit model, estimated using the supplemental LOGIST procedure from the Statistical Analysis Systems Institute (SAS). The dependent variable was one (1) for farms with a heat recovery system, and zero (0) for those without such a system.

Since one of the objectives of the research was to investigate the importance of various variables to investment behavior, considerable searching within the data was anticipated. Thus, the sample was split into an estimating sample which was used to test alternative model specifications and a holdout sample which was used to determine the statistical properties of the final model. Observations were assigned to the two samples using a computerized random assignment process.

The initial model included six variables that were identified using the procedure outlined in the first (literature) section of this paper. Size of business represented by number of cows was included to reflect the economies of size inherent in such fixed investment. However, we did not expect the probability of investment to increase significantly for sizes larger than that required to establish clear profitability. For this reason, a squared term was included.

Whether a farm has a parlor or pipeline, rather than bucket milker, is expected to be important because ownership of such a system indicates an acceptance of milking system technology. Also, such systems usually use more water that must be heated for milking and cleaning.

Age was included to reflect the planning horizon of the operator. Also included was a direct measure of management which incorporated observations on a number of management functions such as obtaining price quotes, tracking market prices, recordkeeping and record use, managing personnel and reviewing performance toward goals. Better managers were expected to be more likely to observe and calculate the advantage of a heat recovery system, that is, determine whether it was a good investment. They were also likely to adopt new technology that would improve the efficiency of their business and be able to identify methods of managing the timing of water use and milk cooling to make the system effective for their farm situation.

However, when a model using these variables was estimated, a number of variables were insignificant and added little to the models ability to predict investment in a heat recovery system. Several alternate specifications were tried and evaluated based on the Chi Square value for individual variables, model statistics and the classification ability of the model.

The probability cutoff point for forecast classification of farmers as to whether they would be expected to invest or not was the sample probability of investing, which was 38.6 percent. This procedure is appropriate where the misclassification costs of type I and type II error are equal (Maddala, 1987).

Using these criteria, the "best" model contained fewer variables (Table 6), but was not particularly "behavioral" in nature. All the variables have the expected sign and are significant at the .01 level. The overall model has a high chi square. The estimated adjusted pseudo R value appears quite low, but is good for logit models with individual farm data. The C statistics[1/] is .791 which is also acceptable for this type of study. The model classified 68.5 percent of all farms correctly for the estimating sample with 66.3 percent of farms with heat recovery being correctly classified and 73.5 percent of the farms without the system being correctly classified. The classification efficiency of the model was 70.7 percent which is significantly greater than the conditional probability naive model rate of 52.6 percent.[2/]

[1/]The C statistic has a range of .5 to 1 with .5 indicating no apparent discriminatory power and 1 indicating perfect discriminatory power. It represents the probability that a randomly chosen farm with a heat recovery system will be correctly rated with greater probability than a randomly chosen farm without a heat recovery system.

[2/]The prior probability of investment is 38.6 percent, thus, the conditional prior probability of correctly classifying a farm given this knowledge is (0.386)(2.386) + (0.614)(0.614) = 52.6 percent.

Table 6 *Heat Recovery Model (Estimating Sample)*
261 Observations

Variable	Coefficient	Chi Square	P Value
Intercept	-1.93840	30.56	0.00
Cows	0.01616	21.98	0.00
Cows Squared	-0.00001	9.89	0.00
Pipeline	2.55233	11.65	0.00
Parlor	3.11514	15.35	0.00
<u>Model Statistics</u>			
Chi Square with 4 D.F.		64.09	
P Value		0.000	
Pseudo R		0.405	
C Stat		0.791	
<u>Correct Classification Percentages</u>			
Total		70.9%	
With Heat Recovery		66.3%	
Without Heat Recovery		73.5%	
Classification Efficiency		70.7%	
Conditional Naive Model Rate		52.6%	

The holdout sample results were as expected (Table 7). The coefficients differed somewhat but not significantly. The herd size squared term did become statistically significant at only the 0.05 level. The overall fit of the model was similar. The overall classification rate did decrease modestly. Surprisingly, the holdout sample model predicted farms with heat recovery systems at a much higher rate but did much poorer in classifying farms without such a system.

From this analysis, it appears that the expected profitability of these systems can be sufficiently predicted from the type of milking system and herd size that the other variables thought to influence investment add very little to the predictive ability of the model.

Precooler Model

Use of a precooler is possible only on farms with a parlor or pipeline. By making the milking system decision, farmers may simultaneously eliminate the possibility of precooler ownership. Thus, we have self-selectivity bias. We can only observe precooler ownership with farmers who have the appropriate milking system. To correct for this bias, a model of self-selectivity is used. (Maddala, 1987).

Table 7 *Heat Recovery Model (Holdout Sample)*
267 Observations

Variable	Coefficient	Chi Square	P Value
Intercept	-3.33828	28.61	0.00
Cows	0.01235	7.58	0.01
Cows Squared	-0.00001	4.97	0.03
Pipeline	2.22352	12.55	0.00
Parlor	3.55575	12.89	0.00
<u>Model Statistics</u>			
Chi Square with 4 D.F.		66.33	
P Value		0.000	
Pseudo R		0.401	
C Stat		0.772	
<u>Correct Classification Percentages</u>			
Total		68.5%	
With Heat Recovery		84.8%	
Without Heat Recovery		56.8%	
Classification Efficiency		56.8%	
Conditional Naive Model Rate		67.6%	

To estimate the likelihood of adopting a precooler, the probability of having a parlor or pipeline must be accounted for. Including this information corrects for the bias that would occur from use of only farms with a parlor or pipeline, which are effectively non-randomly selected farms because it is limited to farms with a parlor or pipeline (Heckman, 1979). Therefore, this model is a simultaneous probit model which will simultaneously estimate the likelihood of selecting a parlor or pipeline milking system and of the probability of investing in a precooler.

This model was estimated using the Bivariate probit option of LIMDEP by William Green. The two simultaneously estimated equations include one for investment in a precooler and one for ownership of a parlor or pipeline system.

Since the precooler has similar technological and investment characteristics to a heat recovery system, the precooler equation is based on the "best" heat recovery model. The probability of investment is a function of herd size and education.

Education was added to represent the likely affinity for adaption of new technology because ownership of a parlor or pipeline milking system is being handled through the second equation.

The milking systems equation includes four variables. Parlors are usually profitable for larger farm businesses and are almost an economic necessity for very large herd sizes. Pipelines are frequently used to allow milkers to handle more animals than can be handled with a bucket system. Management was included for the same reasons that it was initially included in the heat recovery system model.

Table 8

Bivariate Precooler Model
497 Observations

Equation 1: Y = Precooler

Variable	Coefficient	T Ratio	Significance
Intercept	-2.758	-4.231	0.00
Cows[a/]	0.908	3.799	0.00
Cowsa/ Squared	-0.083	-2.903	0.00
Education	0.102	2.642	0.01

Equation 2: Y = Parlor or Pipeline vs. Bucket

Variable	Coefficient	T Ratio	Significance
Intercept	-1.769	-6.216	0.00
Cows[a/]	2.263	10.054	0.00
Management	0.267	3.368	0.00
Region 1	0.660	2.987	0.00
Region 2	0.515	2.728	0.01
Region 4	0.452	2.059	0.04
Cash Income[b/]	0.515	1.489	0.14

Correlation = -0.752; Significant at 0.00 Level
Correct Classification Percentages

Total	65.8%
With Precooler	85.4%
Without Precooler	60.2%
Conditional Naive Model Rate	65.2%
Model's Classification Efficiency	65.8%

a/ Number of Cows/100.
b/ Cash income = (25% 1980 cash farm income + 50% 1985 cash farm income + 25% 1986 cash farm income)/100,000.

Investment in a parlor or pipeline system represents a major investment that is expected to have a relatively long life. Thus, income expectations would likely play a large part in the decision to make such an investment. Within a naive expectation framework, current net income can be used as an indicator of expected income. Thus, net cash income was included. Investment in a parlor or pipeline system could have occurred any time during the 1980-86 period so the cash flow variable used combined the farmer's estimate of net cash income for 1980, 1985 and 1986, weighted 25 percent, 50 percent and 25 percent, respectively. For those who invested before 1980 the variable represents the results of that investment and, thus, would be appropriate only if their expectation at the time of investment were fulfilled.

Regional dummies were included to reflect differences in soil and climate resources between geographical regions of the state.

All the variables in the milking system equation, except cash income, are significant at the usually accepted levels of significance (Table 8). The correlation of the error terms of the two equations was significant at the .01 level, confirming the importance of correcting the precooler equation for the selection bias that would result from estimating the precooler equation using only farms with a parlor or pipeline.

The variables in the precooler equation were all significant at the .01 level. The model does a good job of classifying farms with a precooler (85.4 percent correct). However, it is much less efficient in classifying farms without precoolers (60.2 percent). The model's overall classification efficiency is 65.8 percent which is above but likely not significantly different from the conditional naive model rate of 65.2 percent.

Conclusions

The results presented today are preliminary and, thus, our conclusions are tentative. However, most of the variables identified by the literature as important in investment behavior are of little value in predicting investment in heat recovery systems or precoolers. It appears that size of herd is the most important determinant. Size combined with some measure of milking technology adoption, either the presence of a parlor or pipeline, or level of education, provide as much explanatory power as models including more variables. This might be interpreted to say that the basic expected profitability of these investments is determined by herd size and that fact determines adoption with some modification of adoption rates depending upon the operators receptiveness to new technology. These results may be specific to the particular investments considered, which are generally modest in price. But, based on the results of the analyses conducted, it appears that while the variables listed in the literature may be important to some farmers, their importance is not generalizable to the entire dairy farm population.

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FARMERS' USE OF FUTURES AND OPTIONS UNDER ALTERNATIVE FARM PROGRAMS: A FARM LEVEL FINANCIAL ANALYSIS

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Introduction

It is well accepted that farmers' use of futures and options to hedge growing and stored crops can reduce price risk and decrease the variance on the return to equity. However, despite these benefits few farmers actually use futures or options to hedge. For example, Heifner (1972a) notes that less than five percent of cattle on feed were hedged in 1969. Similarly, a 1977 report on farmers' use of futures markets by the Commodity Futures Trading Commission indicated that only five percent of farmers participate in the futures market (Berck). Patrick, Whitaker and Blake surveyed 97 Indiana corn and soybean producers, finding that only 12 to 13 percent hedged part of their corn and/or soybean crops. Recently Shapiro and Brorsen found that for a sample of 41 Indiana farmers (in 1985) 63 percent hedged at least some of their corn, soybean or wheat crop, over the previous years. However, the mean percent of crops hedged was only 11.4 percent. And a 1982 survey by the Ontario Ministry of Agriculture and Food found that only two percent of 607 livestock producers used futures markets and from this group only 62 percent used them specifically for hedging purposes.

These data are not in accordance with the expected behavior of risk averse farmers predicted by some mean variance and expected utility models of optimal hedging (Johnson; Heifner (1972a); Peck; Robison and Barry). Therefore, there must be alternative motivations to farmers' use of hedging strategies, other than reducing price risk, which are not accounted for in the traditional theory of hedging. Examining one such motivation - the liquidity position of the farm firm - is the central focus of this study.

The purpose of this research is to investigate the liquidity motive underlying farmers' use of futures and options with respect to their capital structure and alternative farm programs. Specifically, the objectives are to a) determine how the financial characteristics of the farm affect hedging strategies, and b) to determine how alternative farm programs affect the hedging strategies. In order to achieve these objectives a theoretical model of optimal hedging with credit

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considerations is reviewed. This theoretical model provides some hypotheses which are tested using a discrete stochastic programming model of a representative Indiana cash crop farm in which corn and soybean yields and prices are stochastic. The DSP model simulataneously examines the effect of alternative farm programs and debt on the optimal hedge.

Background

Although the liquidity motive behind hedging has been discussed by some researchers (Hieronymus), it has not been examined in great detail. Indeed, the only study which looked specifically at the effects of farm debt on marketing strategies is Barry and Willmann's paper on forward contracting. They conclude that when credit is valuable, optimal plans will include contracting even for managers with little or no risk aversion.

The availability of credit is directly affected by the farm's capital structure. The debt-to-equity or debt-to-asset leverage ratios are often used by lenders to determine the amount of debt made available to farmers. The amount of unused debt, called a credit reserve, can be drawn upon in times when cash flow decreases due to low yield or price outcomes (Barry, Baker and Sanint; Robison, Barry and Burghardt). However, persistent losses which decrease retained earnings and equity also affect the leverage ratio and credit availability. Hence, in times of adversity credit reserves decrease, forcing some farmers to seek alternative sources of liquidity. One source of liquidity is the futures markets. By its very nature the problem of liquidity is associated with low product prices and other causes of reduced income. And low income due to unfavourable prices is exactly what hedging with futures and options is intended to avoid. Thus, hedging may provide an efficient substitute for other forms of liquidity such as debt. In fact, Hieronymus characterizes the hedging decision as a substitute of financial debt for commodity debt. In subsequent sections it is argued that high debt farmers with low credit reserves are more likely to hedge than low debt farmers with substantial credit reserves. This is consistent with the survey findings by Shapiro and Brorsen that farmers who perceive themselves to be highly leveraged are more likely to hedge than those who perceive themselves to be less leveraged.

Another reason why farmers may not use futures and options is the presence of farm programs. Gardner (1977,1980) has alluded to the similarities between farm programs and put options, and Turvey, Brorsen, and Baker note that the provisions of the loan program prior to harvest are like a put option, while the provisions for the post-harvest storage period are like a call option. Because of these similarities, Gardner claims that farmers' motivation to hedge are eliminated since the government is providing the same service as an option but relatively free of charge.

U.S. farm programs affect farm liquidity in two ways. First, through price supports (i.e. loan rates) the probability distribution of prices is altered such that the probability of disastrously low price outcomes are diminished, if not eliminated. This tends to increase the density of price outcomes at, or around, the loan rate (Boehlje and Griffin; Featherstone, Moss, Baker and Preckel). The effect decreases the variance on the returns to equity and skews the returns positively. This effect increases the expected return to equity which in turn increases credit reserves available to farmers. Because credit reserves are a source of liquidity the need to hedge for liquidity purposes is diminished.

A second source of liquidity from farm programs is through direct subsidies to farmers through deficiency payments. Income augmenting farm policies provide liquidity by increasing cash flows, retained earnings, and equity, thus further reducing the need to hedge.

The effect of farm debt and government policies should have a substantial influence on farmers' use of futures and options. However, there has been little, if any, theoretical or empirical work to support the claim. This study is dedicated to doing just this. In the following sections a theoretical model of optimal hedging is reviewed. This model provides some hypotheses regarding the effect of debt on the optimal hedge. Then a discrete stochastic programming model (DSP) of a hypothetical Indiana corn-soybean operation is used to examine the simultaneous effect of farm debt and government policies on farmers' use of futures and options. The results of the model and some conclusions are then presented.

A Theoretical Model of Optimal Hedging Under Alternative Capital Structures and Risk Aversion

This section draws on the results of a theoretical model which examines farmers' use of futures under alternative debt structures (Turvey and Baker). The model is based on Collins' expected utility model of debt, equity, and risk balancing. This is an appropriate framework because it accounts for debt, risk and risk aversion.

The return on assets is defined in terms of a long futures position (Heifner 1972a; Kahl);

$$(1) \qquad \tilde{R}_A = \frac{[\tilde{P}Y + (\tilde{f}_1 - f_0)\, H + rB]}{A} + g$$

where $\tilde{P}$ is the stochastic cash price, Y is output, assumed constant; f_0 is the futures price at which a long position is taken; $\tilde{f}_1$ is the random futures price at which the hedge is lifted; H is the amount of crop hedged; r is the return on bonds; B is the amount of bonds; g is the growth rate in assets; and A is assets. The expected value of (1) is,

$$(2) \qquad \bar{R}_A = \frac{[\bar{P}Y + (\bar{f}_1 - f_0)\ H + rB]}{A} + g$$

and its variance is

$$(3) \qquad \sigma_A^2 = \frac{[\sigma_p^2 Y^2 + \sigma_f^2 H^2 + 2YH\rho\sigma_p\sigma_f]}{A^2}$$

where σ_p^2 is the cash price variance, σ_f^2 is the futures price variance and ρ is the correlation between $\tilde{P}$ and $\tilde{f}_1$.

Using Collin's basic framework the expected utility of the return to equity is,

$$(4) \qquad E[U] = [\bar{R}_A - i\delta]\ \frac{1}{1-\delta} - \frac{\lambda}{2}\ \sigma_A^2\ \frac{1}{[1-\delta]^2}$$

Where i is the cost of debt capital; δ is the debt-to-asset leverage ratio; and λ is the risk aversion coefficient. Substituting (2) and (3) into (4) and differentiating with respect to H and Y yields,

$$(5) \qquad \frac{\partial E[U]}{\partial H} = \frac{f_0 - \bar{f}}{A[1 - \delta]} - \frac{\lambda}{A^2[1 - \delta]^2}\ [H\sigma_f^2 + Y\rho\sigma_p\sigma_f], \text{ and}$$

$$(6) \qquad \frac{\partial E[U]}{\partial Y} = \frac{\bar{P}}{A[1 - \delta]} - \frac{\lambda}{A^2[1 - \delta]^2}\ [H\rho\sigma_p\sigma_f + Y\sigma_p^2] \ .$$

Solving (5) and (6) simultaneously yields the theoretical equations to determine the optimal hedge, H*, and output, Y*,

$$(7) \qquad H^* = \frac{A[1 - \delta]\ [\sigma_p^2\ [\bar{f} - f_0] - \bar{P}\rho\sigma_p\sigma_f]}{\lambda[\sigma_p^2\sigma_f^2 - \rho^2\sigma_p^2\sigma_f^2]} \ ,$$

and

$$(8) \qquad Y^* = \frac{A[1 - \delta]\ [\bar{P}\sigma_f^2 - (\bar{f}_1 - f_0)\rho\sigma_p\sigma_f}{\lambda[\sigma_p^2\sigma_f^2 - \rho^2\sigma_p^2\sigma_f^2]}$$

This is very similar to the optimal hedge discussed in Kahl; Robison and Barry; Heifner 1972a; and Bond and Thomson. The only real difference is that leverage enters as an argument in the optimal hedge.

Under fairly plausible assumptions, $\sigma_p^2 > \sigma_f^2$ and $\rho < 1$, which implies that the denominator is always positive. Also if it is assumed that the cash position, $\bar{P}$, dominates the return on the hedge $(\bar{f} - f_0)$ the numerator is likely to be negative. This implies a short hedge (Heifner 1972a). Differentiating (7) with respect to δ and λ gives,

$$\frac{\partial H^*}{\partial \delta} > 0 \text{ , and} \tag{9}$$

$$\frac{\partial H^*}{\partial \lambda} > 0 \tag{10}$$

Under the assumptions of this theoretical model, an increase in the amount of debt relative to assets increases the amount of crop hedged. An identical statement is that an increase in the equity of the farm decreases the hedge. The second result, equation (10), states that as risk aversion increases, the optimal hedge increases. These results are taken as hypotheses to be tested in the empirical model.

Another hypothesis, based on the original Collin's model as well as that presented by Featherstone, Moss, Baker and Preckel, is that as farm policies reduce business risk farmers will hedge less. With respect to the results of the theoretical model, a decrease in business risk will increase expected equity thereby reducing the amount hedged.

Method

Maximizing Expected Utility

This study uses a direct expected utility maximizing model to test the above hypotheses. This optimization model is a two stage discrete stochastic program (DSP) of an Indiana corn-soybean farm (Cocks; Rae 1971a,b; Kaiser; Yaron and Horowitz). The two stages involve making hedging decisions at planting time (beginning of stage 1) for the growing crop and at harvest time (end of stage 1, beginning of stage 2) for stored crop or crop put under loan. The DSP is an appropriate model to use since it can capture the effects of liquidity across different stochastic outcomes, can account for the timeliness of the hedging decision, and can model the price distributions under alternative farm programs with no restrictions on the type of distribution used. The objective is to maximize the expected utility of terminal net worth at the end of the second stage. Balance sheet identities were defined for each state of nature in stage 1 and stage 2. At the end of the second stage terminal net worth was accumulated and transferred to the objective function. The objective function used was a power utility function of expected terminal net worth which exhibits constant relative risk aversion. Specifically, the objective function can be stated as,

$$(8) \qquad \max_{W} \sum_{i=1}^{K} \sum_{j=1}^{L} \theta_{ij} \frac{1}{1-\gamma} W_{ij}^{1-\gamma}$$

Where W_{ij} is the terminal wealth in state j of stage 2 following state i in stage 1; θ_{ij} is the discrete probability of W_{ij} occurring, and γ is the coefficient of constant relative risk aversion. There are K x L terminal (stage two) states of nature. Therefore the objective function satisfies

$$\sum_{i=1}^{K} \sum_{j=1}^{L} \theta_i \cdot \theta_{ij} = 1.$$

This study examined three levels of relative risk aversion. The risk neutral, profit maximizing producer is represented when $\gamma = 0$, the case of logarithmic utility is examined when $\gamma = 1$, and the risk averse case is examined when $\gamma = 5$. The DSP was solved using MINOS (Murtagh and Saunders).

Two performance measures often used in expected utility models are the certainty equivalent and risk premiums associated with the stochastic outcomes (Robison and Barry; Cass and Stiglitz). The certainty equivalent measures a level of certain wealth, W_i^* with which the hedger would be indifferent to the

expected stochastic outcome $\bar{W}$. For the power utility function the certainty equivalent is given by,

$$(9) \qquad W^* = ((1-\gamma)\ E[U])^{1/1-\gamma}.$$

The difference between expected terminal net worth and the certainty equivalent is called the risk premium. The risk premium measures the amount of wealth the hedger is willing to give up to receive the certainty equivalent.

It is expected that as the variance of terminal net worth decreases, the risk premium decreases and the certainty equivalent decreases. As risk aversion increases the certainty equivalent decreases and the risk premium increases, and as wealth increase the certainty equivalent increases and the risk premium decreases.

Based on these expectations it follows that high-debt farms will have higher risk premiums and lower certainty equivalents than low-debt farms; the risk premium will be lower for farms that hedge relative to those that don't hedge; and, the risk premiums will be lower in the presence of farm programs than when no farm policies exist.

Simulating Alternative Farm Policies

Corn and soybean yields and cash prices were simulated using FEEDSIM, a multi-period stochastic simulation model of the U.S. corn, soybean meal and soybean oil markets (Holland and Sharples). Changing policy parameters such as loan rates and target prices alters the distribution of cash prices. Each of the farm policies simulated provided 500,000 jointly distributed price and yield observations. These observations were then converted into discrete probabilities for use in the DSP.

Three policies were examined. The first policy, NOBILL, eliminated all target prices and loan rates. This was used to simulate the economic environment if farm programs were completely eliminated. Since the variance of prices is expected to increase under such a program, it was expected that farmers' use of futures and options increased. The second policy, LOAN, introduced support prices to the model. Loan rates were set at $1.55/bu. for corn and $4.95/bu. for soybeans. The policy provides liquidity to participating farmers if cash prices fall below the loan rate. Because the government program acts as a contingent claim on the cash commodity (Turvey, Brorsen and Baker), it is expected that farmers will use less futures and options under the policy. The third policy, TARGET, introduces a target price of $1.84/bu. for corn in addition to the corn and soybean loan rates. This policy of income augmentation, as well as price support, was expected to reduce the hedging requirements even more.

Corn and Soybean Price and Yield Distributions

The FEEDSIM price and yield observations are based on national average prices and yields. It was therefore necessary to convert the national average prices, through historical relationships, to better reflect yields and prices in Indiana. The FEEDSIM model was modified to take on this role.

The stochastic nature of corn and soybean yields were modelled in the following manner (Featherstone and Baker),

$$Y_{it} = M_i + b_{it} - e_{it}$$

Where Y is yields, M is maximum yield potential, b is the estimated trend in yields and e are the error terms distributed multivariate normal with mean υ and variance Σ. The subscript i identifies corn and soybeans and the subscript t identifies the time period.

Local corn and soybean prices are assumed to be stochastically related to national average prices according to the following stochastic process,

$$P^L_{it} = P^N_{it} + (\overline{P^L_i} - \overline{P^N_i}) + e_{it}$$

Where P^L_{it} is the local price, P^N_{it} is the national average price, $\bar{P}^L_i - \bar{P}^N_i$ is the historical difference between local and national average prices and e_{it} are normally distributed error terms with means equal to zero and variance σ^2. This relationship was used to generate both harvest and post-harvest cash prices by appropriately adjusting the value for $\bar{P}^L_i - \bar{P}^N_i$.

For use in the DSP the local observations for yield, harvest prices and post-harvest prices were converted into discrete probability states. In all there were 3 states of nature defined for each of corn and soybean yields, 5 states of nature for each of corn and soybean harvest prices, and 5 states of nature for each of post-harvest corn and soybean prices. Since these states of nature define joint probabilities there were 225 (3 x 3 x 5 x 5) possible states of nature at the end of the first stage and 5,625 (225 x 5 x 5) possible states of nature at the end of the second stage.

The Distribution of Futures Prices

There are two possible times at which the farmer can hedge; at planting the growing crop is hedged, and at harvest the stored crop (or crop under loan) is hedged. Future prices are required each time a hedge is placed or lifted. Therefore, 4 future prices were specified for each of corn and soybeans.

To obtain futures prices random shocks from a joint normal distribution of local basis were applied to each of the 225 harvest price and 5,625 post-harvest price states of nature. The basis data were generated from weekly price or futures observations at a Lafayette, Indiana elevator over the period 1979 through 1986. The resulting futures prices represented October futures prices on the November soybeans, and December corn futures contracts, and the April futures prices on the May corn and soybean futures contracts.

Specifically, the stochastic process used to determine these futures prices is given by,

$$f_i = P_i + \bar{B}_i + e^B_i$$

Where f_i is the futures price, P_i is the cash price, $\bar{B}_i$ is the mean basis, and e^B_i is the jointly distributed error of the basis with mean 0 and variance σ^2_B. The subscript i refers to the state of nature. This process is used to generate the futures prices at which a short position is offset (i.e. these are the long future prices).

It is assumed that the initial futures prices, i.e. those prices at which a short futures position is taken, are unbiased estimates of the stochastic long future prices. This assumption implies a zero profit from the hedge (actually a negative profit when transaction costs are included). The short futures price for corn and soybeans initiated at the beginning of stage 1 is therefore calculated as,

$$f_0 = \sum_{i=1}^{K} \theta_i \cdot f_i \cdot p_i$$

Where f_0 is the initial futures price, f_i is the state i futures price and θ_i is the state i probability of f_i occurring. The term $\sum_{i=1}^{K} \theta_i \cdot f_i$ is just the expected value of the harvest futures price on November soybean or December corn across all states of nature. Therefore, the initial futures price is just the expected value of the harvest futures price.

Similarly the initial harvest time futures contracts on May corn and soybeans are defined to equal the conditional expectations of the post-harvest (April) futures prices. This can be represented as,

$$f^h_{0i} = \sum_{i=1}^{K} \sum_{j=1}^{L} \theta_{ij} \cdot f_{ij}$$

where the h superscript denotes initial futures price at the end of stage 1 (harvest time), the j subscript refers to stage 2 states of nature following state i in the first period, and θ_{ij} is the probability of state ij occurring.

<u>Put Option Premiums</u>

Agricultural options are written on commodity futures contracts. A put option grants the holder the right, but not the obligation, to sell one futures contract at a specified strike price. In this study it is assumed that all options are purchased at-the-money. Thus the strike price is equal to the expected futures prices across all states of nature. The returns distribution on a put option can be characterized as MAX [0, E - f], where E is the strike price and f is the futures price at expiration. The difference E - f is the intrinsic value of the option. If E is greater than f, then the option is exercised such that a futures contract is sold at price E and another purchased at price f.

In a discrete probability model an appropriate method for determining the purchase price of the option is the binomial pricing model (Cox and Rubinstein). This model exactly prices options according to their intrinsic and time value. The price of a put option is just the present value of the probability that in state i the option will expire in-the-money;

$$P_0 = (1 + r)^{-T} \sum_{i=1}^{K} \theta_i \cdot MAX[0, E - f_i]$$

and

$$P^h_{0i} = (1 + r)^{-T} \sum_{c=1}^{K} \sum_{i=1}^{L} \theta_{ij} \cdot MAX[0, E - F_{ij}]$$

where r is the treasury bond interest rate, E is the strike price equal to either f_0 or f^h_{0i}, and f_i and f_{ij} are, respectively, the observed harvest and post-harvest futures prices. T is the period over which the option is to be held.

The difference between put options and futures is found in the returns. A routine futures hedge has unlimited loss whereas hedging with put options limits the loss to the premium on the put option. But because the premium is always paid on the put option the maximum profit potential from put options is always less than the maximum profit potential from the futures hedge.

Other Considerations In Model Building

The DSP farm model was assumed to represent the stochastic hedging decisions facing an 800 acre corn-soybean farm in west central Indiana. As well as activities for hedging, there were also activities for cash renting land, cash selling crops, purchasing and selling land, acquiring credit, and holding cash reserves.

Unfortunately, however, the size of the DSP model prohibited defining a constraint set which would realistically restrict farm production. Ideally, temporal labor and machinery constraints would be included. It was, therefore, implicitly assumed that variable and fixed factors of production were non-binding and these constraints were left out. Thus only constraints relevant to the problem were used. These included constraints which limited the amount of crop hedged to be less than or equal to expected production (in stage 1), or the amount of harvested crop stored or put under loan (in stage 2). Other constraints restricted debt, and kept track of assets, liabilities and owner's equity.

The design of the DSP was based on a philosophy of internally consistent relationships based on steady state prices. To account for land value changes under each of the alternative farm policies land valuation equations similar to those reported in Featherstone and Baker were used. A feedback control ensured that initial cash rent and land values started off in steady state. Therefore, under each state of nature capital gains and losses were treated as deviations from steady state with an expected value of zero. Similarly, by assuming that the expected value of futures prices equalled the initial short futures price the average gain to the hedge was zero. And since the options premiums were based on internally consistent futures prices the put premiums and returns to the put premiums were also internally consistent. In the type of model used internal consistency is important. Since the input coefficients, probability states and farm policies are an abstraction from reality, internal consistency ensures that the results reflect expected economic behavior under the assumed conditions.

Steady State Cash, Futures and Options Prices

Cash prices and crop yields under each of the three policy scenarios were simulated under steady state conditions. The simulated steady state observations were converted into discrete probabilities. Historical basis relationships were then used to convert the cash prices into futures prices. And the binomial optimum pricing model was used to calculate the put option premia.

Expected corn and soybean yields were approximately 113 and 38 bushels per acre, respectively. The marginal distributions of cash, futures and put prices are given in Table 1 for each of the three policies. The "initial" period is defined as the beginning of stage 1, the "harvest" period is described by the marginal distributions of the stage 1 outcomes (end of stage 1, beginning of stage 2), and the "spring" period is described by the conditional (marginal) probabilities of prices at the end of stage 2.

Under steady state conditions there is not a large difference in prices among the different policies. Corn prices are slightly higher and soybean prices are slightly lower under the NOBILL program than LOAN or TARGET. But the standard deviation of cash prices is substantially higher under NOBILL reflecting the fact that government price supports and deficiency payments do reduce risk.

This risk reduction is reflected in the standard deviation of futures prices. As expected a decrease in the standard deviation of cash prices due to farm programs decreases the standard deviation of futures prices. In response to this decrease in the variance of futures prices, option premiums are decreased substantially relative to the NOBILL program.

These results are consistent with the expected behavior of cash and futures prices under the alternative farm programs. As program benefits (i.e. loan rates and target prices) decrease, or are eliminated, the market risk of cash and futures prices increase. It is this increase in price risk which induces farmers to hedge more of their corn and soybean crops under the NOBILL farm program, than LOAN or TARGET programs.

This section has described, in terms of the marginal distributions, the stochastic relationships between cash prices,

Table 1. Steady State Cash, Futures and Options Prices Under Alternative Farm Programs ($/bu.)

Price Category	NOBILL		LOAN		TARGET	
	Expected Value	Standard Deviation	Expected Value	Standard Deviation	Expected Value	Standard Deviation
Cash Prices						
Corn Harvest Price	1.60	.606	1.59	.386	1.58	.382
Soybean Harvest Price	5.56	1.100	5.65	.751	5.59	.706
Corn Spring Price	1.76	.516	1.88	.388	1.89	.384
Soybean Spring Price	6.34	1.603	6.12	.76	6.05	.713
Futures Prices						
Initial Price December Corn	1.72	-	1.68	-	1.70	-
Initial Price November Soybeans	5.71	-	5.80	-	5.73	-
Fall Price December Corn	1.72	.611	1.68	.405	1.70	.380
Fall Price November Soybeans	5.71	1.111	5.80	.756	5.73	.697
Fall Price May Corn	1.78	.362	1.90	.319	1.91	.299
Fall Price May Soybeans	6.38	.750	6.17	.741	6.09	.674
Spring Price May Corn	1.78	.528	1.90	.413	1.91	.397
Spring Price May Soybeans	6.38	1.61	6.17	.771	6.09	.704
Put Premiums						
Initial Premium December Corn	.227	-	.157	-	.152	-
Initial Premium November Soybeans	.395	-	.287	-	.252	-
Fall Premium May Corn	.147	.034	.101	.029	.100	.026
Fall Premium May Soybeans	.526	.130	.069	.015	.065	.015

futures prices, and put option premiums under alternative farm programs. In the following section the hedging results of the DSP are described.

Results

The results of the DSP hedging model are summarized in Tables 2, 3 and 4. These tables reflect the major objectives of the study which were to determine how the firm's financial characteristics, and how farm policies affect hedging decisions.

Table 2 provides results consistent with the hypothesized results of the theoretical model. These results were generated from the NOBILL policy scenario. As relative risk aversion increases the amount of crop hedged increases. The risk neutral farmer ($\gamma = 0$) hedges very little, as expected, relative to the log utility ($\gamma = 1$) or risk averse case ($\gamma = 5$). The effects of different levels of debt, however, are clear. The high-debt farm uses 16,145 put options to hedge the growing crop, but only a negligible amount of stored corn and soybeans are hedged using put options. Futures contracts do not enter the hedging plan. As risk aversion increases, the proportion of crop hedged increases. For example, the high-debt log utility case hedges 33,869 of an expected 48,285 bushels of corn using put options. This implies a hedge ratio of about 70 percent on total expected production. For stored crops, that is crops sold in the second stage, 6,458 of 12,946 bushels of corn and 2,702 of 5,649 bushels of soybeans were hedged, implying hedge ratios of 49.9 percent and 47.8 percent for corn and soybeans respectively. For the low-debt farm, none of expected corn or soybean production was hedged but a negligeable amount of stored corn (.247 percent) and about 56 percent of stored soybeans was hedged.

The amount of crop hedged by the risk averse farmer ($\gamma = 5$) was more than the risk neutral or logarithmic utility farmer. Both put options and futures contracts were used to hedge expected corn production. The percentage of expected corn hedged using either put options or futures was 79, 77, and 70 percent, for the high, medium and low- debt farm, respectively. The proportion of stored crop was somewhat higher. For all levels of debt, virtually all of the soybeans were hedged with put options. Using both puts and futures, 97.2 percent of corn was hedged by the high-debt farm and using put options only 96.7 percent and 97.1 percent of corn was hedged by the medium and low-debt farms.

Some general conclusions relating to the hypotheses can be derived from these results. It is clear that as risk aversion increases, so does the amount of crops hedged. But it is also evident that hypotheses regarding the firm's capital structure can be accepted. As the amount of debt relative to assets increases and credit availability is restricted, farmers will hedge more of their crops. In light of Barry and Willmann's conclusion for forward contracting, the same conclusions apply

Table 2. Farmers' Use of Futures and Put Options Under NOBILL Program With Varying Degrees of Risk Aversion and Debt

	Risk Neutral $\gamma = 0$			Log Utility $\gamma = 1$			Risk Averse $\gamma = 5$		
Activity	High Debt	Med. Debt	Low Debt	High Debt	Med. Debt	Low Debt	High Debt	Med. Debt	Low Debt
FINANCING									
Initial Owners' Equity	201050	335090	469120	201050	335090	469120	201050	335090	469120
Initial Debt	469120	335090	201050	469120	335090	201050	469120	335090	201050
Terminal Net Worth	209994	359906	509109	209166	359576	509038	209166	359576	509038
Certainty Equivalent	209994	359906	509109	205398	356671	506145	195787	350896	502044
Risk Preimum	0	0	0	3773	2906	2893	12062	7319	5687
Std. Dev. of Terminal Net Worth	45960	43750	43960	38247	39640	42736	33349	33970	35614
HEDGING									
Buy Dec. Corn Put	0	0	0	33869	22458	0	23090	22339	25538
Buy Nov. Soy Put	16145	0	0	0	0	0	0	0	0
Short Dec. Corn Futures	0	0	0	0	0	0	14890	14995	8136
Short Dec. Soy Futures	0	0	0	0	0	0	0	0	0
Buy May Corn Put	40	41	42	6458	55	41	11442	12851	15516
Buy May Soy Put	2	2	2	2702	4083	3307	5373	5542	5634
Short May Corn Futures	0	0	0	0	0	0	96	0	0
Short May Soy Futures	0	0	0	0	0	0	0	0	0
MARKETING									
Sell Corn in Fall	35218	34183	31577	35339	34346	31705	36420	35008	32311
Sell Soybean in Fall	10418	10295	10255	10496	10315	10255	10765	10590	10510
Sell Corn in Spring	13067	14101	16708	12946	13939	16580	11865	13277	15974
Sell Soybeans in Spring	5727	5850	5890	5649	5830	5890	5380	5556	5636

here; as credit becomes more valuable, farmers will tend to increase their use of futures and options to hedge their crops.

In terms of the direct expected utility approach used in the study the relative values of the standard deviation and certainty equivalents of expected terminal net worth, and the risk premiums provide some insights into hedging behavior under uncertainty. As risk aversion increased, the standard deviation of terminal net worth decreased. For the high-debt farms these standard deviations were $45,960, $38,247 and $33,349, for γ equal to 0, 1 and 5, respectively, and the certainty equivalents decreased from $209,994 to $205,398, and $195,787. The risk premium for all levels of debt was zero for the risk neutral farmers and was higher for the log utility and risk averse farmer. From Table 2, as debt increased, the risk premium increased. For example, for γ equal to 5, the risk premium was $12,062, $7,319 and $5,687, for the high, medium and low-debt farmers, respectively. This illustrates that the capital structure of the farm does affect the marketing and hedging strategies. But, since liquidity was constrained by credit reserves, the results also lend substantial support to the value of credit reserves as a source of liquidity. And when credit becomes constraining, hedging with futures and options can be an effective source of liquidity.

The second objective of this study was to examine how alternative farm programs affect hedging decisions. This objective was achieved by eliminating loan rates and target prices (NOBILL), introducing loan rates only for corn and soybeans (LOAN), and introducing a target price for corn along with the loan rate (TARGET). The results of the analyses are presented in Table 3 and 4, for alternative capital structures and γ equal to 5. Table 3 presents the results when either put options or futures can be used. Table 4 restricts the use of both futures and options to zero. The differences in terminal net worth, certainty equivalent, risk premium and standard deviation described by the two tables are indicative of the role put options and futures can play in providing liquidity and reducing risk.

Table 3 presents the hedging results under alternative farm policies. As expected, the standard deviation of terminal net worth was most under the NOBILL plan and lowest under the TARGET plan. Because the steady state conditions differ across policies, the certainty equivalents are not directly comparable, but the risk premiums can be. Since government programs reduce the return to equity and increase expected credit reserves across all states of nature, it was expected that the amount of crops hedged would decrease. Viewing Table 3 these expectations were borne out. The greater amount of crop hedged occurred from the NOBILL plan with the least amount of hedging occurring for TARGET. Under NOBILL the hedge combined corn puts and futures to hedge expected corn production. Stored corn and soybeans were hedged predominantly with put options.

Table 3. Farmers' Use of Futures and Put Options Under Alternative Farm Programs With Varying Degree of Debt ($\gamma = 5$)

Activity	NOBILL High Debt	NOBILL Med. Debt	NOBILL Low Debt	LOAN High Debt	LOAN Med. Debt	LOAN Low Debt	TARGET High Debt	TARGET Med. Debt	TARGET Low Debt
FINANCING									
Initial Owners' Equity	201050	335090	469120	218600	364340	510080	262670	437790	612900
Initial Debt	469120	335090	201050	510800	364340	218600	612900	437790	262670
Terminal Net Worth	209166	359576	509038	215835	377802	539452	251854	446201	640551
Certainty Equivalent	195787	350896	502044	208443	373257	536194	246135	442830	638043
Risk Preimum	12062	7319	5687	7392	4545	3258	5719	3371	2508
Std. Dev. of Terminal Net Worth	33349	33970	35614	26372	27293	27483	24681	25172	26003
HEDGING									
Buy Dec. Corn Put	23090	22339	25538	2173	0	0	0	0	0
Buy Nov. Soy Put	0	0	0	16142	16142	16142	16140	13191	6413
Short Dec. Corn Futures	14890	14995	8136	3138	0	0	0	0	0
Short Dec. Soy Futures	0	0	0	0	0	0	0	0	0
Buy May Corn Put	11442	12851	15516	11418	4504	1911	9595	3086	409
Buy May Soy Put	5373	5542	5634	19	50	0	145	3	2
Short May Corn Futures	96	0	0	0	0	0	0	0	0
Short May Soy Futures	0	0	0	0	0	0	0	0	0
MARKETING									
Sell Corn in Fall	36420	35008	32311	18058	17668	17129	18507	18257	18039
Sell Soybean in Fall	10765	10590	10510	10021	10021	10021	10001	10001	10000
Sell Corn in Spring	11865	13277	15974	0	0	0	0	0	0
Sell Soybeans in Spring	5380	5556	5634	0	0	0	0	0	0
Put Corn Under Loan	—	—	—	30160	30549	21089	29684	29936	30153
Put Soybean Under Loan	—	—	—	6120	6120	6120	6140	6140	6140

In contrast, the proportion of corn hedged was substantially less than the proportion of soybeans hedged for the LOAN program. And none of expected corn production was hedged under TARGET. Under LOAN program virtually all of expected soybean production was hedged but only a negligeable amount of stored soybeans (put under loan) were hedged. The proportion of corn stored (put under loan) was only 37.8 percent, 14.7 percent and 9.1 percent for high, medium and low debt respectively. These hedge ratios are substantially lower than those found under NOBILL.

Adding a target price provided expected deficiency payments which was received in even proportions at the end of the first and second stages. The deficiency payment is a direct source of liquidity to the farmers. As expected this extra source of liquidity decreased the use of futures and options. None of expected corn production was hedged for all levels of debt while all of expected soybean production was hedged for the high-debt farm, 81.7 percent were hedged for the medium-debt farm and 39.7 percent were hedged for the low-debt farm. This is not unexpected since the deficiency payment was linked to corn production only. As debt decreased the hedging of stored corn and soybeans also decreased.

The differences in expected terminal net worth, certainty equivalents, risk premiums and standard deviations between Tables 3 and 4 can be directly attributed to the use of futures and options.

Without hedging (Table 4), the expected terminal net worth is higher, but the certainty equivalent is lower. This corresponds with a higher variance of terminal net worth. Consequently, the risk premiums, when hedging is not permitted, are substantially higher than when hedging is allowed. This is especially true for the high-debt farms. Under the NOBILL policy with hedging the risk premium for the high-debt farm is $12,062 whereas the risk premium without hedging is $21,056. The differences between the risk premiums decrease as leverage decreases. For the low-debt farm, the risk premium is $5,687 when hedging is allowed and $8,082 when hedging is not allowed. These differences in risk premiums are attributable to the introduction of crop hedging activities.

Similar results are found for the LOAN and TARGET policies. The risk premium is always lowest when hedging is allowed and the certainty equivalent is always higher. These risk premiums tend to be lower than the NOBILL plan because the liquidity provided through price supports and deficiency payments tended to decrease the amount of crops hedged.

It is important to recognize here the relationship between farmers use of futures, options and liquidity. Futures and options are intended to decrease risk thereby adding stability to the return on equity. It was hypothesized that the varying

Table 4. Farmers' Non-Use of Futures and Put Options Under Alternative Farm Programs With Varying Degree of Debt ($\gamma = 5$)

Activity	NOBILL			LOAN			TARGET		
	High Debt	Med. Debt	Low Debt	High Debt	Med. Debt	Low Debt	High Debt	Med. Debt	Low Debt
FINANCING									
Initial Owners' Equity	201050	335090	469120	218600	364340	510080	262670	437790	612900
Initial Debt	469120	335090	201050	510081	364340	218600	612900	437790	262670
Terminal Net Worth	208804	359635	508958	216549	378187	539801	252303	446515	640687
Certainty Equivalent	187748	347355	500156	207228	372736	535924	245646	442716	638025
Risk Preimum	12056	12280	8802	9321	5451	3877	6662	3799	2662
Std. Dev. of Terminal Net Worth	42609	42948	43265	29831	29914	29993	26659	26773	26796
HEDGING									
Buy Dec. Corn Put	-	-	-	-	-	-	-	-	-
Buy Nov. Soy Put	-	-	-	-	-	-	-	-	-
Short Dec. Corn Futures	-	-	-	-	-	-	-	-	-
Short Dec. Soy Futures	-	-	-	-	-	-	-	-	-
Buy May Corn Put	-	-	-	-	-	-	-	-	-
Buy May Soy Put	-	-	-	-	-	-	-	-	-
Short May Corn Futures	-	-	-	-	-	-	-	-	-
Short May Soy Futures	-	-	-	-	-	-	-	-	-
MARKETING									
Sell Corn in Fall	40596	36148	33323	18556	17671	17130	19074	18292	18038
Sell Soybean in Fall	11858	10943	10616	10021	10021	10021	10001	10001	9997
Sell Corn in Spring	7689	12137	14962	0	0	0	0	0	0
Sell Soybeans in Spring	4287	5203	5529	0	0	0	0	0	0
Put Corn Under Loan	—	—	—	29661	30546	31087	29118	29900	30155
Put Soybean Under Loan	—	—	—	6120	6120	6120	6140	6140	6144

degrees of debt-to-assets and credit reserves would affect the optimal hedging strategy. The results of this study support such a hypothesis. Similarly, it was hypothesized that farm programs reduce the need to hedge since they provide liquidity in terms of price supports and deficiency payments. The results of this study support this hypothesis as well.

Conclusions

This study examined liquidity as a motivation for farmers use of futures and options. It was hypothesized that high-debt farms with few credit reserves as a source of liquidity would hedge more than low-debt farms with substantial credit reserves. It was also hypothesized that liquidity provided by farm programs would reduce the amount of crop hedged. Neither hypothesis could be rejected by the results of the study.

To summarize the results the following conclusions were reached:

1) As relative risk aversion increases, hedging increases;
2) As credit reserves decrease, hedging increases;
3) Farm programs tend to reduce the hedging requirements of the farm firm;
4) The standard deviation of terminal net worth decreases as hedging is introduced into the farm plan;
5) The certainty equivalents increase and risk premiums decrease as hedging is introduced into the farm plans.

The results of the study support our conjecture that liquidity may be a motivation in farmers' use of futures and options. This, by no means, is intended to replace the conventional wisdom that farmers use of futures and options is to reduce business risk. Rather, it may offer an explanation of why so few farmers hedge. The results of this study are based on an analysis of farms characterized by different capital structures but facing the same states of nature in terms of probabilistic price outcomes. If farmers' use of futures and options were independent of the capital structure then the hedge ratios would be expected to be similar across all levels of debt. This was not found to be the case.

Several policy implications follow from these results. First, policy makers, extension agents, and commodity brokers should be aware of the liquidity motivation behind futures and options hedging. Perhaps these groups should define hedging recommendations in terms of the farm capital structure and focus extension efforts towards high-debt farmers who have most to gain from hedging.

Second, lenders may want to re-evaluate external credit rationing decisions for high-debt farms who do want to hedge. The results of this study indicate that this group would benefit most in terms of hedging. Alternatively, lenders may wish to require high-debt farms to hedge with futures and options in order to receive extra funds. This recommendation is consistent with Heifner's (1972b) claim that lenders will benefit from hedging by either decreasing the riskiness of their loan portfolio or increasing their loan portfolio without an increase in risk.

Finally, policy makers should be aware of the relationship between farmers use of futures and put options when farm programs are in place. The results of this study support the general arguments put forth by Gardner that farm policies provide disincentives to hedge. With the possible elimination of loan rates and target prices in future Farm Bills, farmers' use of futures and options will increase substantially. Therefore policy makers should promote further research and increase extension efforts in the area of futures and put options.

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AN EMPIRICAL INVESTIGATION OF RISK DIVERSIFICATION OPPORTUNITIES WITHIN THE FARM CREDIT SYSTEM

by

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Farm financial stress during the early 1980s put agricultural financial intermediaries into a precarious situation. Recently, farms and financial intermediaries have been able to reduce earlier problems. The 1988 drought, however, may push financially vulnerable farmers into a worse financial position increasing the level of financial stress for agricultural credit suppliers in the near future. Because the Farm Credit System is the largest farm real estate lender, it is usually the most severely affected financial intermediary during periods of farm stress.

The Farm Credit System's share of agricultural debt expanded rapidly during the 1970s compared with other lenders. The average pricing of interest rates during periods of increasing inflation and increasing real interest rates gave the Farm Credit System a price advantage when compared with commercial banks and other agricultural lenders. In addition, the Farm Credit System was able to make real estate loans other financial institutions were unwilling or unable to make. As a result, the Farm Credit System's share of lending, especially real estate lending, grew substantially.

In October 1979, the Federal Reserve Board embarked on a program to reduce the rampant rate of inflation experienced during the late 1970s. In reducing the rate of inflation, the Federal Reserve Board's policies caused upward pressure on the real interest rate. The net result of the increased real

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interest rate was a high dollar, lower export levels, decreased farm prices and lower returns to agricultural assets (Tweeten, Barclay and Tweeten). The lower returns caused a downward adjustment in future expectations of earnings which lead to a decline in agricultural asset values and increased stress for farmers and financial intermediaries.

Because the Farm Credit System lends only to agriculture, it's losses were greater than the other financial intermediaries who lend to farmers. These losses prompted policymakers to enact legislation to aid the ailing intermediary. The legislation contained several provisions addressing a multitude of issues within the Farm Credit System. Two important issues addressed by the legislation include the potential merger of Farm Credit System districts and the establishment of secondary markets for agricultural real estate loans.

One argument for both mergers of Farm Credit districts and secondary markets is that additional diversification would lessen the risk of farm lending without significantly reducing the return to the system as a whole. This hypothesis is supported by the fact that some districts such as Springfield are doing rather well. Diversification through loan participation could allow ailing districts to better their position without the necessity of merging. The critical question, therefore, is whether risk gains from diversification exist. In other words, is a pure profit possible from trading loans between Farm Credit System Districts?

The profitability of additional diversification between Farm Credit System districts has implications for the secondary market for agricultural real estate debt. One possible function of the secondary market would be an equalizing of risk-adjusted interest rates across geographic regions. If current risk-adjusted interest rates are not equal across districts, investors could gain by purchasing loans from different geographical regions. If the Farm Credit System could gain from additional internal diversification, the secondary market would also be able to exploit the diversification opportunity and likely have a larger probability of success.

The purpose of this study is to empirically investigate diversification opportunities within the Farm Credit System. Specifically, an Arbitrage Pricing Theory (APT) is used to test whether risk-free profits could be obtained by trading loans between the districts of the Farm Credit System. A mean variance model is formulated to examine the consistency of the mean variance and APT results.

Diversification and the Farm Credit System

There are two major diversification aspects in the current organization of the Farm Credit System. The most important is the joint liability on Farm Credit System bonds. The Farm Credit System sells bonds to raise capital used in making agricultural loans. Once issued, the Farm Credit System as a whole are liable for the repayment of the bonds. As a result, if the Omaha district could not meet its bond obligations, then the remaining banks would be liable for the debt. Thus, the liabilities of a single bank are ultimately backed by the resources of the system as a whole.

Unfortunately, the joint liability on Farm Credit System bonds represents diversification as a last resort. After a given bank has suffered all the losses possible, the rest of the banks make up the difference. This diversification does not help individual banks keep out of trouble, it simply provides for full repayment of investors after the worst has happened. Put another way, joint liabilities represents diversification in liquidation not operation.

Another mechanism for diversification in the current organization of the Farm Credit System involves the composition of the various districts. When the districts were created, some states with the same major commodities were placed in different districts. For example, Illinois, Iowa, and Indiana which are extremely dependent on corn and soybeans were placed in three separate districts. If a single bank had included all three states, it would be very susceptible to large loan losses when corn and soybean incomes are depressed.

The Farm Credit Districts are not completely diversified. Agriculture in Nebraska is less dependent on corn and soybean prices than Iowa, however, corn and soybeans are still important crops in Nebraska. Furthermore, other crops in Nebraska may be highly correlated with corn and soybeans. Even if a district consisted of crops whose prices are uncorrelated, the effects of weather and other natural phenomenon may cause farm income in a given district to be highly correlated.

Although the Farm Credit System is restricted by law from lending outside the farm sector, additional diversification may be available through diversification across districts. U.S. agriculture as a whole is fairly diverse. In Florida farmers produce tropical fruits while in Oklahoma cattle, wheat, and cotton are important. Diversification between commodity groups and across climates in the United States may provide the Farm Credit System additional opportunities to reduce the risk of lending. Such diversification could result in lower interest rates for borrowers and lessen the likelihood of a future crisis in the Farm Credit System.

Arbitrage Pricing Theory

Arbitrage Pricing Theory (APT) is gaining acceptance as an alternative to the Capital Asset Pricing Model (CAPM). Using the APT, market efficiency can be tested without the risk-free asset or market portfolio assumptions required by CAPM. In addition, APT requires less stringent assumptions about utility. In this section, APT is discussed and empirical results for diversification between FCS districts are presented.

At its basic level APT simply states that if capital markets are in equilibrium then no pure profits can be made by arbitrage. From an agricultural economist's perspective, this result is analogous to a spatially separated arbitrage model. If markets are in equilibrium, the price between markets must be no greater than the cost of transporting goods between markets. If a difference above transportation costs exists, arbitragers would quickly exploit the arbitrage opportunity to make a profit and the price differential would be returned to the cost of transportation.

In capital markets, the price difference between assets is due to differences in risk. A more risky asset demands a higher return assuming the investor is risk averse. Arbitrage profits in a capital market would mean that two or more assets could be bought or sold in a manner such that; (1) investment remains unchanged, (2) a profit could be made, and (3) there is no change in the riskiness of the portfolio. In other words, an equal dollar amount of securities or assets could be bought or sold so that the investor's wealth is unchanged while a profit is realized. For example, an investor sells an asset with a lower return and uses the proceeds to buy a higher yielding asset without accepting additional risk. If such a trade is possible, then the capital markets are not arbitrage efficient.

Mathematically, the APT assumes that asset returns in society are functions of k common factors δ_i for i = 1, ... k (Ross, Huberman). For a particular asset j, the return can be described as:

$$(1) \qquad r_j = E_j + \beta_{1j}\,\delta_1 + \beta_{2j}\,\delta_2 + \ldots \beta_{kj}\,\delta K + \xi_j$$

$$\text{for all } j = 1, \ldots n;$$

where r_j is the return to asset j, δ_i is the ith common factor scaled with a mean of zero, E_j is the mean return to asset j, β_{ij} is the response of the return in asset j to the common factor i, and ξ_j is the random noise term. The noise term (ξ_j) is the unsystematic or idiosyneratic risk component of asset r_j. The expected value of ξ_j is zero and it is unrelated to the noise terms of other assets and the systematic factors. In matrix form, equation 1 is expressed as (omitting the error term):

$$(2) \qquad r = E + \beta\, \delta + \xi.$$

By eliminating the error term, equation 2 states that each asset's return is a linear combination of the return on a riskless asset and the returns from the k factors.

Consider an alteration of the current portfolio by changing the amounts invested in different assets without changing total investment. In this study the alteration (arbitrage) portfolio represents the sale and purchase of loans with other districts. Let the arbitrage portfolio be a vector X such that

$$(3) \qquad \Sigma_i x_i = 0.$$

An individual will consider all available arbitrage portfolio's before altering the current portfolio. The effect of arbitrage on returns is

$$(4) \qquad X'r = X'E + X'\beta\,\delta.$$

The arbitrage portfolio, X is chosen so that it adds no systematic risk. Levy and Sarnat refer to this as a zero-beta portfolio. This implies that

$$(5) \qquad X'\beta = 0, \quad \text{or}$$

therefore, $X'\beta\,\delta = 0$.

$$(6) \qquad X'r = X'E.$$

If markets are efficient then a zero-beta portfolio, X, must imply zero expected profits, or

$$(7) \qquad X'E = 0.$$

In equilibrium, all portfolios which satisfy the conditions of using no wealth and having no risk, must return no return on average (Roll and Ross).

Connor shows that the above conditions for arbitrage efficiency can be rewritten by use of matrix theory. Basically, equation 5 states that X is orthogonal to the β matrix. A portfolio so selected must be orthogonal to a vector of constants. Thus,

$$
\begin{bmatrix}
1 & 1 & 1 & \cdots & 1 \\
\beta_{11} & \beta_{12} & \beta_{13} & \cdots & \beta_{1k} \\
\beta_{21} & \beta_{22} & \beta_{23} & \cdots & \beta_{2k} \\
\vdots & \vdots & \vdots & & \vdots \\
\beta_{n1} & \beta_{n2} & \beta_{n3} & \cdots & \beta_{n}
\end{bmatrix}
$$

must be an orthonal basis of δ space, or for some constants $\lambda_0, \lambda_1, \ldots \lambda_k$

(8) $$E[r_j] = \lambda_0 + \lambda_1 \beta_{1j} + \ldots \lambda_k\beta_{kj}$$

$$\text{for all} \quad j = 1, \ldots n.$$

Otherwise an arbitrage opportunity exists and the market is not arbitrage efficient. Put differently, if the vector of expected returns are not linear in the factor betas, then the market is not arbitrage efficient.

Given that the expected return is a linear function of the constants $\lambda_0, \lambda_1, \ldots \lambda_k$, more information can be obtained from the results. λ_0 is the risk-free rate of return within the asset bundle. In other studies, it is assumed that $\lambda_0 < 0$ is not possible, however, in this study $\lambda < 0$ is admissable because of inflation. Roll and Ross point out that the remaining constants $\lambda_1, \lambda_2, \ldots \lambda_k$, are risk premia for the appropriate factor.

Factor Analysis

This section presents the empirical model used to test for arbitrage efficiency by Roll and Ross. Roll and Ross's procedure first estimates the common factors which determine the asset returns. Next, the factors are used to estimate a time series model and test for arbitrage efficiency.

As discussed previously, the focal point of APT is that a set of asset returns are manifestations of common factors in society. Alternatively, each interest rate can be explained by its reaction to factors that also determine other interest rates in society. Some theoretical justifications of these factors are societies impatience to consume and the real return to capital in society. All returns to investment depend on these factors, however, the amount of reaction may vary between investments. The reaction of each investment to these common factors in the

APT is akin to the reaction of investment returns to the market portfolio in the CAPM.

Thus, if the common factors were known a simple regression could be used to explain variations in asset returns and to test whether the returns where in arbitrage equilibrium. Unfortunately, the common factors are not directly observable. Therefore, Roll and Ross use factor analysis to estimate the common factors which determine return on assets. Factor analysis decomposes the variance matrix into a matrix of factor loadings, a diagonal variance matrix for the common factors, and a diagonal matrix of nonsystematic risk. The factor loadings represent the effect of a common factor on asset returns. For example, suppose that the variance matrix for asset returns is Σ. Factor analysis can be used to decompose Σ into a smaller number of common factors such that

$$(9) \qquad \Sigma = \beta \, \Omega \, \beta' + \theta$$

where β is a matrix of factor loadings, Ω is the diagonal variance matrix of common factors, and θ is diagonal matrix of unexplained variation or nonsystematic risk.

To estimate the factor loadings, the maximum likelihood technique described in Lawley and Maxwell is often used. The objective as described in Goldberg is to choose β to

$$(10) \qquad \max_{\delta} \quad L = -\tfrac{1}{2} T[\log |\Sigma| + tr\,(\Sigma^{-1} r' r)]$$

$$r = E + \beta\,\delta + \xi$$

$$\Sigma = \beta\,\Omega\,\beta' + \theta_0$$

where T is the number of observations.

After the common factors which determine the return on assets are estimated, the return generating model for the group of investments can be estimated (equation 8). Each asset in society is a function of the risk-free rate of return, c_0, and its response to the common factors, c,

$$(11) \qquad r = c_0 + c\,\beta + v$$

where v is an error term, and δ are the factor loadings. The constant c_0 and vector c can be estimated using generalized least squares and the results from the factor analysis. Specifically, Σ and β from equation 9 can be used in the generalized least squares estimator

$$(12) \qquad \hat{c} = (\hat{\beta}' \, \hat{\Sigma}^{-1} \, \hat{\beta})^{-1} \, \hat{\beta} \, \hat{\Sigma}^{-1} \, r,$$

by augmenting the factor matrix with a vector of ones the constant component can be simultaneously estimated.

Testing the Arbitrage Pricing Model

The final step is to test the results for consistency with the APT. Roll and Ross state that the returns are arbitrage efficient if the hypothesis that $\lambda_1 = \lambda_2 = \ldots \lambda_k = 0$ is rejected in equation 11. Intuitively, if $\lambda_1 = \lambda_2 = \ldots \lambda_k = 0$, then $E[r_j] = \lambda_0$ for all j. If $E[r_j] = \lambda_0$ and one or more factors exist, then a vector orthogonal to the factor betas is not necessarily orthogonal to a vector of ones or it is possible to construct a zero beta portfolio with a positive return. Another explanation involves the fact that the λ_j's are risk premia. The change in betas between assets indicates a change in the riskiness of the asset. If a particular λ_i is positive and $\beta_{ij} > \beta_{ik}$, then $E[r_j] > E[r_k]$, or the increase in risk must be paid by an increase in expected return. If all the λ_i's are zero, but the β_{ij}'s are not identical, then the change in riskness is not compensated by a change in expected returns.

The hypothesis presented by the APT are slightly different than the standard regression. Specifically, the arbitrage pricing theorem has as its null hypothesis that the market is not arbitrage efficient,

$$H_A: \quad \lambda_1 = \lambda_2 = \ldots \lambda_k = 0.$$

This set of hypothesis allows us to reject arbitrage efficiency. If the null hypothesis was that $\lambda_1 = \lambda_2 = \ldots \lambda_k = 0$, then it would be impossible to reject arbitrage efficiency.

The divergence from the standard has caused alternative approaches to testing for arbitrage efficiency. Roll and Ross generated numerous samples and tested the number of times that significant risk premia were observed. However, Gultekin and Gultekin recently applied a methodology developed in Dhrymes et al. to directly test arbitrage efficiency. Specifically, they estimate T vectors of risk premia where T is the number of observations

$$\text{(13)} \qquad \bar{C}_t = (\hat{\beta}' \hat{\Sigma}^{-1} \hat{\beta})^{-1} \hat{\beta}' \hat{\Sigma}^{-1} r_t \qquad t=1, \ldots T.$$

where $\bar{C}_t$ is the estimated vector of risk premia in year t, $\hat{\beta}$ is the estimated matrix of factor loadings, $\hat{\Sigma}$ is the estimated sample variance, and r_t is the observed vector of returns in year t. The $\bar{C}_t$ vectors give the risk premia or price associated with each factor in year t. The average risk premia are then computed,

$$(14) \qquad \bar{C} = \frac{1}{T} \sum_{t=1}^{T} \bar{C}_t .$$

The statistical significance of the risk premia can then be computed as

$$(15) \qquad T\bar{C}' \; W^{-1} \bar{C} \overset{A}{\sim} \chi^2_k$$

$$W = \left(\frac{1}{T}\right) \sum_{t=1}^{T} (\bar{C}_t - \bar{C}) \; (\bar{C}_t - \bar{C})' .$$

Rejecting the hypothesis means that the risk premia as a group are not zero, or that the market is arbitrage efficient.

Data

The data used in this study were derived from the annual reports of the FCS from 1972 to 1986. The nominal rate of return to Federal Land Bank (FLB) lending was computed for each district by dividing the nominal income from loans adjusted for bad debt expense by the total dollars in loans outstanding at the beginning of each period. The bad debt expense adjustment for each district was computed by computing the change in accruals for bad debt and adding the adjustment for bad debt expense in the current period. The real rate of return for each district was computed by subtracting the rate of inflation computed using the PCE component of the implicit GNP deflator.

The mean real return to FLB lending in each district is given in table 1 along with the standard deviation for lending in each district. The largest mean return was 2.48% in the Baltimore district while the smallest mean return was 1.67% in the Sacramento district. The correlation matrix for returns is given in table 2. The reported standard deviations and correlations have been adjusted for first order autocorrelation.

Results

The maximum likelihood results indicate that the variance matrix for returns to lending in the twelve FLBs can be represented by two common factors. The hypothesis that no common factor exists is rejected at the .01 level of confidence, and the hypothesis that two factors are sufficient to represent the variance matrix is not rejected at the .01 level of confidence. Three factors are unable to be estimated because of singularity problems. The standardized factor scores are given in table 3.

The annual estimates of the risk premia and the average risk premia across years are given in Table 4. On average the risk-free rate of return in the across districts is slightly negative, and two positive risk premia exist. The positive risk premia are consistent with expectations, but their relative magnitude calls into question their statistical significance. Testing the significance of the risk premia using the methodology of Dhrymes et al. in equations 14 and 15 yield a $\chi_c^2 = 23.31$ which is statistically significant at 3 degrees of freedom. Thus, we accept the hypothesis that arbitrage profits cannot be made by trading loans within the Farm Credit System.

Therefore, there is no evidence that riskless arbitrage gains are available within the FCS. The APT results indicate that a portfolio shift between FLB districts that add no systematic risk, imply no change in wealth, and increase expected returns is not possible. An alternative method to test this result is to see whether any of the assets are first degree stochastically dominated (Jarrow).

Comparison with Mean Variance Results

The remainder of this study examines the diversification opportuni-ties using the classical mean variance framework. Arbitrage pricing theory is based on market interaction. Mean variance analysis is based on an individuals analysis of the returns. Mean variance and APT analysis should result in roughly the same conclusions. Specifically, under mean variance analysis, the certainty equivalent value of the FLB current portfolio is compared with the certainty equivalent for an optimal portfolio. A significant change between certainty equivalents would indicate that arbitrage profit may be present.

Using arguments from Meyer, it can be shown that the mean variance criteria is consistent with a wide variety of utility and distribution functions. Exact equivalence between the mean variance objective function and the certainty equivalent value of a portfolio is guaranteed by Freund's assumptions of negative exponential preferences and normally distributed returns (Robison and Barry). The certainty equivalent for a risky investment becomes

$$(15) \qquad z = X'c - \frac{\rho}{2} X'\Omega X$$

where x is a vector of activities, c is a vector of expected returns, ρ is the Pratt-Arrow relative risk aversion coefficient,[1] and Ω is the covariance matrix for asset returns. The mean returns and the covariance matrix is construct using tables 1 and 2.

The benefit of arbitrage within the FCS for risk aversion coefficients between .001 and 1.000 is found in table 5. The gain from additional diversification appears to be marginal. For example, the certainty equivalent for the current portfolio is 2.07% with a risk aversion coefficient of .001. Under the optimal portfolio with the same risk aversion coefficient the certainty equivalent is 2.42% for a change of .35%.

The shadow value of including a nonoptimal activity in the optimal portfolio in certainty equivalents is found in table 6. At a risk aversion coefficient of .001, the shadow value is -.15% if Columbia is added to the optimal portfolio. Thus the mean return for Columbia would need to increase by .15% for it to be included into the optimal portfolio at some level. However, the standard error on the estimate of the mean of Columbia is .47%. Thus, the increase needed to include Columbia in the optimal solution is only one third of the estimate of the standard error of the mean. Only New Orleans and Sacramento need an increase in the mean larger than the standard error to be included in the optimal portfolio at levels of risk aversion of .2 or less. Only marginal gains are possible through additional diversification in the FCS. Thus, in this case the mean-variance and the APT results appear to be entirely consistent.

Conclusions

The results from the Arbitrage Pricing Model indicate that gains from additional diversification with the Farm Credit System are not likely. Thus, trading loans between districts will not result in a risk-free profit. Any gain in return will be offset by higher risk. The results from the mean variance model are consistent with the APT results.

These results imply that the Farm Credit system will probably not geographically diversify through the secondary market for agricultural real estate loans. The results also imply that future policies of merging districts of the FCS are not justified based on diversification gains.

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[1]If the mean-variance model is formulated in rate of return then the risk aversion coefficient in the mean variance model is the relative risk aversion coefficient (Pulley).

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Table 1. Mean and Standard Deviation Real Rate of Return on the Federal Land Bank Loan Portfolio 1972-1986.

Bank	Mean	Std Deviacion
Springfield	2.46%	2.04%
Baltimore	2.48	2.28
Columbia	2.29	1.81
Louisville	2.35	2.17
New Orleans	1.81	2.39
St. Louis	2.25	2.17
St. Paul	1.95	2.28
Omaha	2.03	2.48
Wichita	2.17	2.25
Houston	1.92	2.01
Sacramento	1.67	2.90
Spokane	2.44	2.02

Table 2. Correlation Between the Real Rates of Return on the Federal Land Bank Portfolio 1972-1986.

	Spring-field	Balti-more	Colum-bia	Louis-ville	New Orleans	St. Louis	St. Paul	Omaha	Wich-ita	Hous-ton	Sacra-mento	Spo kane
Springfield	1.000	.967	.952	.962	.921	.909	.859	.981	.918	.969	.771	.957
Baltimore		1.000	.856	.970	.953	.920	.826	.888	.928	.944	.801	.983
Columbia			1.000	.879	.814	.865	.848	.812	.804	.944	.690	.850
Louisville				1.000	.949	.947	.900	.877	.774	.924	.837	.959
New Orleans					1.000	.864	.893	.953	.908	.918	.768	.901
St. Louis						1.000	.812	.760	.778	.905	.817	.935
St. Paul							1.000	.853	.729	.868	.763	.782
Omaha								1.000	.938	.872	.620	.816
Wichita									1.000	.860	.676	.886
Houston										1.000	.738	.929
Sacramento											1.000	.808
Spokane												1.000

Table 3. Standardized Factor Scores for a Two Factor Representation of Federal Land Bank Returns by District.

Bank	Factor 1	Factor 2
Springfield	0.07650	-0.44420
Baltimore	0.03490	-0.11333
Columbia	0.13056	-0.72886
Louisville	0.16604	-0.22888
New Orleans	0.02840	0.36305
St. Louis	0.08597	0.09896
St. Paul	0.09227	1.10229
Omaha	0.09545	1.40733
Wichita	0.06924	0.75514
Houston	0.06740	-0.26110
Sacramento	0.00176	-0.00544
Spokane	0.15884	-1.92075

Table 4. Annual and Average Estimates of Risk Premia.

Year	Constant	Factor 1	Factor 2
1971	-.02247	.02040	.00188
1972	-.04151	.02470	-.00042
1973	.02019	.01888	.00140
1974	.02135	-.01324	-.00054
1975	.01171	-.00437	.00128
1976	-.00657	.01044	.00057
1977	-.00763	.02409	.00017
1978	-.03026	.00572	.00021
1979	-.00087	-.00969	.00140
1980	.00883	-.00536	.00125
1981	-.00312	.01650	.00011
1982	.01312	.01486	.00022
1983	.01389	.00011	.00084
1984	-.00622	.00545	.00124
1985	-.00753	.01542	.00011
Average	-.00247	.00826	.00065

Table 5. The Certainty Equivalent Between the Optimal Federal Land Bank Portfolio and the Current Federal Land Bank Portfolio.

θ	Optimal Portfolio	Current Portfolio	Difference
.005	2.45	2.09	.36
.001	2.42	2.07	.35
.020	2.38	2.02	.36
.030	2.33	1.98	.35
.040	2.29	1.94	.35
.050	2.25	1.89	.36
.100	2.05	1.68	.37
.200	1.69	1.24	.45
1.000	-.93	-2.23	1.30

Table 6. Shadow Value of Bringing Various Federal Land Banks into the Optimal Portfolio.

θ	Springfield	Baltimore	Columbia	Louisville	New Orleans	St. Louis	St. Paul	Omaha	Wichita	Houston	Sacramento	Spokane
.005	-.01	---	-.16	-.12	-.66	-.22	-.51	-.44	-.30	-.54	-.80	-.02
.001	---	---	-.15	-.12	-.66	-.21	-.50	-.43	-.29	-.54	-.81	-.01
.020	---	-.00	-.14	-.11	-.66	-.21	-.50	-.44	-.29	-.53	-.81	-.01
.030	---	-.01	-.13	-.12	-.67	-.21	-.50	-.44	-.29	-.53	-.81	-.00
.040	---	-.02	-.11	-.12	-.68	-.20	-.49	-.45	-.29	-.52	-.83	---
.050	---	-.03	-.10	-.12	-.68	-.21	-.49	-.45	-.29	-.52	-.84	---
.100	---	-.07	-.02	-.14	-.72	-.21	-.46	-.47	-.30	-.50	-.90	---
.200	-.04	-.15	---	-.19	-.78	-.27	-.48	-.42	-.30	-.53	-1.01	---
1.0	-.57	-.82	---	-.69	-1.41	-.68	-.90	-1.25	-.50	-.89	-1.85	---

ADAPTING TO TURBULENT CREDIT MARKETS: LOAN PRICING OPTIONS FOR THE FARM CREDIT SYSTEM

Merritt R. Hughes

The Farm Credit System may now be in recovery from what has been one of the most tumultuous decades in its history. Recovery has been propelled to a significant degree by legislative and financial aid from the Federal government. This paper examines the extent to which the System is able to dampen future shocks to net income through use of discretionary tools already at its disposal. In particular, the effect of different loan pricing rules on net income instability are analyzed from an economic perspective.

A simple model is developed describing the System as a set of accounting identities and discretionary loan pricing rules mediating between farmer/borrowers and bond investors.[1] These discretionary policies are then shown to influence the responsiveness of loan volume and the effective interest rate spread, hence System net income, to shifts in general credit market conditions. The degree of net income instability is then compared for several alternative loan pricing policy regimes.

The loan pricing strategies discussed include fixed versus flexible interest rates, with the loan interest rate on new or repriced loans being based either on the new bond interest rate or the weighted average interest rate of all outstanding bonds. The degree of net income instability is shown to vary with the loan pricing rule, with the exact nature of the dependency being determined by the elasticity of loan demand and the extent to which swings in net income influence the risk premium attached to Farm Credit System (FCS) bonds.

This paper is organized as follows. Section I motivates the analysis by outlining the sources and extent of recent volatility in the System's net income. Some legislated changes that address this problem by modifying portfolio and portfolio-related characteristics of the FCS are also summarized. It is noted that, although these changes make the System less likely to need Federal financial assistance in the future, they do little to reduce potential volatility of the System's income stream. Section II provides an overview of the causal links

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[1] The Farm Credit System is a system of cooperatives that by charter lend virtually exclusively to farm and farm-related businesses by bond issuance.

determining the effect of loan pricing policies on the variability of System net income resulting from a given change in market interest rates. Section III presents the formal model and Section IV derives and discusses the mathematical expressions for these effects. Section IV summarizes the main results and discusses their implications for loan pricing policy.

I. Recent Instability

From 1975 to 1983 the System increased its volume of farm loans from roughly $23.0 billion to $67.4 billion, and total market share from roughly 28.5 to 33.5 percent. Since that time both have dropped considerably. Among the most widely cited explanations for the System's financial success in the late 1970's and early 1980's was its practice of basing the interest rate of new loans on the average cost of outstanding bonds. Since this was a period of secularly rising interest rates, the System lagged, hence under-bid its competitors' largely marginally priced loans. By the early 1980's, however, the System experienced a series of adverse developments. Interest rates began to drop from the historic highs of 1981 just after the System issued long-term, noncallable bonds. Almost simultaneously, the farm sector experienced a financial crisis which resulted in heavy loan defaults and a large drop in the sectoral debt to asset ratio. As a result, the System was faced with dropping loan volume and a high default rate at the same time it was locked into funding costs that were rising above those of its competitors. Surplus, (the Farm Credit System equivalent of accrued retained earnings), during the crisis years of 1985 to 1987 shrank from more than $6 billion to less than $1.3 billion.

In response to the System's financial problems, Congress authorized individual System institutions to price loans by whatever method they chose, rather than being tied to a System-wide policy, beginning in 1986. The effect of that legislation was to encourage institutions to set loan interest rates closer to their competitors' rates by using a reference closer to the cost of new System bond issuances. The pricing flexibility has not been revoked by subsequent legislation and allows institutions to return to average cost pricing if it is perceived as more advantageous.

By 1987 direct aid seemed imperative to retain System solvency, and Congress passed an assistance package with numerous provisions including a $4 billion line of credit and mandated organizational changes such as the establishment of a bond insurance fund and increased capital requirements. These organizational changes decrease the likelihood that the System will be forced to ask for direct aid in the future, but do not necessarily imply that the System will operate so as to stabilize net income in the face of future shifts in credit market conditions.

The newly established bond insurance fund, like the implicit Federal guarantee the FCS has historically enjoyed, assures bondholders of eventual receipt of principal and interest due, but does not (again like the historic Federal guarantee) assure them of timely repayment.

Just as risk premiums occurred despite Federal guarantee in the past, high risk premiums on funding capital are likely to re-occur in the future if the System experiences significant difficulties.

While these changes may strengthen the System's capacity to absorb fluctuations in net income, doubts must remain that these organizational changes address the type or magnitude of effects generated by external shocks or the ability of the System's routine operational strategies to avoid or dampen the adverse effects as they occur.[2] But it is exactly the success with which the FCS can cope with unforeseen shocks that will determine its continued viability. For example, sharp interest rate fluctuations that caught the System off-guard in 1981 may continue to be relatively common. It is important, therefore, to ask how System operational strategies currently within its discretion, such as loan pricing rules, can be used to influence the effect of unforeseen autonomous changes in credit market conditions on its net income.

II. Conceptual Issues

To what extent can the Farm Credit System reduce its vulnerability to adverse capital market shocks through the operating policies at its disposal? I examine this question by analyzing which loan pricing policies are best suited to reduce the instability in System income resulting from movements in the general level of interest rates. Four loan pricing options are analyzed below. Reflecting the most widely discussed pair of rating options used by the FCS, the interest rate on new FCS loans may be set with reference to either the interest rate associated with new bond issues or to the weighted average interest rate on bonds outstanding. I shall refer to these two policies as marginal and average cost pricing, respectively. The FCS has recently made wide use of loans with flexible interest rates in attempt to avoid losses from unanticipated changes in the cost of funds. This second set of policy options is addressed by examining a pair of limiting cases: interest rates on loans may be either fixed at the time of contract, or be continually repriced as the general level of interest rates fluctuates. These two policies will be referred to as the fixed and flexible pricing policies. Since operation involves the choice of one option from each policy pair, the choices may be combined in four distinct ways, each implying different effects on net income from shocks originating in the external credit market.

A simple model based on income and balance sheet accounts of the consolidated System is presented in the next section and used to

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[2]Since the FCS member banks lend almost exclusively to farms and farm-related businesses by charter, the System's performance will continue to be highly dependent on the health of the overall farm sector. The recent legislation has provided significant relief for risk associated with this dependence by requiring mergers between Federal Land Banks and Federal Intermediate Credit Banks. Additionally, the newly legislated secondary market for farm mortgages may decrease some risk associated with the long-term nature of farm mortgages.

analyze the choice of loan pricing policies. Unlike previous accounts-based models, a loan demand function and a risk premium function on funding cost are explicitly recognized. This allows for a fuller accounting of direct and indirect effects of loan pricing rules in mediating the impact of a change in market interest rates on net income.

Most directly, the loan pricing rule affects net income by determining how a change in market interest rates affects the spread between the average earnings on loans and the average cost of capital. The pricing rule, however, may also affect net income through a change in loan volume as the interest rate charged on loans by the FCS diverges from the interest rate offered by its competitors. These "first round" or <u>direct</u> effects on net income may then induce secondary feedback or <u>indirect</u> effects as shifts in net income cause System investors to reassess the level of risk premium appropriate for FCS bonds, thus further changing funding costs.

Under a marginal cost pricing rule, net income is affected primarily through the change in the spread between the weighted average interest rate on loans and that of bonds. No direct volume effect exists in this case since FCS competitors' loans are also assumed to exhibit marginal cost pricing. Net income reacts pro-cyclically to change in the general level of interest rates (e.g., rises as market interest rates rise) if interest revenue changes more than interest expense. Pro-cyclical change thus occurs when more loans than bonds are quickly adjusted to the new interest rate level. Accordingly a loan portfolio composed solely of contracts with flexible interest rates almost certainly leads to pro-cyclical change in net income. A loan portfolio of fixed rates, however, may yield either a pro-cyclical or counter-cyclical reaction. Secondary changes in spread and volume will then occur as bond investors react to the direct impact on net income by adjusting the risk premium demanded. It will also be important to determine whether these secondary affects amplify or dampen the initial change in net income.

Under an average cost pricing regime, net income is less affected by directs changes in the spread than under the marginal cost pricing regime, since the loan interest rate is tied to the average bond interest rate. The fact that the System loan interest rate no longer moves one-for-one with the rate charged by its competitors, however, generates a direct volume effect and the elasticity of loan demand plays a key role in determining the size of net income shift. This suggests the average cost pricing regime results in greater net income volatility than the marginal cost pricing regime when demand elasticity is sufficiently high. As in the marginal case, the direct effects can be either amplified or dampened by additional indirect effects through the risk premium on FCS bonds.

<u>III. Formal Model</u>

The following model is designed to illustrate the effect of an autonomous change in the general level of interest rates on net income under a variety of loan pricing rules. Exogenous interest rate shocks are translated into changes in net income through direct and indirect effects on, (a), the spread between the effective interest rates of assets and liabilities, and, (b), the total volume of assets. In this model assets are defined as "loans" and liabilities include "bonds" and "surplus." Surplus, in turn, is defined as the accumulation of net income. To simplify the analysis, operating overhead and all other earnings and expenses not directly associated with the interest of loans and bonds are assumed to be proportional to total loan volume, hence easily modelled as a constant mark-up term. Since the same cost mark-up applies to FCS competitors, these costs have no influence on the end results presented here, and will for the most part be ignored.

Current net income (NI_t)[3] may be described as the product of current total volume of loans, times the spread (pi_t) between the weighted average interest rate on outstanding loans (i^l_t) and the sum of the annualized cost of funding capital to the System (i^k_t), and per unit operating costs (mu):

EQ 1 $$NI_t = L_t * pi_t$$

where

EQ 2 $$pi_t = i^l_t - i^k_t$$

A basic accounting identity from the balance sheet is that total loans (L_t) equal total bonds (B_t) plus surplus (S_t):

EQ 3 $$L_t = B_t + S_t$$

The cost of funding capital in this model incorporates the implicit subsidy which surplus provides to the weighted average cost of outstanding bonds. As surplus increases, System interest expenditure stretches over a larger volume of loanable funds. The internal cost of capital (i^k_t) therefore equals the weighted average bond interest rate (i^b_t) multiplied by total outstanding bonds (B_t) divided by total outstanding loans:

EQ 4 $$i^k_t = \frac{(B_t)i^b_t}{L_t}$$

Substituting equations (2), (3) and (4) into equation (1) produces an alternative expression for net income that emphasizes the subsidy from (S_t):

EQ 1' $$NI_t = L_t(i^l_t - mu) - (L_t - S_t)i^b_t$$

where ($B_t = L_t - S_t$).

But what is the weighted average interest rate of bonds? Total interest payments are equal to new interest payments plus payments on bonds remaining from the past:

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3 Throughout this paper subscript (t) indicates the current time period and subscript (t-1) refers to the previous time period.

EQ 5 $$i^b{}_t B_t = i^b{}_t B^1{}_t + i^b{}_{t-1} B^2{}_t$$

where $i^b{}_t$ and $i^b{}_{t-1}$ are the new, and weighted average old interest rates respectively, and $B^1{}_t$ and $B^2{}_t$ are the new, and old (remaining) bonds, respectively[4]. Thus:

EQ 5 $$B_t = B^1{}_t + B^2{}_t$$

Using equation (6) we can rewrite equation (5) to express the current weighted average interest rate on bonds as a partial adjustment of last period's average rate to this period's marginal rate:

EQ 4' $$i^b{}_t = i^b{}_{t-1} + \frac{(B^1{}_t)}{B_t} * (i^b{}_t - i^b{}_{t-1})$$

The determination of the interest rate on new FCS bonds follows traditional capital market analysis. First, the notion of a "general level of interest rates" is captured in this model by a basic riskless interest rate ($i^t{}_t$). This rate is then translated into the interest rates charged by investors in FCS bonds through addition of a variable risk premium. This risk premium (rho) is assumed to adjust instantaneously to net income (NI_t), which in this simple model is identical to the change in surplus from one period to the next, hence is a good barometer of the solvency of the System:

EQ 7 $$i^b{}_t = i^t{}_t + rho(NI_t) \quad , \quad \text{where } rho' < 0$$

and

EQ 8 $$NI_t = S_t - S_{t-1}$$

Farmer/borrowers of this model are comparison shoppers. New loan demand by borrowers is based on the difference between the rate currently offered by the System and that of its competitors ($i^c{}_t$):

EQ 9 $$L^1{}_t = V(i^1{}_t - i^c{}_t) \quad , \quad \text{where } V' < 0$$

The interest rate charged by competitors is assumed to fluctuate in tandem with the treasury rate (i.e., $i^c{}_t = i^t{}_t + mu$, where mu is a mark-up reflecting operating costs).

Total loans equal new loans plus loans remaining from the past period:

EQ 10 $$L_t = L^1{}_t + L^2{}_t$$

Similar to the derivation for the weighted average interest rate on bonds, the weighted average interest rate on outstanding loans ($i^1{}_t$) can be expressed as the partial adjustment of the average interest rate on remaining loans ($i^1{}_{t-1}$) to the new loan rate where the degree of

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[4] I assume that interest rates on retiring bonds were representative of those on remaining bonds, so that the current average interest rate on old bonds is last period's average bond rate.

adjustment equals the ratio of new to old loans:

EQ 11 $\quad i^l_t = i^l_{t-1} + (L^l_t/L_t)*(i^l_t - i^l_{t-1})$

If all loans have flexible rates, (i.e., are repriced with each shift of (i^t_t)), (L^l_t/L_t) will equal unity: all loans are effectively new. As average time to maturity of outstanding loans increases, the ratio becomes smaller. Thus, the fixed versus flexible pricing rules are captured by the ratio (L^l_t/L_t) in equation 11.

Determination of the new loan interest rate is the other pricing policy variable which is discussed in this paper. The marginal pricing rule allows the new loan interest rate to follow the new bond interest rate paid:

EQ 12.a $\quad i^l_t = i^b_t + mu$

where (mu) is the markup rate covering operating costs and is assumed to be equal to that of competitors.

Alternatively, the average cost pricing rule bases the interest rate of new loans on the weighted average interest rate of outstanding bonds:

EQ 12.b $\quad i^l_t = i^b_t + mu$

IV: Evaluation

Equations 1 through 11, plus either 12.a or 12.b define model containing 12 endogenous variables: NI_t, pi_t, L_t, L^l_t, B_t, B^l_t, i^l_t, i^l_t, i^b_t, i^b_t, rho_t, V_t. By the implicit function theorem, the model's equations define net income as an implicit function of the exogenous variables, including (i^t_t), and the derivative of (NI_t) with respect to (i^t_t) can be calculated. Solving the model for each of the four pairs of policy options allows examination of which of the pairs of policy options produce the smallest derivative (i.e., the least volatility of net income in response to an autonomous interest rate change) under a variety of conditions.

Taking the total derivative of equation (1') with respect to a change in the treasury rate, and using equations (2) through (11) to substitute out endogenous variables, yields policy results for the marginal cost pricing regime. For the fixed loan rate case:

EQ 13
$$\frac{dNI_t}{di^t_t} = \frac{L^l_t - B^l_t}{1 - i^b_t - rho'(L^l_t - B^l_t) - rho'V'(i^l_t - i^b_t)}$$

The expression for the change in net income induced by an autonomous change in the Treasury rate is most easily understood if it is first decomposed into the direct and indirect effects. The direct effects can be identified by setting $(rho' = 0)$ in equation (13):

EQ 13' $\frac{dNI_t}{di^t_t} = (L^1_t - B^1_t)/(1-i^b_t)$

Thus, the direct effect on net interest inflow is proportional to the relative values of loans and bonds carrying a new interest rate.

If the value of new loans, (L^1_t), is greater than the value of new bonds, (B^1_t), some new loans will, in effect, be backed by bonds carrying the old weighted average bond interest rate, and net income will react pro-cyclically to change in the treasury rate (i.e., the total derivative is positive.) High system surplus or maturity levels on bonds that are high relative to those for loans, thus, contribute to pro-cyclicality of net income. The direct spread effect, captured by the numerator of equation (13') is enlarged by the effective subsidy to operation that the additional net income provides (the denominator equals unity minus the weighted average bond interest rate, hence is positive but less than unity.)

The direct spread effect causes a set of indirect effects as changing conditions in FCS finance induces bond investors and farmer/borrowers to modify their behavior. Bond investors will react to the change in net income by changing the risk premium in the opposite direction, and the resulting feedback term is captured by the last two terms in the denominator of equation (13). In the case of a pro-cyclical direct effect $(L^1_t > B^1_t)$, the resulting reduction in (rho) dampens the initial rise in the new bond interest rate, (third term in the denominator) thereby dampening the direct spread effect and reducing the pro-cyclicality of net income. The fall in (rho), however, also creates an indirect volume effect (fourth term in the denominator of equation (13)), by reducing the FCS new loan interest rate below the rate charged by competitors, and thereby tending to re-enforce the pro-cyclicality of net income. In sum, the indirect effect may either exacerbate or dampen the instability of net income in the pro-cyclical case.

Alternatively, if the value of new loans is less than the value of new bonds, some loans carrying the old loan interest rate will be, in effect, backed by bonds with new interest rates. The direct spread effect will thus operate counter-cyclically, and an increase in the treasury rate will reduce the spread between the old weighted average loan interest rate and the new bond interest rate causing net income to fall. A secondary round of effects will occur as bond investors react by increasing the risk premium, further squeezing the spread. Borrowers will also react to the higher rate by further curtailing loan demand, with the result both indirect effects magnify the counter-cyclical instability of net income.

While direct effects are equal with respect to pro-cyclical and counter-cyclical shifts in net income, the feedback effects are not. Asymmetry in feedback effects under the marginal cost pricing regime imply that maturity mixes of loans and bonds which induce direct counter-cyclical movements in net income encourage greater income volatility than maturity mixes which induce pro-cyclical direct movements of the same magnitude.

Net income shifts under the marginal cost pricing regime with flexible loan interest rates are the same as that of a regime with fixed rates, except now the direct spread effects are based on the difference between all outstanding loans (since they are all instantaneously repriced) and new bonds:

EQ 14

$$\frac{dNI_t}{di^t_t} = \frac{L_t - B^1_t}{1 - i^b_t - rho'(L_t - B_t) - rho'V'(i^1_t - i^b_t)}$$

The flexible rate marginal pricing case is clearly more likely to induce pro-cyclical net income change given an autonomous interest rate shock than the fixed rate case, the numerator of equation 14 $(L_t - B^1_t)$ exceeds the numerator of equation 13 $(L^1_t - B^1_t)$. Unless there is negative surplus, some new-priced loans will be backed by old-priced bonds, and, an increase in the treasury rate causes interest inflow to rise faster than interest outflow, increasing net income. To the extent that the flexible interest rate policy leads almost certainly to pro-cyclical shifts in net income the total indirect effect is composed of two off-setting effects and is likely to be small.

The derivative in equation 13 is zero when $(L^1_t = B^1_t)$. The key to net income stability in the marginal cost pricing regime is thus to match the maturity structure of loans and bonds. This is most easily accomplished with fixed pricing where (L^1_t) is maintained approximately equal to (B^1_t).

The results for the average cost pricing regime are similar to marginal cost pricing in a number of respects. The expressions for net income instability are, however, somewhat more complicated since there are direct effects both on volume and spread. Temporarily setting volume change equal to zero ($V' = 0$) allows easier comparison with the marginal cost pricing regime. The induced change in net income resulting from an autonomous change in the treasury rate for fixed and flexible loan rates under the average cost pricing regime, without volume effects, are presented in equations 15 and 16, respectively:

EQ 15

$$\frac{dNI_t}{di^t_t} = \frac{(L^1_t - B_t)*(B^1_t/B_t)}{1 - i_{bt} - rho'(L^1_t - B_t)*(B^1_t/B_t) - (i^b_t - i^b_{t-1})*(L^1_t - B_t)*((B^2_t/(B_t)^2)}$$

EQ 16

$$\frac{dNI_t}{di^t_t} = \frac{(L_t - B_t)*(B^1_t/B_t)}{1 - i^b_t - rho'(L_t - B_t)*(B^1_t/B_t) - (i^b_t - i^b_{t-1})*(L_t - B_t)*((B^2_t/(B_t)^2)}$$

The effective subsidy to operation that additional net income provides (second term in the denominator of both equations) shows up as an amplifying effect, similar to the marginal regime results. Moreover, the difference between fixed and flexible interest rates under the average cost pricing regime is conceptually the same as under marginal pricing. Whereas the fixed rate case has only a fraction of total loans with the new interest rate, in the flexible rate case all outstanding loans have the new loan interest rate.

There are also some differences. The spread in the numerator differs from that for marginal pricing in that the difference expression is now between repriced loans and all (not just new) bonds, and the difference is reduced in absolute magnitude by the ratio $(B^1{}_t/B_t)$. The weighted average bond rate on which the new loan interest rate is now based does not increase one-for-one with the Treasury rate, and the new loan interest rate in the average pricing regime is based on all outstanding bonds. Furthermore, an additional term appears in the denominator. For very small changes in $(i^t{}_t)$, hence $(i^b{}_t)$, this term is near zero and it clearly becomes the case that the flexible rate rule would imply a smaller spread effect in the average than marginal pricing regime[5]. As the size of the interest rate change increases, the spread effect in the average pricing flexible rate case is dampened relative to the marginal case.

Since $(L^1{}_t - B_t)$ is less than $(L^1{}_t - B^1{}_t)$, and typically negative, a fixed rate loan policy is more likely to induce a counter-cyclical spread effect under average cost pricing than marginal pricing. For a very small positive change in the interest rate (i.e., very small fourth term in the denominator of equation 15) the spread effect of the average pricing fixed rate case is more counter-cyclical than the marginal pricing case. As the change in interest rates increase, the spread effect is further magnified (i.e., increases more than linearly.)

The average cost pricing regime is subject to an additional direct force on net income that does not occur under marginal pricing. Because competitors are assumed to base their loan rate on a marginal cost pricing policy, the discrepancy between marginal and average bond rates created by a change in $(i^t{}_t)$ leads to a divergence between the FCS loan rate and its competitors' loan rate, inducing a shift in FCS loan volume. The total derivatives of net income with respect to a change in the treasury rate may be written in their entirety for the fixed and flexible cases, respectively:

EQ 17

$$dNI_t/di^t{}_t = ((L^1{}_t-B_t)*(B^1{}_t/B_t) - V'(L^1{}_t-B_t)*(i^b{}_t-i^b{}_{t-1})*((B^2{}_t/(B_t)^2))/$$

$$(1 - i_{bt} - rho'(L^1{}_t-B_t)*(B^1{}_t/B_t) - (i^b{}_t-i^b{}_{t1})*(L^1{}_tB_t)*((B^2{}_t/(B_t)^2) -(i^b{}_t-i^b{}_{t-1})*V'(1-i^b{}_t)*((B^2{}_t/(B_t)^2))$$

EQ 18

$$dNI_t/di^t{}_t = ((L_t-B_t)*(B^1{}_t/B_t) - V'(L_t-B_t)*(i^b{}_t-i^b{}_{t-1})*((B^2{}_t/(B_t)^2)) /$$

$$(1 - i^b{}_t - rho'(L_t-B_t)*(B^1{}_t/B_t) - (i^b{}_t-i^b{}_{t-1})*(L_t-B_t)*((B^2{}_t/(B_t)^2) - (i^b{}_t-i^b{}_{t-1})*V'(1-i^b{}_t)*((B^2{}_t/(B_t)^2))$$

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5 It is assumed that the new bond interest rate is above last period's weighted average bond interest rate, since $(di^b{}_t/di^t{}_t)$ equals the change in the treasury rate $(di^t{}_t)$ plus a (small) feedback effect on rho.

Comparison between equations 15 and 16 reveals that the direct volume effect is captured by the second terms in the numerators and the fourth terms in the denominators. The value of the direct volume effect depends on the age mix of bonds and loans, (e.g., relatively fewer new bonds implies a greater interest lag), the interest responsiveness of loan demand (V'), and the value of bond interest rate change from one period to the next.[6] The results for the fixed rate, average cost pricing derivative (equation 17) suggest that for small changes in the bond interest rate, the volume effect will be relatively small. As the interest rate change increases, however, the volume effect works both to re-enforce counter-cyclical movement in the numerator, and dampen it in the denominator. Following a flexible rate rule (equation 18), the volume effect augments pro-cyclical force of the spread in the numerator, but dampens it in the denominator. Whether the marginal or average cases are more likely to be stable depends on which of the numerator or denominator effects dominate.

While relative magnitudes of net income change in flexible and fixed rate cases depend on a substantial number of other relative values, it is possible to pinpoint the optimal degree, with respect to minimizing net income volatility, of loan rate flexibility for the average pricing regime. Thus, when ($L^1_t = B_t$), both terms in the numerator of equation 17 equal zero. The average cost pricing regime has a stable solution when the value of loans with a new loan interest rate equals the total value of bonds. In other words, ($B^t = L_t - S_t$) should be repriced each year, as compared to just ($B^1_t = L_t - S_t - B^2_t$) under marginal cost pricing. If (S_t) is near zero, net income stability under average cost pricing requires flexible interest rates for almost all loans.

V: Conclusion

During the last decade the Farm Credit System has been exposed to considerable volatility in its net income. Legislation recently passed diminishes apprehension of immediate System insolvency and works toward removal of certain sources of risk leading toward instability. Volatile capital markets remain a potential source of instability in System net income, however. This paper has examined two pairs of loan pricing options the FCS has at its disposal that can influence the volatility of net income with respect to autonomous shocks in the general level of interest rates. The two pairs of options were flexible versus fixed loan interest rate rules, and marginal versus average cost pricing regimes. Conditions under which each of the four possible combinations of these options may be expected to ameliorate instability in net income resulting from a shock in the underlying "treasury rate", accounting for reactive behavior by farmer/borrowers and FCS bond investors, were investigated.

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6 The exposition assumes an infinitesimal increase in the treasury rate is the only factor that induces (i^b_t) to be different from (i^b_{t-1}).

This model suggests that in both the marginal and average cost pricing regimes it is possible to insulate net income from changes in the general level of interest rates. It is noted that the marginal cost pricing case implies zero shift in net income when the values of loans and bonds with new interest rates are equal. In the average cost pricing case zero net income shift occurs with a loan portfolio primarily of new rate loans. When zero shift conditions do not hold, which of the four cases exhibit the least net income volatility overall depends to a significant degree on the magnitude of the interest rate change and loan demand elasticity. The model suggests as loan demand elasticity and/or interest rate changes become very small, net income shift is larger in the marginal than average pricing regimes for pro-cyclical change, but larger under the average pricing regime for counter-cyclical change.

The model shows why as deregulation of the financial markets took place the FCS could be expected to find income stability a difficult objective to achieve if they had maintained an average cost pricing rule. As deregulation took place, volume effects grew dramatically. Both loan demand elasticity and interest rate change blossomed into significant de-stabilizing forces. The model suggests moving to marginal cost pricing as the financial markets became more unstable did work to decrease net income volatility. The decrease in volatility came from decreasing the potential volume effect caused by divergence of FCS and competitors' loan interest rates as market interest rates fluctuated. Furthermore, as interest rates fell, lengthening the average maturity on loan relative to bonds is shown to act as a counter-cyclical force, stemming net income loss.

Conditions for net income stability in this model suggest that the average loan maturity under average cost pricing should be shorter than under marginal. Alternatively, if a decision were made to lengthen the effective maturity of farm loans, e.g., to decrease the interest rate risk that farmer/borrowers must face, maintaining a marginal cost pricing regime is relatively conducive to stable Farm Credit System net income.

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