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Agricultural Finance Review

The invited articles in this special issue were also presented and discussed in a pre-conference workshop titled *Agricultural and Rural Financial Markets in Transition* at the 2005 annual meeting of the American Agricultural Economics Association in Providence, Rhode Island.

Agricultural Finance Review

Department of Applied Economics and Management, Cornell University
Volume 65, Number 2, Fall 2005

Preface

Agricultural Finance Review (*AFR*) provides a forum for discussion of research, extension, and teaching issues in agricultural finance. This publication contains articles contributed by scholars in the field and refereed by peers.

Volume 43 was the first to be published at Cornell University. The previous 42 volumes were published by the United States Department of Agriculture. *AFR* was begun in 1938 by Norman J. Wall and Fred L. Garlock, whose professional careers helped shape early agricultural finance research. Professional interest in agricultural finance has continued to grow over the years, involving more people and a greater diversity in research topics, methods of analysis, and degree of sophistication. We are pleased to be a part of that continuing development. We invite your suggestions for improvement.

AFR was originally an annual publication. Starting with volume 61, Spring and Fall issues are published. The *AFR* web page can be accessed at http://afr.aem.cornell.edu/. Abstracts of current issues and pdf files of back issues since 1995 are available.

The effectiveness of this publication depends on its support by agricultural finance professionals. We especially express thanks to those reviewers listed below. Grateful appreciation is also expressed to the W. I. Myers endowment for partial financial support. Thanks are also due to Faye Butts for receiving, acknowledging, and monitoring manuscripts, and Judith Harrison for technical editing.

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Foreword and Dedication

Agricultural Finance Review Special Issue "Agricultural Finance Research: Past, Present, and Future"

For over three decades, university researchers, industry practitioners, and government policy makers and analysts have worked in a coordinated fashion to address pressing issues related to the supply and use of financial capital in agriculture and rural America. This special issue of the *Agricultural Finance Review* provides the opportunity to take stock of the past research conducted within the agricultural finance arena, and to intentionally propose an agenda of candidate topics for those interested in conducting agricultural finance research in the future.

The idea to set this "survey marker" on the agricultural finance landscape was put forth and shepherded in large part by Paul Ellinger with help from Eddy LaDue, Cole Gustafson, Allen Featherstone, Calum Turvey, and many other members and participants of the NC-1014 Regional Research Committee on Agricultural Finance. The Regional Research Committee structure provided a natural vehicle both for supplying the historic perspective and for identifying the contemporary challenges facing the industry.[1]

Early versions of the papers included in this issue were presented and discussed in a special workshop on Agricultural and Rural Financial Markets in Transition at the July 2005 annual meetings of the AAEA, and materials provided by the industry discussants are included as well. The authors of each of the invited papers successfully completed their charge to organize and interpret the historic progression of thought in their given topical partition, and to identify what they believe to be the most pressing issues deserving future attention by those conducting research in agricultural finance.

At each juncture, Eddy LaDue provided thoughtful guidance and leadership for the development of this special journal issue, and to the contributing authors. Moreover, he likewise provided his characteristically perceptive judgment and service to the Regional Research Committee and its predecessors for much of the period over which they have existed. He has always been willing to help write proposals, develop project activities, coordinate publications and meetings, and to serve in all the necessary roles to promote the professional development of the members and successful contributions of the whole.

Those efforts coincided with his equally impressive contributions to the agricultural finance profession in the large. Eddy LaDue developed and was the Director of the Cornell Program on Agricultural and Small Business Finances, and founded and taught numerous other ag-banking schools. He also served as co-editor and/or editor of this journal from 1990 to 2005, and held the W.I. Myers Professorship in Agricultural Finance from 1998 until his appointment as Professor Emeritus in 2005.

In recognition of the many facets of the profession that bear witness to his influence, and will continue to do so for many decades to come, this issue is dedicated to Professor Eddy L. LaDue. Thanks, Eddy! Well done.

— Bruce J. Sherrick
AFR Associate Editor

[1] See http://www.ace.uiuc.edu/agfin/ for an archive of annual proceedings of the NC-1014 and its predecessor committees for most years from 1984 through the present.

Farm Financial Structure

Allen M. Featherstone, Gregory A. Ibendahl, J. Randy Winter, and Aslihan Spaulding

Abstract

The structure of U.S. agriculture is a topic of relevance to farmers, policy makers, farm organizations, and academics. Over the last century, farm financial structure issues have become extremely important as the United States moved from an agrarian economy to a more industrialized one. Traditionally analyzed topics such as optimal capital structure, equity capital markets, entry into production agriculture by beginning farmers, and tax issues remain important. Societal effects caused by changing farm financial structure and the effect on the rural landscape are issues needing further research. Finally, research is needed on farm financial structure changes in other regions of the world that may affect the competitiveness of U.S. agriculture.

Key words: farm financial structure, optimal capital structure, research issues

The structure of U.S. agriculture is a topic of importance to farmers, policy makers, farm organizations, and academics. A precise definition of farm financial structure is difficult to construct because it means many different things to different individuals. Farmers are concerned about farm financial structure with regard to finding the capital necessary to continue to be competitive in a global agricultural economy. Policy makers view farm financial structure as it relates to the viability of rural communities and the ability for young farmers to amass the capital necessary to be successful. Finally, farm organizations and academics are concerned about farm financial structure for all the reasons stated above.

Thus, the farm financial structure of agriculture influences a multitude of issues, from the competitiveness of U.S. agriculture in a global food economy to the appropriate level of public support for limited-resource and mid-sized operations. Moreover, policy prescriptions for agriculture originate from various interests, ranging from those promoting economic efficiency to those concerned about sociological conditions in rural communities.

LaDue, Gloy, and Cuykendall (2003) have estimated that by 2020, the number of dairy farms in the United States would decrease by about 85% (89,000) from 2000 levels, with more than 80% of milk production occurring on farms with more than 500 cows. Projections such as this suggest a dramatic restructuring and reallocation of resources, including the financing of such operations.

This article examines the state of knowledge associated with farm financial structure.

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We begin by reviewing the historical and current situation in U.S. agriculture that has caused individuals to be concerned about farm financial structure. Over the last century, farm financial structure issues have become extremely important as the U.S. moved from an agrarian to a more industrialized economy. Next, issues that transcend U.S. borders are discussed, as farm financial structure issues in other countries have important implications for farm financial structure in the U.S. The academic farm financial structure literature is then reviewed,[1] followed by an examination of emerging issues relevant to the topic of farm financial structure.

Farm Financial Structure in the United States

The U.S. farm situation has changed dramatically over the last 50 to 100 years, which in turn has dramatically altered the financial structure of U.S. agriculture. Technological advances in both mechanization and genetics have made U.S. farms more efficient and productive. These changes, in combination with the move toward a global marketplace and times of economic crisis, have transformed the typical farming operation. Not only has there been a structural change in the physical characteristics of a farm, but there has also been a change in the farm's financial structure. These financial changes can be classified by their effects on the use of debt and equity capital, the use of leasing, and changes in key farm financial ratios.

Physical Changes

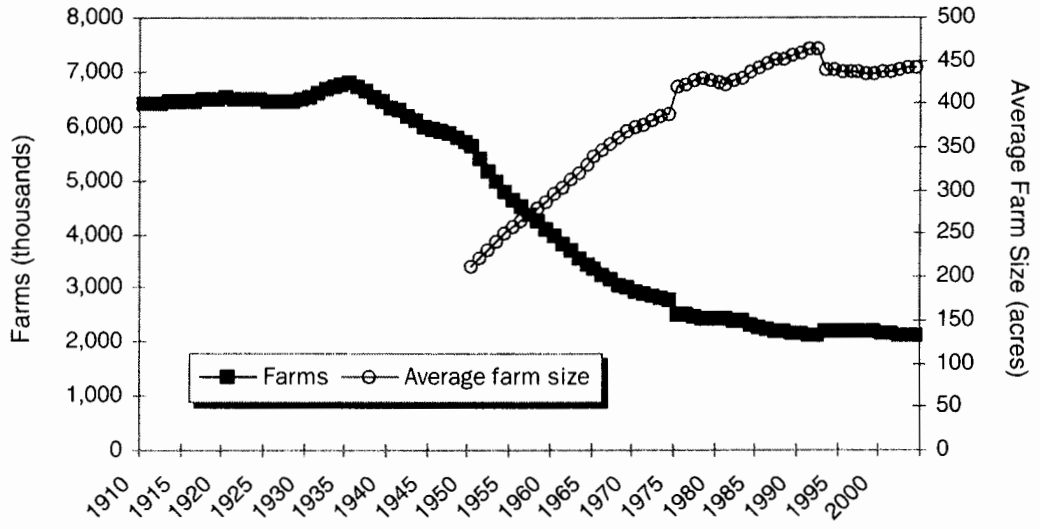
For the past 70 years, there has been an almost uninterrupted decline in the number of farms in the United States. That decline has changed the U.S. economy from an agrarian-based economy to an industrial and service-based economy. Farm numbers peaked in 1935 at slightly over 6.8 million (Figure 1). This was a period of widespread economic depression in the United States with limited off-farm employment opportunities, so people migrated to farms as a means of survival. Following the 1935 peak in farm numbers, there was a steady decline through roughly 1975. After 1975, the decline in farm numbers slowed.

Because the definition of a farm has always been fairly conservative, there are a large number of small farm operations. For example, 56% of all farms in 2002 had agricultural sales less than $10,000. Additionally, the definition of a farm has been changed from time to time. When the definition changes, there can be an unusually large adjustment in the number of farms. As a result of the most recent change (1974), the number of farms declined by nearly 10% from 1974 to 1975, from 2.795 million to 2.521 million.[2] Notwithstanding these anomalies, clearly there has been a trend toward fewer farms in the United States, with a steady increase in the average farm size.

Several factors fueled and sustained the decline in the number of farms and the resulting change in farm structure. First, there has been a marked substitution of capital for labor. Important examples include the shift from four-footed horse power to mechanical "horsepower." Farm machinery and power units grew in size, allowing one person to cover more acres. Another major capital-for-labor substitution has been the improvement in crop protection chemicals which lowered the dependence on tillage for weed control—again making it possible for one person to efficiently produce on greater acreages. An obvious effect of the substitution from labor is a greater need

[1] It is important to note that much of the literature cited was originally presented at workshops of the NC-1014 Committee or one of its precursors. However, to facilitate ease of obtaining copies of the literature, those presentations actually published in academic journals will be cited instead.

[2] For a detailed accounting of the changes in farm definitions, interested readers are referred to USDA/NASS (2004) Statistical Bulletin No. 991, *Farms and Land in Farms: Final Estimates by State and United States, 1998-2002.*



Source: USDA/NASS (2004), Statistical Bulletin No. 991.

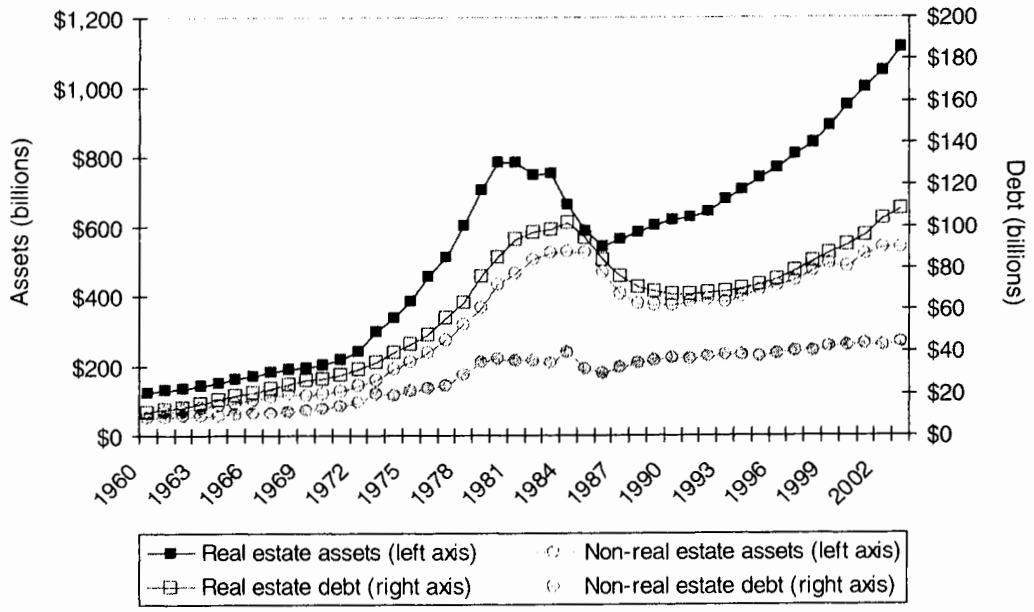
Figure 1. U.S. Farm Numbers and Average Farm Size (1910–2004)

for capital, and the financing of that capital to sustain the farming operation.

A second factor which has contributed to increasing farm size and declining number of farms is a general reduction in the operating profit margin of production agriculture. As the profit margin declines, some argue there is pressure to become more efficient by expanding the size of the farm to maintain the level of net farm income. The total land base available for agriculture in the United States is relatively fixed (actually declining with continuing development of land for nonfarm uses). Consequently, increases in farm size come at the expense of consolidating units, resulting in fewer farms.

Both of these factors contribute to an increased need for debt capital for the operation of the commercial farm unit. This need for debt capital is further exacerbated by an increase in the capital requirements of the commercial farm—associated strongly with higher land and machinery prices. As a result, the amount of debt capital in the production agriculture sector began increasing, from the 1960s or earlier. The use of debt capital exploded during the 1970s, retrenched during the financial crisis of the 1980s, and has steadily increased during the 1990s and 2000s (Figure 2). With declining farm numbers, debt per farm follows the same general trends as total debt, but is more pronounced.

In addition to the growing amounts of debt, there are some other important financial structural considerations based on the farm sector balance sheet. Assets and debt are commonly divided between real estate and non-real estate components. From the asset side of the farm balance sheet, the real estate component accounts for the largest percentage of total assets (Figure 2)—typically representing 75%–80% of total farm assets. However, the distribution of debt between debt secured by real estate and debt secured by non-real estate tends to be more evenly divided. These distributional differences between assets and debt have important implications for the operational characteristics of the farm. Financial managers typically suggest there should be a matching of debt capital with the assets



Source: USDA/ERS online Farm Briefing Room.

Figure 2. U.S. Agricultural Assets and Debt (1960–2003)

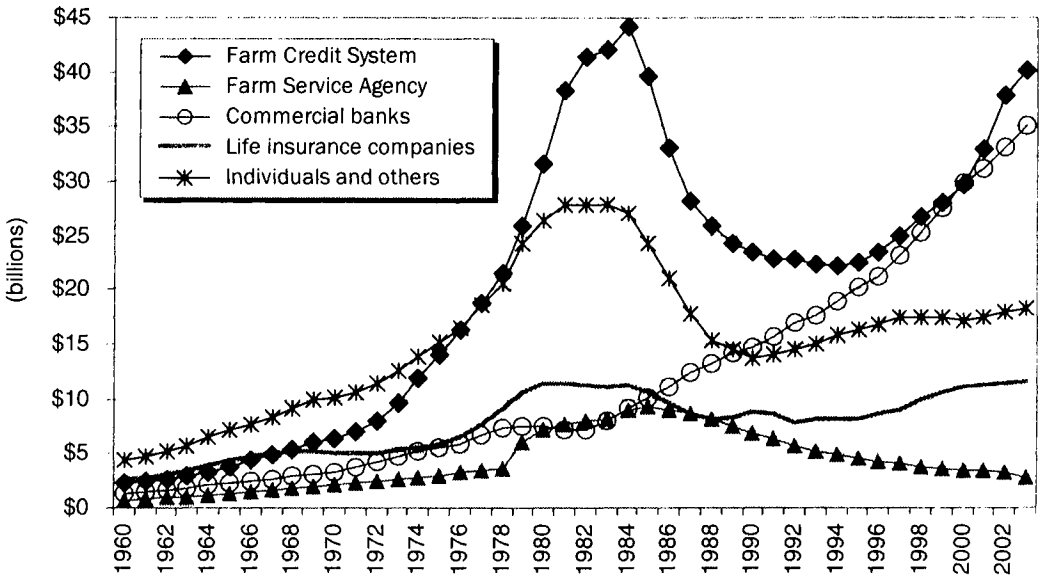
being supported. However, while real estate represents 75%–80% of the total assets, it supports approximately 50% of the debt. By contrast, non-real estate assets represent 20%–25% of the total assets but support 50% of the debt. Much of this difference can be explained by the average age of farmers. Moreover, the financing of assets by debt or equity has important implications for those farmers who are attempting to enter production agriculture.

Sources of Debt Capital in Agriculture

The providers of debt capital for commercial agricultural producers include commercial banks (as a group), the Farm Credit System, life insurance companies, government agencies, and individuals, dealers, and merchants. The market shares of the various lenders have changed over time and differ when comparing real estate and non-real estate debt. Figure 3 shows the trends in agricultural real estate debt by provider for the United States from 1960 through 2003.

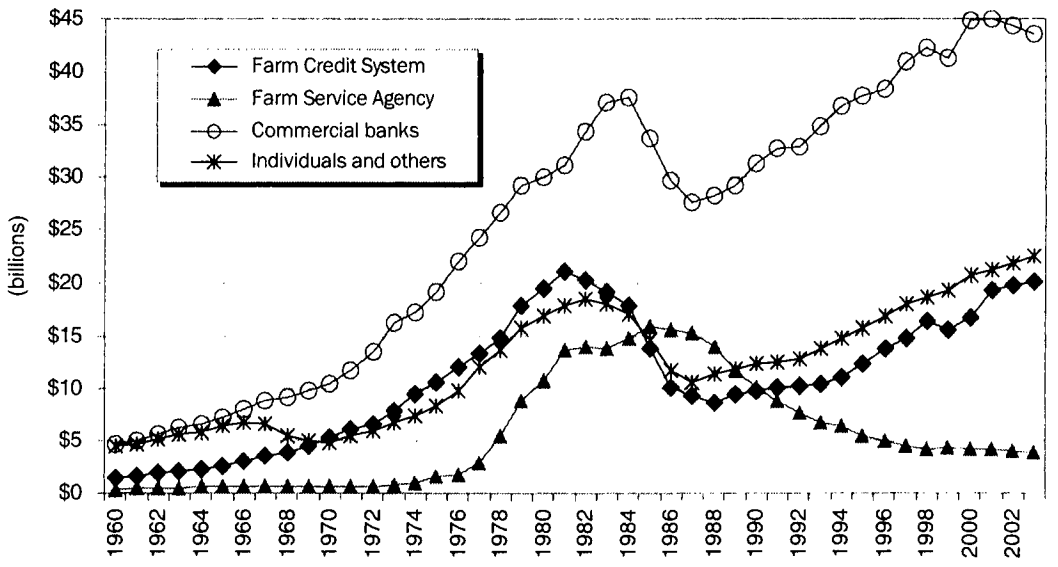
The Farm Credit System is the largest provider of real estate debt, followed closely by commercial banks. A limited number of life insurance companies provide debt capital for agricultural land, but their contribution has been relatively minor (although stable) in recent years. Commercial banks have held an increasing share of real estate debt since the financial crisis in the 1980s. The Farm Service Agency (representing the Commodity Credit Corporation and the former Farmers' Home Administration) increased market share during the financial struggles of the 1980s, but currently holds a relatively small portion of real estate debt.

The same information for the non-real estate component of agricultural debt is reported in Figure 4. Commercial banks are clearly the largest provider of non-real estate agricultural debt. Individuals, merchants, and dealers are next, with much of this lending undertaken as a promotion for equipment and other agricultural input purchases such as seed, chemicals, and fertilizers.



Source: USDA/ERS online Farm Briefing Room.

Figure 3. Agricultural Real Estate Debt by Lender (1960–2003)



Source: USDA/ERS online Farm Briefing Room.

Figure 4. Agricultural Non-Real Estate Debt by Lender (1960–2003)

Changes in Farm Financial Ratios

Increasing farm size, greater use of debt capital, and smaller per acre profitability has affected farm financial ratios. In addition, many of the ratios vary geographically or by crop. Thus, ratios calculated from either state or national level income statements or balance sheets hide a degree of dispersion among those farms. The per farm use of debt capital has increased as farm size has increased. However, the percentage of debt capital employed has remained fairly constant since 1990.

As shown by the debt-to-asset ratio (Figure 5), U.S. farmers finance 15% of their assets with debt. In the mid-1980s, this ratio was much higher due to a major farm crisis. In the early 1980s, high inflation led to rapidly increasing land values. Lenders provided credit based on the market value of land. When land prices declined, some farmers found themselves with debt greater than the value of their asset.

The relatively constant debt-to-asset ratio illustrated in Figure 5 also indicates increases in the asset base of the structure have been financed with an increase in equity. That equity has been enhanced by the increase in legal forms which have limited the liability for nonfarm investors. The increase in vertical coordination and ownership in the poultry and pork industries have changed the way those industries are financed.

Figure 5 also reveals geographical differences in the use of debt capital. California and Mississippi tended to have higher debt-to-asset ratios than the rest of the U.S., while Texas is below the debt-to-asset average and Illinois is average to below. In addition, Texas did not encounter the increase in the debt-to-asset ratio during the 1980s experienced by the rest of the country.

Some of these regional differences in the debt-to-asset ratio can be explained by the type of agriculture in each state. For example, California and Mississippi tend to grow higher value per acre crops, requiring greater production expenses. This increased use of inputs means more short-term debt is needed to produce the crop.

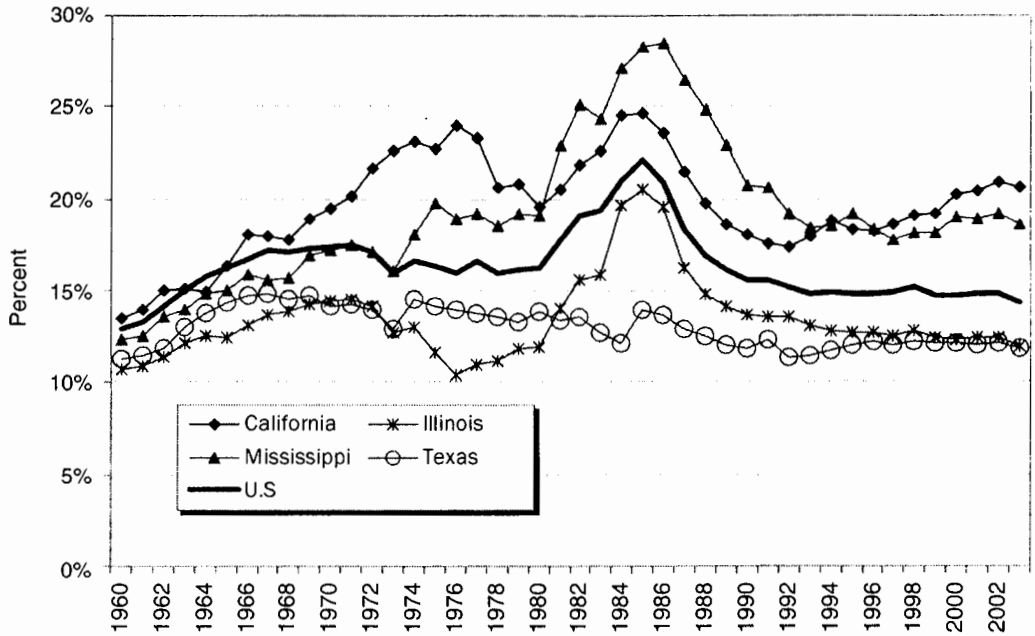
The debt-to-asset ratios based on national and state numbers include all farm and owner/operator types. Many farms with older owners have much of their debt repaid. Similarly, part-time farmers may not have much debt. The result is that active full-time farmers who are trying to expand their operations to maintain profitability often have higher debt-to-asset ratios than reflected in the aggregated averages.

Another financial measure that can foreshadow problems is the interest expense ratio.[3] The U.S. average over the period 1960–2004 is shown in Figure 6. Interest expense rose in relation to the value of farm production during the mid-1980s, when large debt loads and high interest rates pushed the ratio to near 20%. Surprisingly, there are few regional differences among states for this ratio. Even Texas, which had a low debt-to-asset ratio during the mid-1980s, had a high interest expense ratio at this time.

Two other ratios are graphed in Figure 6: operating profit margin and asset turnover ratio. When multiplied together, these two ratios give return on assets (ROA). The ratios show some variability, but operating profit margin has declined since 1970. The asset turnover ratio reached a low in the early 1980s, which may have indicated land prices were becoming too high. Since 1990, both ratios have declined, as reflected in the U.S. average drop in ROA.

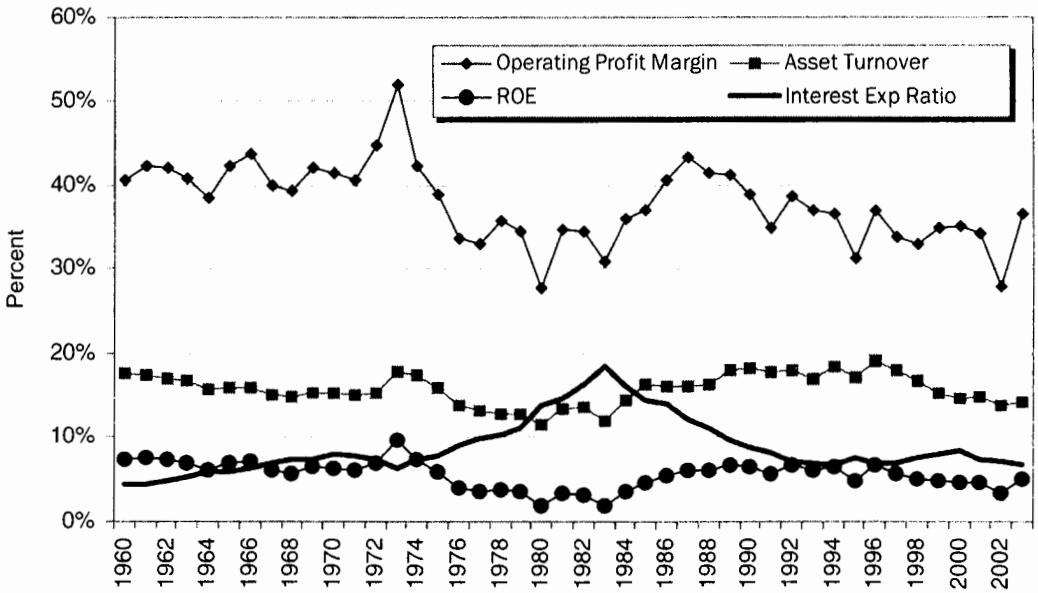
Profitability is shown by the use of the ROA and the return on equity (ROE) ratios. ROA for the U.S. and selected states is presented in Figure 7, and ROE for the

[3]The interest expense ratio is calculated by dividing interest expense by value of farm production. Value of farm production is the farm-produced gross returns (i.e., total gross returns less feed and livestock purchases).



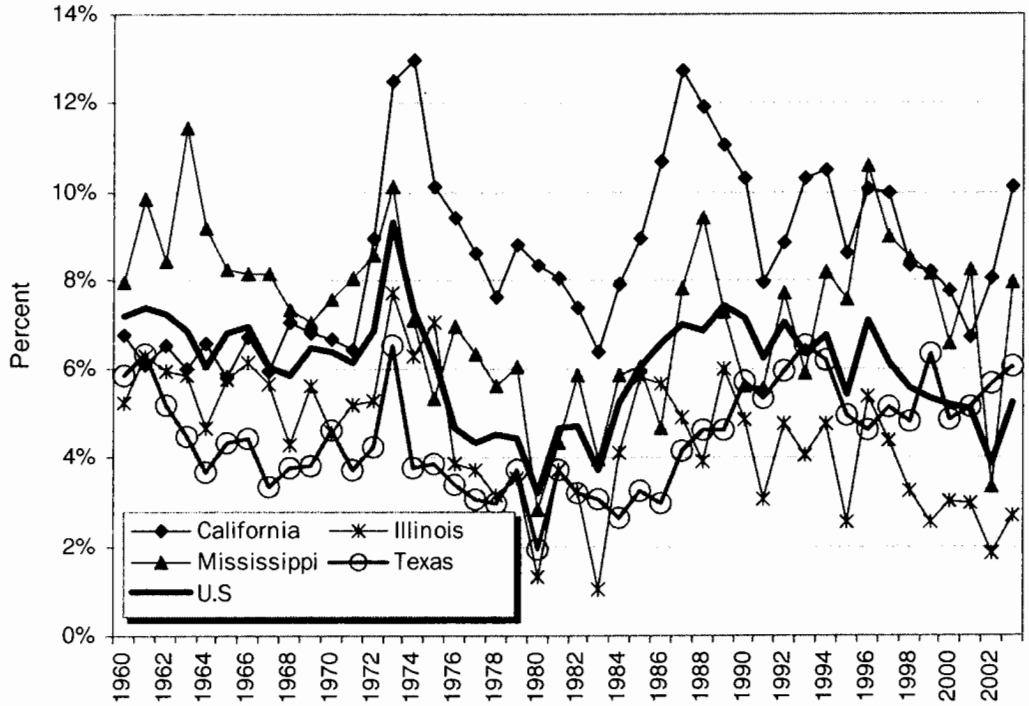
Sources: USDA/ERS online Farm Briefing Room, and authors' calculations.

Figure 5. Debt-to-Asset Ratio for Various States (1960–2004)



Sources: USDA/ERS online Farm Briefing Room, and authors' calculations.

Figure 6. Selected Financial Ratios for the United States (1960–2004)



Sources: USDA/ERS online Farm Briefing Room, and authors' calculations.

Figure 7. Rate of Return to Assets for Selected States (1960–2004)

U.S. is shown in Figure 6. The ROA is calculated by adding interest expense to net farm income and then dividing by total assets. The missing components are the charge for operator labor and unrealized capital gains. ROE is calculated by dividing net farm income by total equity.

As Figures 6 and 7 show, profitability is highly variable. The average ROA for the United States since 1960 is 6%, while the average ROE is 5.6%. Typically, both of these ratios are low compared to nonfarm businesses because unrealized capital gains from land appreciation are not included in the calculation of the numerator. Since land represents a large percentage of most farms' assets, and capital appreciation is not included, these ratios understate the total return to agriculture and make it difficult to compare to each other or to other assets.

Leasing

Another important component in farm financial structure is not just the ownership of assets, but the management of assets. The Agricultural Economics and Land Ownership Surveys of 1988 and 1999 [U.S. Department of Agriculture/National Agricultural Statistics Service (USDA/NASS)] reveal interesting trends about leasing in the United States. First, leasing is an important way for farmers to control farmland. As observed from Table 1, leasing of farmland accounted for 35% of a farm's acres in 1988, but by 1999, this percentage had increased to 42%. The Midwest had the highest percentage of rented land in both surveys (42.9% in 1988, and 51.7% in 1999). Higher farmland prices in the Midwest make it more difficult for farmers to control land

Table 1. Ratio of Leased Land to Total Land for Selected U.S. Regions (1988 and 1999)

Region	All Leases (%)	Cash Leases (%)	Rent per Acre ($)	Share Leases (%)	Cash/Share Leases (%)	Other Leases (%)
	<----------	(1988)	---------->			
U.S.	34.4	23.1	27.30	10.5	1.1	0.6
Northeast	20.8	17.9	38.89	1.2	0.2	1.5
Midwest	42.9	24.1	36.06	16.6	1.4	0.7
South	38.2	27.5	23.59	8.9	1.3	0.5
West	25.0	18.1	17.66	5.6	0.7	0.6
	<----------	(1999)	---------->			
U.S.	42.0	25.0	38.47	10.1	4.5	2.5
Northeast	29.5	21.5	43.82	0.8	1.0	6.2
Midwest	51.7	28.1	52.56	14.5	7.7	1.4
South	46.1	29.4	24.03	8.9	3.4	4.3
West	27.7	17.4	33.98	6.6	2.1	1.6

Source: USDA/NASS, Agricultural Economics and Land Ownership Surveys, 1988 and 1999.

by purchasing and financing it. Renting is an option for those farmers looking to expand but unable or unwilling to purchase land.[4]

The other important trend is the change in the type of lease (Table 1). Share leases in all parts of the U.S. are either remaining steady or declining. Other lease types are increasing, especially the cash/share lease. Cash leasing remains the dominant lease type. Guaranteed income to the landlord and low record-keeping requirements for the tenant make cash leases popular.

While the cash/share lease is a small percentage of total leases, its use increased dramatically from 1988 to 1999. As reported by Barry (2002), the use increased from 3.2% of total leases in 1988 to 10.8% in 1999. In the Corn Belt states of Illinois and Indiana, this rental arrangement increased from around 2% of all leases to over 26% of leases. The increase in this type of lease reflects the advantages provided to both landlords and tenants. Landlords receive a minimum level of liquidity while tenants achieve a measure of risk sharing.

To summarize, farm financial structure has changed over time, with production agriculture becoming much more capital dependent. Farm financial structure varies across regions, and the source of financing has also changed over time. Changes in leasing to manage the financial structure of the sector have different risk-return characteristics that affect the overall risk in the sector.

Farm Financial Structure Globally

The changing structure of production agriculture in the United States has led to several important issues in the financing of farms. With this evolution in the structure of agriculture, the source of financing production agriculture has changed. In addition, the transformation in agricultural structure and the resulting change in financial structure have been correlated with improved productivity—though not all would agree there is a causal relationship.

[4] As one reviewer pointed out, tax laws and government regulations may have caused the leasing changes.

Table 2. Percentage Distribution of Land Holdings in Selected Countries

Country	No. of Arable Hectares	< 10 Hectares (%)	≥ 10 and < 100 Hectares (%)	≥ 100 and < 1,000 Hectares (%)	≥ 1,000 Hectares (%)
Argentina	177,000	23.45	38.64	30.65	7.26
Australia	447,000	4.96	20.50	50.14	24.40
Brazil	263,580	49.65	39.61	9.71	1.02
China	553,957	99.80	0.20 [a]	—	—
Czech Republic	4,273	72.53	20.48	4.88	2.03
France	29,555	37.72	57.93	4.34 [b]	—
India	181,177	98.78	1.21 [a]	—	—
United States [c]	411,863	29.52	39.62	30.86	—

Source: Food and Agriculture Organization (FAO) Stat.

[a] This category is ≥ 10 hectares.

[b] This category is ≥ 100 hectares.

[c] For the U.S., the category breaks are < 20.2 hectares; ≥ 20.2 and < 105.2 hectares; and ≥ 105.2 hectares.

Given increased global competition in the production of basic commodities, it is important to understand the financial structure of production agriculture globally. Developments that occur globally in production agriculture have important implications for U.S. agricultural policy and the income of U.S. farmers.

The percentage distribution of land holdings in selected countries is presented in Table 2. These eight countries (Argentina, Australia, Brazil, China, the Czech Republic, France, India, and the United States) represent roughly 41% of arable land globally. They were selected for their importance regarding food and fiber production, the demand for food and fiber, and the availability of data. Data for Russia and much of the former Soviet Union countries are unavailable, although the Czech Republic may be somewhat indicative of the land holdings situation in those countries.

Food and fiber production in China and India predominantly occurs on farms with land holdings of less than 10 hectares (Table 2). An operational holding is defined as all land wholly or partially used for production and operated by one person. Globally, agricultural production is predominantly produced on relatively small parcels. In many cases, this occurs because of the lack of opportunities for employment in other segments of the economy. Consequently, financing needs are much different in these countries than in other areas of the globe.

As capital is substituted for labor, the financial structure of production agriculture could shift dramatically, which would have important implications for the production of bulk commodities and trade globally. The extent to which this may occur is certainly dependent on the financial markets available globally. Research on the capital structure of production agriculture outside of the United States is extremely limited, but may offer important signals as to adjustments that will occur in the U.S. While the U.S. Department of Agriculture readily publishes current data for U.S. farms, little information is available from other regions of the world, making it difficult to anticipate the potential impacts of changes in financial structure.

Additionally, in countries such as Brazil, where tremendous expansion of land area devoted to commodity production has taken place with heavy reliance on equity capital, intergenerational transfer issues may become very important and will provide clues to the relative competitiveness of U.S. agriculture.

Development of well-functioning capital markets including debt will be important for facilitating this transfer. Data on financial structure may also be indicative of the development of capital markets necessary to support the agribusiness complex required to sustain production agriculture, again affecting the income of U.S. producers and the resulting financial structure adjustments that may occur.

While the issues identified above are important, data for understanding the current situation are extremely limited. This has prompted the Food and Agriculture Organization (FAO) to examine agricultural finance in a six-part series. In the first of the series, "Agricultural Finance Revisited: Why?" (FAO, 1998), it is clearly articulated that agricultural finance is at a crossroads. While the financial requirements are expanding, a broader view of rural finance is replacing traditional agricultural credit, where market interest rates are essential to optimally allocate capital and allow financial institutions to be viable.

Within many parts of the world (Table 2), there is a need to ensure that the entire production sector has access to credit services—i.e., the small farm households as well as larger farm enterprises (FAO, 1998). Among the recommendations (Heney, 1999) is the need for households to be more literate, acquire more analytical skills, and be more adept at financial management. At the same time, financial institutions and farmers need to be more adept at financial management, and measures of the relative abilities of farmers need to be developed to comply with the New Basel Accord's capital adequacy requirements and risk assessments. Specifically, these criteria include evaluating a firm's repayment capacity, solvency, earnings, operating leverage, financial efficiency, liquidity, management, and industry standing (Basel Committee on Banking Supervision, 2003). Defining management ability and industry standing in a more objective manner is an issue that must be addressed by financial institutions not only in the U.S. but globally.

Farm Financial Structure Research

Farm financial structure research has been examined in numerous contexts over the years. Much of the corporate finance literature has argued that financial structure with efficient capital markets and a world without taxes is indeterminate. However, the farm finance situation does not meet all of the conditions to make capital structure indeterminate due to taxation and the lack of an efficient equity market. This section examines the literature regarding determinates of financial structure, outside equity investment in agriculture including leasing, agency costs associated with financial structure, and the social aspects of financial structure.

Optimal Debt and Financial Structure

Barry and Baker (1977) provided a comprehensive discussion regarding the management of financial structure of the agricultural firm. They argued that farm finance research reoriented from an institutional and accounting approach in the 1950s and 1960s to a financial management approach in the 1970s. Issues such as leverage, liquidity management, credit evaluation, debt management, and capital accumulation became more important factors in agricultural finance. Examining research and communication issues with respect to the reporting of aggregate financial structure, Penson (1977) cautioned against the use of aggregate numbers with econometric analysis. Specifically, Penson asserted that more consideration should be given to the optimizing behavior of producers in the modeling process.

Gabriel and Baker (1980) introduced the concept of risk balancing in managing capital structure. They presented a behavioral framework which suggested a firm will balance business and financial risk to maintain an approximate level of overall risk. Aggregate evidence was

presented that farmers make financial adjustments in response to a change in business risk. Barry, Baker, and Sanint (1981) provided a mean-variance portfolio model to illustrate how credit risk combines with other financial and business risks to determine a firm's total risk.

Collins (1985) offered a theoretical argument in support of the Gabriel and Baker (1980) risk-balancing hypothesis. He suggested that in addition to the risk-reducing dimension of agricultural policy, expected income may also increase due to risk balancing. Barry and Robison (1987) used equilibrium analysis to examine the financial structure of a firm, and concluded that the importance of adjustments in leverage and financial risk must be considered when examining risk management strategies.

Featherstone et al. (1988) extended the expected utility results by assessing whether the increase in financial risk caused by a reduction in business risk, due to agricultural policy changes, increases the likelihood of bankruptcy. Using aggregate data, they found that while on average a producer is better off in expected utility terms, the probability of bankruptcy does increase. Thus, the financial risk effect in many cases may more than offset the reduction in business risk.

Moss, Shonkwiler, and Ford (1990) tested whether the theoretical result above holds empirically. Using an autoregressive conditional heteroskedastic model, the authors confirmed that reductions in the riskiness in aggregate agricultural returns will increase the amount of debt in the farm sector. In fact, their findings revealed an elasticity of greater than one.

Featherstone, Preckel, and Baker (1990) demonstrated the use of discrete stochastic programming to empirically examine the risk-balancing hypothesis by adding expected utility functions, asymmetries of liquidity, and collateral risk into their model. Gwinn, Barry, and Ellinger (1992) used quadratic programming to derive risk-efficient financial structures for an Illinois grain farm. According to their findings, less risk-averse farmers use a higher amount of leverage than their more risk-averse counterparts.

Ahrendsen, Collender, and Dixon (1994) furthered the work on optimal capital structure by including depreciation, taxes, economies of scale, and wealth effects in the expected utility models. Using data from North Carolina dairy farms, those policies that increase farmers' profit or decrease their business risk were found to induce farmers to increase financial risk via the use of additional debt in relation to equity. Empirical results reported by Jensen and Langemeier (1996), using Kansas data, were consistent with the expected utility model of optimal leverage. Specifically, operating profit, tax policy, and risk were identified as important in determining capital structure.

Another line of research, conducted by Sonka, Dixon, and Jones (1980), examined the lender response to farm financial structure. They presented five simulated loan scenarios to lenders to determine how responsive lenders were to the farm financial situation. They concluded lenders were responsive to the financial situation in terms of the amount loaned. Further, lenders were focused on both the borrower's net worth and the income-generating capacity when analyzing credit capacity.

Collins and Karp (1995) extended the optimal leverage from a static to a dynamic framework. In addition to the distribution of the rate of return on assets and risk aversion, age and wealth were also shown to affect optimal leverage. The authors determined that the dynamic model was more consistent with Arkansas farm data than the static model. Investigating the consumption investment tradeoff, Ramirez, Moss, and Boggess (1997) found the debt-to-asset ratio is elastic to changes in the expected rate of return on assets and the riskiness of that return.

Escalante and Barry (2003) studied the tradeoff between business and financial risk to adjust capital structure. In a study of Illinois grain farms, they noted that examining the strength of correlation between annual pairings of business and financial risk measures provides insight into adjustments of capital structure. If the correlation measure is negative, the authors argued that a farmer has made offsetting adjustments in leverage in response to changes in business risk. A positive correlation coefficient indicates an adjustment was not made. When examining 2-, 3-, 5-, 7-, and 9-year correlation measures, Escalante and Barry found the 2-, 3-, and 5-year measures resulted in significantly different means for farms with positive and negative correlations.

External Equity Capital

In general, the optimal leverage work in agricultural finance has been predicated on the notion that farmers in some respects do not have easy access to equity capital. This essentially constrains the growth of a farm to retained earnings, beginning equity, and a substantial use of debt. Unlike corporate firms, farmers must carefully balance growth plans with the growth of equity to prevent the firm from being unable to manage leverage. This has led to the investigation into external equity markets as a mechanism to provide farmers with more flexibility in determining farm size without being so reliant on the use of debt.

Moore (1979) examined the flow of equity capital into agriculture via vertical integration, conglomerate diversification, partnerships, direct investment, corporations, and trusts. Based on his findings, favorable tax considerations made production agriculture attractive for both active and passive equity capital.

The potential use of nonfarm equity capital as a possible solution for the financial stress of the 1980s was the focus of an analysis by Fiske, Batte, and Lee (1986). They discussed barriers and motivations for the use of nonfarm equity capital and observed that much of this capital has flowed into direct ownership of technology or other farm assets. Matthews and Harrington (1986) examined mechanisms for facilitating nonfarm equity in agriculture and concluded an equity infusion does not need to result in a loss of control.

Collins and Bourn (1986) provided a possible institutional setting for equity capital and a pricing mechanism. They found that only higher risk-averse or heavily indebted farmers would have an interest in equity arrangements. However, given the concentration of debt held by individuals heavily in debt, they determined a sizeable market may exist.

Lowenberg-DeBoer, Featherstone, and Leatham (1989) provide a comprehensive review of the work on external equity capital in production agriculture. The farm financial crisis of the early 1980s, combined with the loss of some agricultural lenders, once again brought the use of equity capital to the forefront. The uncertainty associated with the supply of debt, in addition to the relatively inflexible nature of payments, suggested equity placement may be an attractive alternative. However, the relatively high transaction costs involved with the use of equity, as well as potential agency conflicts, remained drawbacks to be overcome.

Crane and Leatham (1995) proposed a contractual and institutional arrangement where external equity could be used with debt to finance production agriculture. The authors' profit and loss sharing equity market is based on Islamic investment deposits (Crane and Leatham, 1993). They argued that any of the current providers of U.S. agricultural debt could set up this investment process, but did suggest government financial backing may be needed to start this type of investment mechanism.

Crop share leasing is one of the ways for farmers to acquire outside equity. The

literature generally reports that the choice of lease type and the choice of leasing versus ownership are important factors in the financial structure of the farm. Bierlen, Parsch, and Dixon (1999) found credit constraints were important determinants of the choice of lease contracts in Arkansas, with crop share leases more likely if the financial strength of the tenant was weaker and land quality was higher. According to the results of a study by Sotomayor, Ellinger, and Barry (2000), crop share leases in Illinois are more likely used under the following conditions: if income is less variable, soil quality is higher, the tract of leased acreage is larger, if the relationship with the landlord is longer, the debt-to-asset ratio is smaller, and the net worth of the farmer is smaller.

Agency Cost and Financial Structure

The assumption of perfect capital markets is the basis for much of the research in agricultural finance. While the lack of external equity markets is discussed above, more recent work has begun to question the assumption of perfect capital markets on the debt side. Specifically, work has investigated whether agency costs and/or credit constraints affect the performance of production agriculture.

One line of research has been to examine how the use of debt affects the performance of agricultural firms. Whittaker and Morehart (1991) used data envelopment analysis to assess the efficiency of U.S. farms. They added debt and asset constraints to determine financing effects on cost, and found 12.1% of farms were debt constrained. When the debt constraint was relaxed, cost efficiency increased.

Nasr, Barry, and Ellinger (1998) used nonparametric analysis to analyze a sample of 154 Illinois farmers from 1988 to 1994. They found a positive relationship between technical efficiency and financial structure or leverage—i.e., farmers who have higher technical efficiency also manage higher leverage, or farmers who have higher leverage are more efficient, as explained by Jensen's (1986) free cash flow theory.

Using data envelopment analysis, Davidova and Latruffe (2004) looked at the efficiency of corporate and individual farms in the Czech Republic. Corporate farms were found to be more efficient, but the difference was not statistically significant. In addition, a decrease in technical efficiency was associated with higher leverage.

A second line of research considers the notion of credit constraints. Hubbard and Kashyap (1992), employing a Euler equation approach, reported the perfect financial market hypothesis was rejected using aggregate U.S. data. Moreover, a model augmented with a debt constraint indicated that "internal funds" were more highly valued than external funds, suggesting a credit-constrained environment.

Using a fundamental q approach, Bierlen and Featherstone (1998) studied a sample of Kansas farms. Based on their findings, credit constraints were generally not an issue during the 1970s. However, credit constraints became a problem during the 1980s and the early 1990s. Specifically, high-debt younger operators were more susceptible to credit constraints. The authors argued that constraining credit to these farmers may have caused the sector to lose those farms which tended to be more efficient and innovative. Bierlen et al. (1998) found that credit constraints were also more important in the 1980s for farms in the cattle industry. However, differential effects were observed between feeder cattle and beef cow operations.

Barry, Bierlen, and Sotomayor (2000) examined other alternatives to the expected utility hypothesis in explaining optimal debt. Specifically, they considered the pecking order theory and the partial adjustment theory using panel data from Illinois. Results suggested farmers have long-run financial targets for equity, debt, and leasing, but use a pecking order for additional financing needs.

Sociological Impacts of Structure

While the economics profession is often concerned with the efficiency associated with changing farm structure, the public is often concerned with societal effects. As discussed above, the substitution of capital for labor can cause many social problems if there are not off-farm opportunities for labor. This is especially acute in developing countries, but is also important in those countries that are more developed. Much of the research in developed countries has focused on the European Union, and some of the concerns emerged as a consequence of the expansion of the European Union.

Hall, McVittie, and Moran (2004) recently reviewed the issues associated with the multifunctionality of agriculture in the U.K. They noted that the fundamental question of what society wants from agriculture has not been adequately addressed in the existing agriculture and environmental literature. Specific amenities provided by rural areas include agrarian cultural heritage, new and traditional agricultural economy attributes, environmental attributes, rural leisure activities, and cultural attributes. Within their study, the authors found that the body of evidence in the U.S. suggests there are preferences for the traditional cultural roles of family farming. In addition, there is also evidence in the U.S. with regard to limiting urban sprawl and the use of farmland in protecting water quality.

Johnsen (2004) explored the effects of removing agricultural input subsidies and price supports in New Zealand in the 1980s. While other studies have examined some of the adjustment strategies used by farmers, Johnsen looked at the concept of a family farm to determine how traditional linkages have been affected. In the Waihemo area of New Zealand, Johnsen found that the traditional family linkage between the enterprise, household, and property became less interdependent; in addition, intergenerational succession had been reduced. Johnsen also noted that farm structure was more heterogeneous, farm goals were altered, household labor arrangements were weakened, and cultural norms changed in response to agricultural and macro policy reforms in New Zealand.

Using a survey of agricultural households in England, Lobley and Potter (2004) analyzed the effect of agricultural change on these households. Areas of specific focus included the ways in which labor use, land management, and the deployment of capital have changed with respect to the traditional family farm construct in England. Findings indicated the family farm in England was more robust than expected in that survey respondents stated they planned to draw most of the household income from farming. However, results did suggest some evidence of disengagement from farming through more complex relationships between the occupation and management of the land.

Meert et al. (2005) studied how farm families on marginal farms in Belgium were coping with increasing economies of scale. They identified two causes of farm household poverty: farms are too small, or they have poor financial management skills and/or have too much debt. The authors specifically analyzed diversification opportunities for farms in or nearing poverty and found the most accessible strategy in Belgium was off-farm employment. Meert et al. contend this strategy will not only allow the survival of the household, but will also allow the income necessary for survival of farming activities by these households.

Chaplin, Davidova, and Gorton (2004) examined factors which facilitate nonagricultural farm diversification and the factors facilitating or impeding it in individual and corporate farms in the Czech Republic, Hungary, and Poland. Findings reveal the amount of enterprise diversification in these countries has been small, but employment diversification was more common and was linked to the availability of public transportation.

The implications of the works cited above clearly suggest that defining what the public wants from agriculture continues to be a problem. The interest of the public in maintaining the rural heritage needs to be more completely defined as the U.S. begins to wrestle with farm financial structure and rural issues. In addition, as production agriculture becomes more market driven, the evidence indicates the separation between the farm and the family household will increase. If society chooses to place less value on maintaining the rural heritage, off-farm employment opportunities will be important for providing a relatively smooth transition. However, if society wants to preserve marginal farms as family farms, providing off-farm employment opportunities in rural areas is imperative.

Tax Issues and Financial Structure

Tax issues can also affect financial structure. Given the differing treatment of business debt and equity, the financial structure of the farm firm is affected. In addition, special features arising in the policy context from time to time also affect the financial structure. In an examination of the financial structure effects of the Tax Reform Act of 1976, Sisson (1979) noted that changes in policy which affected the ability to form tax shelters were limited with regard to income tax. However, the estate tax changes were more important.

The effects of the Economic Recovery Tax Act of 1981 were evaluated by Nixon and Richardson (1982) using a farm simulation model. Tax savings were estimated over a 10-year planning horizon, and the effect on the leverage ratio from the resulting changes was considered. Carman (1997) summarized research that has examined the effect of taxes on farm firm growth, and concluded investment incentives have encouraged firm growth. Hardesty, Carman, and Moore (1987) investigated optimal investment at the farm level. Investments in machinery and land were found to increase as income taxes rise and as the size of the farm increases.

Exploring the impact of a federal flat tax on taxes, interest rates, and capital investment, Wilson, Featherstone, and Elffner (2002) established that the macroeconomic consequences were important to understanding tax reform. With a downward movement in interest rates, those producers who use debt will benefit compared to those who do not.

Financing the Entry of Young Farmers

Because agriculture is a capital-intensive business, young farmers are at a disadvantage when compared to older, more capital-rich farmers. The average age of farmers has increased since 1978 for each census, and now averages 55.3 years of age. Young farmers under age 35 account for only 5.8% of all farms and only 4.3% of farmland (*2002 Census*).

Young farmers without much capital can gain access to farmland through renting and the use of debt capital to make purchases. However, the use of debt capital is likely to be constrained by the farmer's own equity, as lenders do not want to exceed a given debt-to-asset ratio. Moreover, the use of debt is constrained by profitability and cash flow issues. Land can often be a profitable, long-term investment even though such purchases are frequently unable to generate a positive cash flow in the short term.

Young farmers are using both renting and debt-financed purchases to get control over farmland. Greater use of renting by young farmers is indicated by the average ages by farm types. The average age of full owners is 57 years, while the average age of part-owners is 53.1 years and the average age of tenants is 47.2 years (*2002 Census*). A higher use of rented land is also indicated in the cash rent-to-total expense ratio. For all farmers, cash rents amount to 5.2% of production expenses, while for farmers less than 35 years of age, cash rents make up 8.6% of production expenses.

A greater use of debt capital by young farmers is indicated by the interest expense-to-total expense ratio. For all farms, this ratio is 5.5% (*2002 Census*). For those farmers under 35 years of age, this ratio is 8.8%. The burden of interest expense is magnified even more when looking at the interest expense as a percentage of net cash income. For all farms, this ratio is 23.6%, and for young farmers, interest expense is 37.6% of net cash income.

Because credit is so important to young farmers, the Farm Service Agency (FSA) offers a special program for loans to beginning farmers and ranchers. This program provides direct and guaranteed loans to beginning farmers and ranchers who are unable to obtain financing from commercial credit sources. The FSA offers direct loans up to $200,000 and guaranteed loans up to $813,000. The agency also sponsors a special down-payment farm ownership loan program for beginning farmers.

Research examining financing for young farmers is limited. LaDue (1979) explored the problems facing young farmers entering agriculture in 1979. Notably, these are the same types of problems encountered by today's young farmers—i.e., they do not have adequate personal capital to start farming, and the use of debt capital is constrained by repayment ability and down-payment requirements. LaDue recommended the use of 100% financing of loans to farmers. However, as he cautions, this financing strategy requires young farmers to be much more efficient than the average farmer. For example, in 1970, a new entrant had to be two or three times more efficient in generating cash flow in order to meet a 100% Farmer's Home Administration (now FSA) loan requirement.

Financing for young farmers will continue to be an important issue. As shown by Nehring (2005), large commercial farms have a cost advantage over smaller farmers. These size advantages are especially important in the major corn- and soybean-producing states. Findings reported by Nehring indicate that young farmers have a difficult time expanding from a small farm to a larger farm. Indeed, it is almost necessary for a young farmer to start as a typical size operation from the outset.

Future Farm Financial Structure Issues

Farm financial structure will continue to be an important research issue in the future as the agricultural sector becomes more interconnected through the supply chain and increasing globalization. The traditionally analyzed topics, such as optimal capital structure, equity capital markets, entry into production agriculture by young and beginning farmers, and tax issues, remain important as policy changes and/or research techniques evolve. With the continued development of new theories and methods, more precision in our understanding of farm financial structure is possible.

This continued consolidation has important ramifications for farm financial structure through the aggregate demand for credit, the demand for certain types of credit, and the structure of the lending industry. Featherstone and Sherrick (1992) discuss some of the financial impacts of including financial structure with vertical integration. Those issues continue to require research as the connectedness of firms within a supply chain continues to increase.

In addition, the type of loan product demanded by production agriculture may change. Included in these changes are a lessening of the reliance on collateral-based lending and more reliance on commercial types of credit. Research is needed into the shifting demand for fully amortized loans, common in traditional agricultural lending, to products such as interest-only loans that are similar to bonds.

Mechanisms for providing additional equity to the sector for allowing individuals to optimize leverage ratio are important. Of particular relevance is the entry of young farmers into agriculture. Specifically, an issue in need of research focus is society's desire to provide opportunities to enter the sector to those individuals without family connections and the financial resources necessary to obtain a workable farm financial structure.

Risk-return tradeoffs and the effect on financial structure requires future research. Issues regarding the changing farm lease structure, differences in financial structure geographically and by farm type, and the role of government intervention into the sector need a fresh look. If government intervention changes, are new financial instruments needed to allow farmers to shift risk that has traditionally been borne by the public sector? As financial institutions better model the risk of individual loans, research on how to better access competitive standing needs additional attention.

The Basel Committee on Banking Supervision (2003) has identified eight criteria for banks to measure when evaluating a risk-rating system. Issues such as management ability, operating leverage, and industry standing have not traditionally been explicitly considered when examining farm financial structure, perhaps due to the difficulty in measuring these factors. Future research should address the quantification of these factors and how variability in these factors will affect the appropriate financial structure.

Agency costs, credit constraints, and the relationship to financial structure also need additional research. With the advent of new methods to measure efficiency, non-expected utility-based models, and better information systems, more precise measurement of agency costs and external credit constraints is now possible.

Societal effects caused by changing farm structure, farm financial structure, and the effect on the rural landscape are issues that agricultural finance specialists have not adequately addressed. Research in Europe is more developed in this area, and could serve as a guide as policy makers and society in general confront these difficult issues. Understanding the appropriate tradeoffs between "commercial" agriculture and one that provides agrarian cultural heritage, in concert with the role financial structure may play, are issues deserving of research.

In addition to developing a more in-depth understanding of the situation in the United States, it is imperative to recognize what is happening in other regions of the world. Changes in farm structure in other regions of the globe may have profound effects on the competitiveness and financial structure of U.S. farms.

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Farmland Valuation and Asset Performance

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Abstract

The first theme addressed in this paper is agricultural asset performance. The low rate of return on agricultural assets has been of particular interest to policy makers. From a market portfolio perspective, several studies have analyzed the relationship between farm asset returns and systematic market factors, concluding that farmland adds little systematic risk to a well-diversified portfolio. Because asset values adjust so that the return to each asset is in equilibrium with its relative risk, any persistent low return on agricultural assets may be due to differences in relative risk. The paper's second theme is the valuation of farmland in the United States. Numerous studies have examined the factors affecting farmland values. Most have used the standard present value capitalization formula relating land values to land rents, although these models have been rejected by empirical data. Several studies have reformulated and improved the performance of the present value models. Since changes in rates of return of agricultural assets and land values can have drastic consequences for farmers' wealth and sector solvency, future research needs in this area will continue.

Key words: asset performance, farmland valuation, government subsidies

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A well-established result of the general equilibrium model of the economy is the single price paid for a uniquely defined factor of production. Any disequilibrium between the factor prices across two industries could result in a pure arbitrage gain that would improve total welfare. Against this setting, the accepted hypothesis that returns on resources in agriculture are persistently lower than those for other industries would appear an admission of market failure (Tweeten, 2002).

This paper provides an overview of various efforts to analyze whether the rate of return on capital in agriculture is persistently lower than the rate of return on other capital investments. These studies have used a variety of methodologies to analyze the definition of the rate of return on agricultural assets, or factors which may describe the unique characteristics of agricultural assets. In addition, since land is the dominant asset in the U.S. Farm Sector's Balance Sheet, we present a detailed review of the literature on farmland valuation.

Agricultural Policy

Agricultural economists have shown considerable interest in comparing the performance of farm and nonfarm businesses and analyzing the role the government plays in increasing and stabilizing the income of farm households. Tweeten (2002) summarized the old and new paradigms dominating the agricultural economics field. The old paradigm claimed that the agricultural sector was in chronic disequilibrium and could not earn returns comparable to

those in other sectors of the economy. Therefore, a government intervention was needed to correct for market failures and to raise farm income and returns. The treadmill theory and the fixed asset theory supported the old paradigm of thinking and were able to explain the annual and cyclical instability of incomes, returns, and prices. However, these theories could not explain the empirical fact that successful operators of commercial farms would consistently earn favorable returns over time.

In contrast, the new paradigm, according to Tweeten (2002), emphasizes that agricultural markets work well and government transfers of income may not be needed for many successful farmers. This paradigm implies that farm income and the need for government transfers are now set by the incomes of nonfarmers. Therefore, various comparisons of income, wealth, and rates of return between the farm and nonfarm sectors would have important policy implications.

Hopkins and Morehart (2002) compared the performance of farm and nonfarm businesses using data from the USDA's Agricultural and Resource Management Study and the Fed's Survey of Consumer Finances for 1997. They found nonfarm businesses realized a median rate of return which was three percentage points higher than that of all farm businesses but four percentage points lower than that of large farm businesses with sales greater than $250,000. For firms with returns below the median, nonfarm businesses performed worse than farm businesses. In contrast, for farms with returns higher than the median, the opposite trend was established: nonfarm businesses performed better than farm businesses. Thus, the cross-sectional variability of returns for nonfarm businesses was higher in comparison to their farm business counterparts. Despite these slight differences in rates of return, Hopkins and Morehart concluded that the agricultural sector generally did not suffer from low returns, and farm businesses had returns and net worth distributions similar to those of nonfarm businesses.

Several studies have examined the effects of various government farm programs on the mean and volatility of returns, prices, and revenues. Gray et al. (2004) reported that government payments significantly increased the mean and reduced the variability of the return to land. Lence and Hayes (2002) compared the volatility of commodity prices and farm revenues before and after the Federal Agriculture Improvement and Reform (FAIR) Act. According to their results, FAIR did not lead to significant increases in the volatility of prices and revenues.

Valuation and Performance of Farm Assets

Numerous studies have addressed the relationship between rates of return on agricultural assets and those of comparable-risk nonagricultural assets. Barry (1980) initiated this line of research by analyzing returns to farm real estate with the Capital Asset Pricing Model (CAPM). CAPM hypothesizes that the market portfolio is the only systematic risk factor influencing asset pricing. The excess agricultural returns over the risk-free rate are regressed on the excess returns of the market portfolio. Barry found that farm real estate added little systematic risk to a well-diversified market portfolio and earned higher returns than CAPM would predict for assets with similar risk. His findings are consistent with the "empirical CAPM" and do not automatically imply that agricultural assets earn higher returns than comparable-risk nonagricultural assets.

Irwin, Forster, and Sherrick (1988) extended Barry's CAPM analysis by considering a broader market portfolio and including the uncertain inflation as an additional systematic factor. Their results confirmed previous findings that farm real estate earned slight premiums above those for market risk and also showed that agricultural returns were sensitive to the

inflation factor. Irwin, Forster, and Sherrick essentially extended the CAPM theory to a two-factor Arbitrage Pricing Theory (APT).

The Arbitrage Pricing Theory is based on the law of one price, which assumes two identical assets must sell for the same price. APT assumes asset returns are linearly related to a set of risk factors. These risk factors are determined as either explicitly specified macroeconomic variables (Bjornson and Innes, 1992a) or implicitly specified by principal component analysis (Arthur, Carter, and Abizadeh, 1988; Bjornson and Innes, 1992b; Collins, 1988). Bjornson and Innes (1992a) showed that farm asset returns were positively related to indices of industrial production, unanticipated inflation, and default-risk premia, and were negatively related to changes in expected inflation. Moreover, their findings revealed that a grain-price index has been a "priced factor" in the capital asset markets. Similar to the CAPM findings, the APT results confirmed that farmland exhibits little systematic risk.

Bjornson and Innes (1992a,b) also extended the analyses of Barry (1980) and Irwin, Forster, and Sherrick (1988) by constructing two separate measures of agricultural rates of return to farmer-operators and to landlord-owners of farm real estate. The average returns to farmer-held assets were found to be significantly lower and the returns on landlord-held assets were significantly higher than those on comparable-risk nonagricultural assets.

Farmland represents illiquid investment and is usually traded at thin markets. Therefore, as Barry (1980) suggested, the required rates of return for farm real estate may be higher than what CAPM would predict. Collins (1988) pointed out that the problem of the illiquidity premium, which is implicitly incorporated in the CAPM model, can be avoided by analyzing the returns on the traded equity of agricultural firms. Based on the results from the implicit-factor APT models, the required rate of return for agricultural firms was similar to those of other publicly traded investments. Nevertheless, Duval and Featherstone (2002) demonstrated that it would be beneficial for farmers to invest in publicly traded food and agribusiness firms in addition to investments in a broad well-diversified market portfolio; hence, both agricultural and nonagricultural investors could gain from arbitrage between the sectors.

Bjornson and Carter (1997) relaxed the unconditional specifications of the CAPM and APT models by allowing the risk premia and the required asset returns to vary each period. Their results show a significant time-varying predictability of agricultural asset returns which could be explained with an explicit-factor APT model.

More recently, Sun and Zhang (2001) estimated the CAPM and APT models for forestry-related investments and compared these two models to find which provided a better explanation of the relationship between risk and return. Using three comparison criteria, Sun and Zhang concluded that the APT findings were more robust than the CAPM findings.

In summary, the CAPM and APT models have been used frequently over the past two decades to analyze the returns on agricultural assets. While both the CAPM and APT results indicate that the estimated systemic risk associated with agricultural assets is low, these results are generally more robust for the APT models where agricultural assets are shown to be sensitive to several risk factors.

Valuation and Performance of Farmland

Investigations into factors affecting farmland prices pre-date the agricultural economics field. The most cited classical economic analysis of farmland values is probably David Ricardo's *The Principles of Political Economy and Taxation*, originally published in 1817 (reprinted 1996).

Ricardo's formulation held that farmland prices were defined as the discounted value of economic rents (defined as the return above all variable factors of production) accruing to the cultivation of farmland. While this basic model persists to this day, several modifications have been suggested to deal with anomalous behavior in farmland markets.

Some of the persistent questions regarding the valuation of farmland in the United States can be found in Chryst (1965). Specifically, Chryst asked why farmland values in the United States continued to increase while gross farm incomes appeared relatively stable. He argued that the persistent increase in farmland values could be explained by technological change and government support payments. His argument regarding the change in technology implies that increases in the productivity of capital have increased the rents accruing to land even as the price of agricultural outputs has declined.

This basic argument can be recast as factor bias of technical change following Hayami and Ruttan (1970) where technological innovations are biased toward capital-intensive production methodologies. Some support for this hypothesis can be found in Harris and Nehring (1976) who reported that larger farms were able to bid more for farmland. At first glance, Chryst's second argument (i.e., income support payments are at least partially responsible for maintaining farmland values) would appear consistent with the current debate on farmland values. However, his model linking income-support programs to farmland values depends on production quotas administered based on acreage allotments. Programs that limit farm acreage implicitly distort the land-labor tradeoff, increasing the implicit rate of return to farmland. Thus, Chryst's formulation is not strictly applicable to current agricultural programs.

Kost (1968) compared the rates of returns for farm real estate and common stocks from 1950 to 1963. Extending his formulation slightly, a linear equilibrium between the rate of return on farmland and the rate of return on common stocks could be formulated as follows:

$$(1) \qquad r_{Ag,t} = \frac{Y_{Ag,t}}{P_{Ag,t}} = \frac{Y_{CS,t}}{P_{CS,t}} = r_{CS,t},$$

where $r_{Ag,t}$ is the rate of return on agricultural real estate, $Y_{Ag,t}$ is the income to agricultural real estate or rent, $P_{Ag,t}$ is the price of agricultural real estate, $Y_{CS,t}$ is the income to common stock or dividends, $P_{CS,t}$ is the price of common stock, and $r_{CS,t}$ is the rate of return on common stock.

Assuming the income to agricultural assets and the dividends paid to common stock are exogenous, the prices of each asset would adjust to yield an equilibrium rate of return across sectors. Testing for the equality between the two rates of return, Kost found the average rate of return on common stock was 17.94% while the rate of return to agricultural real estate was 9.26%. Thus, Kost concluded that the rate of return for common stocks and agricultural real estate values were different at the 0.05 confidence level. Kost explained the lower rate of return on agricultural real estate in two ways. First, the increased debt or leverage associated with the purchase of farmland could increase the rate of return to farmer equity. Second, he hypothesized that farmers might consider noneconomic or nonmonetary factors in the purchase of farmland.

The growing influence of inflation in the U.S. economy in the 1970s introduced additional distortions into the farmland market. As described by Lee and Rask (1976):

> Fairly stable relationships existed during the 1960s between land values, net returns to farming, and the general rate of inflation.... However, during the 1970s and especially since 1972, land prices have escalated sharply, net income has been very volatile at high levels, and nonland production costs have increased faster than the general price level

> (consumer price index). These recent trends raise serious questions not only of magnitude but also direction of movement for these important determinants of how much farmers can pay for land (p. 984).

Lee and Rask demonstrated that the maximum bid (i.e., the initial investment in land which will yield a zero net present value for investment in farmland) a farmer is able to pay for farmland ranges from $966 to $2,344 per acre as the inflation rate varies from 0% to 12% per annum. Because they used a finite life in their net present value formulation, much of the variation in results can be attributed to the capital gains accruing to farmland over the period of investment. However, Plaxico and Kletke (1979) noted that land need not be sold for farmers to benefit from capital gains. Specifically, capital gains reduce the relative risk of farmers and allow increased business expansion or even consumption through increased borrowing potential.

Following these studies, Feldstein (1980) proposed a theoretical model of the interaction between farmland and stock prices. In his model, inflation has a portfolio effect that increases the relative price of farmland compared with stocks. This increase is attributable to the differential treatment of capital gains, but is magnified by risk and relative risk aversion. More recently, Moss (1997) reexamined farmland valuation by focusing on the relative explanatory power of returns to agricultural assets, interest rates, and inflation. Using a statistical formulation of information provided by these individual regressors to examine the sensitivity of farmland values to changes in these variables, Moss found that about 82% of the information in the regression results was contributed by inflation.

Pope et al. (1979) examined the parametric consistency of previous structural models of farmland values. Specifically, they reestimated the structural models proposed by Reynolds and Timmons (1969), Tweeten and Martin (1966), and Herdt and Cochrane (1966) using a longer, more recent time period. Their results suggest that the specifications proposed by Reynolds and Timmons, and Tweeten and Martin were sample dependent. Change in the data produced changes in the signs of the estimated coefficients. Further, while the model proposed by Herdt and Cochrane was reasonably robust, it produced a larger root mean squared error than an ad hoc model proposed by Klinefelter (1973) or an autoregressive integrated moving average specification. Their findings cast some doubt on the estimation of farmland markets through structural models of supply and demand for farmland and further support recent efforts to model farmland prices using time-series representations.

Melichar (1979) presented a model demonstrating that growth in real current returns to assets would lead to large annual capital gains and a low rate of current return. Specifically, he showed capital gains could result from a growing stream of net returns. The discounted value of these capital gains would then yield a current rate of return to agricultural assets lower than an equivalent constant rate of return to assets. Commenting on Melichar's analysis, Doll, and Widdows (1981) confirmed the potential effect of growth in returns over time, but failed to find empirical evidence of such growth. In addition, Melichar analyzed real farmland returns and prices by incorporating the inflation measured by deflating both returns and asset values using the consumer price index. Also, he refined the empirical specification of both current returns to farmland and the level of agricultural assets.

Challenging Melichar's conjecture that growth in the current rate of returns explains the growth in farmland prices, Shalit and Schmitz (1982) observed "the data show that, between 1973 and 1976, prices of U.S. farmland increased at an annual real rate of 9.1%, but real net farm income decreased at a 15% annual rate" (p. 710). Shalit and Schmitz departed from the present value model typically used to value farmland and,

instead, developed a derived demand for farmland based on utility-maximizing behavior. Within their framework, farmland provides both income and access to the credit market over time (i.e., collateral which can be used to overcome credit rationing). Savings and accumulated real estate debt were found to be the main determinants of high land prices.

In a 1984 study, Phipps analyzed the theoretical and empirical relationship between farm-based residual returns, the opportunity costs of farmland, and farmland prices. Phipps' definition of farm-based residual returns expanded on one of Melichar's criticisms that researchers used imperfect measures of the return to farmland. Testing the relationship between returns and farmland prices using Granger causality, Phipps found that farm-based residual returns "caused" farmland prices while farmland prices did not "cause" farm-based residual returns. Apart from adding support for the standard capitalization formula, Phipps' results suggest farmland prices are determined mainly within the farm sector.

In the mid- and late 1980s, several studies used rigorous time-series methodologies to test the basic capitalization model of farmland values. Alston (1986) analyzed the growth of U.S. farmland prices and focused on the effect of inflation on farmland values using a distributed lag specification. Unlike Feldstein (1980), Alston's theoretical model found the effect of inflation on farmland prices to be ambiguous. His empirical results indicated that increases in expected inflation had a negative effect on real land prices, but the effect of inflation was comparatively small.

Burt (1986) developed a distributed lag model of the capitalization formula to explain the dynamic behavior in farmland prices. Specifically, he estimated a second-order rational distributed lag on net crop share rents received by landlords on dynamic movements of land prices. Burt estimated that the tax-free capitalization rate in rent associated with equilibrium land prices was 4%. Further, he found that neither the expected rate of inflation nor an exponential trend on rent expectations had a significant effect on land prices.

The formulations of Melichar (1979), Phipps (1984), Burt (1986), and Alston (1986) depict the long-run equilibrium in the farmland market. However, other studies have examined whether farmland prices exhibit short-run price anomalies referred to as speculative or rational bubbles. A bubble can occur when the actual market price depends on its own expected rate of change. Price bubbles arise from three necessary conditions: durability, scarcity, and common beliefs.

Featherstone and Baker (1987) estimated a vector autoregressive specification of farmland prices allowing for both long-run equilibrium and analysis of short-run fluctuations. Net rents could not explain a substantial share of farmland price changes, suggesting there may be purely speculative forces in farmland price determination. The authors concluded that shock in real returns to assets, or real interest rates led to a process in which real asset value overreacted. Further, the results suggested a market with a propensity for bubbles.

Consistent with this result, Tegene and Kuchler (1991) found the present value model to be valid under the assumption of adaptive expectations but not under rational expectations. While rational expectations imply the policy influence will be felt quickly or will be recognized as transitory and therefore have little impact, adaptive expectations imply the effect of policy or nonsystematic shocks could build slowly and persist over time.

The time-series results for farmland values derived during the 1980s and 1990s faced increased skepticism with the advent of cointegration analysis. Cointegration analysis was introduced by Engle and Granger (1987) to overcome the spurious regression problem described by Granger and Newbold (1974). Granger and Newbold

showed that regressing one nonstationary time-series variable onto another nonstationary time series could yield statistically significant parameters even when the two time series were unrelated. Further, this statistically significant relationship would persist even as the sample size was increased. To counter this difficulty, Engle and Granger (1987) proposed an error-correction formulation which focused on the statistical properties of the residual of the linear relationship between the two nonstationary time series. Statistically, if this residual is stationary over time, then the two time series cointegrate or have a long-run equilibrium relationship. One necessary condition for this long-run equilibrium to exist is that the two time series must be integrated of the same order (or in the simplest case, both time series must be nonstationary).

Falk (1991) studied the relationship between farmland cash rents and farmland values in Iowa from 1921 to 1986 using a cointegration technique proposed by Campbell and Shiller (1987). Campbell and Shiller demonstrated that the cointegrating relationship between two nonstationary time series can be formulated as linear restrictions with a vector autoregression model. Following this approach, Falk confirmed both cash rents and farmland values were nonstationary time series with stationary first differences. Thus, they met the necessary conditions for cointegration. However, he rejected the necessary restrictions on the vector autoregressive formulation needed to confirm the existence of a cointegrating or long-run equilibrium relationship between the two series. Hence, Falk concluded that persistent predictable excess positive and/or negative returns appeared to exist in the Iowa farmland market. One possible explanation of the model's failure is that rational bubbles characterize the farmland market. However, another explanation for Falk's findings is the possible variation in the discount rate for farmland over time. Implicitly, Campbell and Shiller's formulation assumes the discount rate is constant.

Erickson, Mishra, and Moss (2003) revisited the question of cointegration between farmland values and returns using the maximum-likelihood approach developed by Johansen and Juselius (1990). Their specification, which allows for changes in returns to agriculture, farmland values, and discount rates, determined that a cointegrating relationship did explain the long-run dynamics in the farmland market.

Building on these various strands of literature, Schmitz' 1995 Waugh Lecture reexamined the behavior of farmland values in a boom/bust cycle context. Econometrically, Schmitz concluded that farmland prices were in equilibrium in the long run (consistent with the later findings of Erickson, Mishra, and Moss), but in the short run, farmland values showed considerable variation which led to significant welfare losses in farming and rural communities. Further empirical support for these boom/bust cycles can be found in the stochastic trend analysis of Featherstone and Moss (2003).

Transactions costs associated with buying and selling land have been proposed as a factor which could cause a short-run divergence between farmland values and returns. Chavas and Thomas (1999) developed a dynamic model of farmland prices that included nonadditive dynamic preferences, risk aversion, and transactions costs. Their econometric findings suggest both risk aversion and transactions costs have significant effects on land prices. During the same year, Lence and Miller (1999) used Iowa farmland data (1910–1994) to investigate whether the farmland "constant-discount-rate" present value model was due to transactions costs. Based on econometric tests, this model is consistent with typical transactions costs assuming a one-period holding horizon, but not when an infinite-period holding horizon is considered.

Further, the challenging question of the effect of government payments on farmland values continues in the agricultural economics field. Tweeten and Martin

(1966) concluded that pressures to increase farm size and the capitalized benefits of farm programs could explain 52% of the variation in land prices. Traill (1980) noted that capitalizing the full benefits of a support program would not affect net farm income in the short run. Using a cointegration approach, Clark, Klein, and Thompson (1993) also found that government subsidies as well as market-based income were capitalized into land values for Saskatchewan.

Just and Miranowski (1993) estimated that government payments accounted for approximately 15% to 20% of the capitalized value of land in the United States, but explained only a small part of the fluctuations. Focusing on the informational content of government payments, Moss, Shonkwiler, and Reynolds (1989) concluded that in the short run, government payments and asset values were negatively correlated. In the long run, however, government payments have a small positive effect on real asset values. Using a different scenario, Featherstone and Baker (1988) estimated that a move to a free market from the 1985 farm programs would reduce land prices in the United States by approximately 13% in five years.

Schmitz and Just (2003) analyzed returns to farmland, farmland values, and government programs for the Northern Great Plains and Mountain States in the United States and the adjacent Canadian provinces. Their findings revealed that government programs, along with other factors such as technological change, were bid into farmland values. In contrast, Gardner (2003) analyzed county-level data within the United States and concluded "... the evidence ... provides only weak evidence that farm programs have increased farmland values" (p. 93).

Finally, the growth of urban areas has emerged as an important factor affecting farmland prices, especially around rapidly growing urban areas of the Southern and Southwestern United States. Several studies (i.e., Shi, Phipps, and Colyer, 1997; Plantinga and Miller, 2001; Hardie, Narayan, and Gardner, 2001; and Plantinga, Lubowski, and Stavins, 2002) demonstrate that urban growth leads to increased farmland values by increasing the demand for the conversion of farmland to urban uses. This increase in farmland values has two divergent impacts on the farm sector. First, increases in farmland values imply an unobserved return to current landowners, raising issues similar to those identified by Plaxico and Kletke (1979) and Shalit and Schmitz (1982). Second, the increased land values represent increased opportunity costs to ongoing agricultural production, reducing the competitiveness and productivity of agriculture in the shadow of urban areas. However, this pressure may be partially offset by increasing agricultural profitability which could result from shifts to higher valued crops (Livanis et al., in press).

Future Research

The problems facing agricultural economists in the analysis of agricultural asset performance continue to be complex. Nevertheless, some of the recent articles provide fertile opportunities. One such opportunity is the ability to move away from the use of sector aggregates and, instead, use data sources such as the USDA's Agricultural and Resource Management Study (ARMS). Sector- or state-level data may disguise the rate of return on commercial operations (as opposed to part-time farmers, limited-resource farmers, or lifestyle operations). The time-series data available through ARMS are growing, and may soon allow for some fairly sophisticated analysis.

Another possibility for future research is to attempt to explain the divergence between the rate of return in the farm sector and other industries using new institutional economics paradigms (Williamson, 1975, 1985). In this framework, governance in the agricultural sector may be most efficiently conducted through commodity markets instead of capital markets.

If this is indeed the case, the sector's capital markets may be in perpetual disequilibrium.

Turning to the challenges facing farmland valuation, many of the potential problems facing the sector, including lenders, involve the determination of the short-run dynamics. A first step to analyzing these dynamics is to adapt emerging methodologies to analyze the speed of adjustment within cointegrated systems. Further, similar disequilibria—such as those discussed above for agricultural capital markets—should revitalize analysis of the linkage between farmland valuation and access to capital.

Finally, issues such as the potential effect of increased urban demand and the effect of transactions costs on farmland price movements may imply an extension of our toolkit beyond standard econometrics. Livanis et al. (in press) follow the approach of Benirschka and Binkley (1994) of incorporating spatial autocorrelation into a structural model of farmland values. Further, approaches such as the stochastic simulation approach employed by Lence and Hayes (2002) may be useful in addressing such issues as transactions costs and the valuation of the option to convert farmland to urban uses.

Summary

From an agricultural policy perspective, there is a growing tendency to view agriculture as an industry in capital market equilibrium with the rest of the economy. Empirical results suggest that after adjusting for various factors, the rate of return on farm assets appears comparable with the rate of return for similar nonfarm businesses. However, these results mask certain persistent features of agricultural returns. Most studies that have directly incorporated risk (using portfolio, CAPM, or APT approaches) found some diversification gains were possible from diversification between the farm and nonfarm sectors. Specifically, either farmers would gain from diversifying into nonfarm assets, or farm assets contributed little systematic risk to nonfarm investors.

Focusing on the sector's dominant asset, the farmland valuation puzzle remains. Since the mid-1960s, several researchers have concluded that farmland prices in the United States were higher than could be justified using the simple capitalization formula. Research conducted to explain this discrepancy has followed a variety of possibilities. The extreme inflation of the 1970s generated a host of studies focusing on the effect of inflation and the possibility that future growth in real returns was systematically understated by the observed data.

As inflation waned in the 1980s, much of the focus shifted to more powerful time-series specifications of the asset value formulation. While several of these formulations indicated farmland values increased proportionally in response to an increase in returns to farmland and declined proportionally with an increase in the interest rate, several questions remain. First, farmland values exhibit significant short- and intermediate-term boom/bust cycles. Second, while changes in farmland values are consistent with the capitalization formula, farmland appears to be consistently overpriced. Finally, the literature does not provide closure on the effect of government payments on farmland values. Intuitively, the overvaluation of farmland could in part be explained by government payments except that most studies already include government payments in their definition of returns.

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Risk Management by Farmers, Agribusinesses, and Lenders

Ashok K. Mishra and Sergio H. Lence

Abstract

Producers and lenders seek to avoid agricultural production-related risks through various managerial and institutional mechanisms. For individual farmers and agribusinesses, risk management involves choosing among alternatives for reducing the effects of risk on the firm, thereby affecting the firm's welfare position. Risk management often requires the evaluation of tradeoffs between changes in risk, expected returns, entrepreneurial freedom, and other factors. Research on risk management issues in agriculture has been among the main topics of interest of the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues, and its predecessors. This paper reviews and summarizes much of the Committee's work and provides a discussion of related topics of interest for prospective future research.

Key words: farm financial performance, federal subsidies, risk-management tools

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In order to discuss risk management issues in agriculture or any other industry, it is essential to define the concept of risk. For the purposes of the present study, risk is defined as the uncertainty faced by a firm (be it an individual, agribusiness, or lender) that affects its welfare. Specifically, risk is often associated with adversity and loss by the firm, and also with its survival as a business; risk is uncertainty that affects an individual's welfare, and is often associated with adversity and loss; risk is uncertainty that "matters" and may involve the probability of losing money.

Agricultural production is risky because it is subject to unpredictable, random shocks caused by weather events, pest damages, diseases, and other natural disasters. The relative frequency of such events (e.g., flood, fire, hail, hurricanes, and drought) is believed to generate significant yield instability. Firms in agriculture are also exposed to substantial price volatility, usually much more so than firms in other sectors of the economy. The sizable volatility of agricultural prices stems in large part from the significant randomness in supply coupled with the inelastic demand which characterizes most agricultural products.

Gabriel and Baker (1980) define two types of risk in agriculture. First, business risk—risk associated with production and price risk—generally is reflected in the variability of net operating income or net cash flow.[1] This would also include technological risks, institutional risk,

[1] Others use the variance of returns on assets as an alternative measure of business risk.

casualty loss risk, legal risk, and human resource risk.[2] Second, financial risk is a source of risk that is very real and has potential effects on the solvency of firms in agriculture. Financial risk differs from yield and price risks in that it results from the way the firm's capital is obtained and financed. A farmer may be subject to fluctuations in interest rates on borrowed capital, or face cash flow difficulties if there are insufficient funds to repay creditors. The use of borrowed capital means that a share of the returns from the business must be allocated to meet debt payments.

In short, risk is prevalent in the agricultural sector. Further, there is strong evidence showing farmers are typically risk-averse (Just and Pope, 2001; Innes and Ardila, 1994; Hardaker, Huirne, and Anderson, 1997) and that they seek to avoid risks through various managerial and institutional mechanisms (Robison and Barry, 1987). The incidence of risk and risk-averse behavior in farming is important to policy makers for various reasons. For example, fluctuating farm incomes, and particularly the risk of catastrophic losses, may present welfare problems for farmers and their families. Farmers exposed to severe risk are also more likely to default on bank loans, which may lead to bad debt and farm foreclosures. In the case of systemic risks (e.g., when catastrophic losses are experienced by many farmers simultaneously), farm failures may trigger failures of other agribusinesses and lenders.

For individual farmers and agribusinesses, risk management involves choosing among alternatives for reducing the effects of risk on the firm, thereby affecting the firm's welfare position. Risk management often requires the evaluation of tradeoffs between changes in risk, expected returns, entrepreneurial freedom, and other factors. Some risk management strategies reduce risk within the firm's operation, others transfer risk outside the firm, and still others build the firm's capacity to bear risk (such as maintaining liquid assets).

Just and Pope (2001) point out that farmers have different attitudes toward risk, which is consistent with the findings of Goodwin and Kastens (1993); Innes and Ardila (1994); and Barry and Baker (1984). Therefore, the "one-size-fits-all" paradigm does not apply in the analysis and implementation of risk management strategies by farmers. For an individual farmer, risk management involves finding the preferred combination of activities with uncertain outcomes and varying levels of expected return. Succinctly, one might state that risk management involves choosing among alternatives for reducing the effects of risk on a farm, and in so doing, affecting the farm's welfare position.

In the present study, risk management strategies are classified into two main categories: "within-firm" strategies and "risk-sharing" strategies. Within-firm strategies include, among others, (*a*) on-farm enterprise diversification; (*b*) collecting more information about scenarios involving uncertainty; (*c*) enhancing product flexibility and/or asset flexibility;[3] (*d*) avoiding risky technologies; (*e*) reducing leverage; and (*f*) increasing liquidity (i.e., the firm's ability to generate cash quickly and efficiently in order to meet financial obligations) and maintaining financial reserves.

Among risk-sharing strategies, the following are of special note: (*a*) buying insurance (e.g., crop insurance, revenue insurance, insurance on buildings and/or machinery, etc.); (*b*) hedging using contracts traded in derivatives markets (e.g., futures and options contracts);

[2] For more information on sources of risk in agriculture, see Hardaker, Huirne, and Anderson (1997); Boehlje and Trede (1977); Baquet, Hambleton, and Jose (1997); and Fleisher (1990).

[3] Product flexibility exists when an enterprise produces an output that has more than one end use. Asset flexibility means investing in assets which can be used in more than one production process.

(*c*) producing under production and marketing contracts; (*d*) leasing inputs and hiring custom work; and (*e*) obtaining off-farm sources of income (e.g., off-farm employment by the operator, the spouse, or both).

To evaluate whether various risk-management tools and strategies are effective in achieving managerial goals regarding risk, it is essential to express risks in quantitative terms. Substantial research has been conducted estimating the price and yield risk faced by farmers (Goodwin and Ker, 1998, 2001; Goodwin, 1994; Ker and Coble, 2003). The exact distribution of these risks has been a topic of much discussion for many years. Economists have used various alternative approaches to model decision making in situations involving risks.[4] These approaches are based on the notion that each risk strategy offers producers a different probability distribution of income, and that determining the best strategy involves describing the different distributions and developing rules to choose among them.

Research on risk-management issues in agriculture has been among the main topics of interest of the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues, and its predecessors. Given the wealth of research performed by the Committee over the years, the purpose of the present study is to review and summarize such work, and to discuss related topics of interest for future research.

The first two sections of the study focus on the research insights gleaned from the papers presented over the past 20 years at the annual meetings of the Committee which dealt with risk-management issues in agriculture. For this purpose, studies are grouped according to the main type of risk-management strategy addressed, by following the previously identified strategy classifications—i.e., within-firm strategies and risk-sharing strategies. The final section is devoted to a discussion of research topics of potential interest which agricultural economists could undertake over the next few years.

Within-Firm Risk-Management Strategies

Diversification

The Farm Credit System expanded its agricultural debt in the 1970s compared to other lenders. Farm financial stress during the early 1980s placed agricultural financial intermediaries in a precarious situation. Since the Farm Credit System was the largest farm real estate lender, it was the most severely affected financial intermediary during periods of farm stress. Moss and Featherstone (1988) examined the possibilities of diversification opportunities within the Farm Credit System. Using the Arbitrage Pricing Theory to test whether risk-free profits could be obtained by trading loans between the districts of the Farm Credit System, they concluded that additional diversification within the Farm Credit System was not likely, and thus trading loans between districts would not result in risk-free profits.

More recently, Katchova (2002) conducted an empirical examination of the effect of diversification across agricultural activities on profitability. She found that a crop/livestock diversified farm had lower average value and lower average return on equity than a combination of a specialized crop farm and a specialized livestock farm with similar overall output. Katchova's results imply diversification in agriculture does not make sense as a strategy to enhance value, but the results do not rule out diversification as an effective strategy to reduce risks. However, because of the data used in her analysis, Katchova's findings should be interpreted with

[4] The most popular approaches are (*a*) the expected utility model, (*b*) the "E-V" and quadratic programming model (which is a special case of expected utility), (c) the stochastic dominance approach, and (*d*) the safety-first approach.

caution. The author used farm-level data from Illinois, where most farms tend to be large and specialized in cash grains. Therefore, benefits of specialization could be more pronounced, but elsewhere (under different agronomic conditions) enterprise diversification could be more beneficial.

In another study, Mishra, El-Osta, and Sandretto (2004) investigated enterprise diversification by U.S. farmers as a self-insuring strategy. In particular, the authors examined various farm, operator, and household characteristics on the level of on-farm enterprise diversification. The study found that large farms were more specialized, and that farms located near urban areas, farmers who participated in off-farm work, and farms with higher debt-to-asset ratios were less likely to diversify. Further, the findings suggest a positive relationship between diversification and participation in crop insurance and direct government payments.

Information

In a Purdue University survey study of large-scale farmers, agricultural lenders, and professional farm managers, Ullerich and Patrick (1995) summarized sources of information, sources of and responses to risk, and the willingness of farmers, lenders, and farm managers to pay for risks. The authors reported that all three groups rated information sources as important in making production decisions. Fewer sources of information were rated important in making marketing and financial decisions. These included information on employees and records, tenants, or borrowers. Ullerich and Patrick reported significant differences among the three groups in the individual's self-assessed willingness to take risk. Results of the survey also indicated no significant differences in risk aversion between farm managers and agricultural bankers.

The use of business information by farmers was examined by Gloy and LaDue (2002), who looked at the business analysis techniques used by a group of New York dairy farms and their respective financial performance. The most commonly used business analysis method employed by these farms was trend analysis. Findings also revealed that almost 75% of farms prepared financial budgets either on an annual basis or when they were planning to make major changes in operations. Importantly, Gloy and LaDue uncovered a strong positive relationship between a farm's usage of investment analysis and its profitability.

The vast majority of the existing crop insurance and risk management literature is underpinned by the assumption that producers accurately understand and rationally respond to the risks they face. Sherrick (2001) asserts that subjective probability beliefs about important weather variables are systematically miscalibrated to the true distributions. In his study, Sherrick examines the assumption that producers possess accurate probability beliefs when evaluating risk variables which affect their financial well-being. He concludes that significant errors in producers' risk assessments and insurance valuations arise simply because producers possess systematically inaccurate probability beliefs, especially about the weather.

Differences in yield-model specifications can significantly impact quantitative assessments of revenue risk, insurance values, and other components of farmers' risk-management decisions. In a related study, Zanini et al. (2000) evaluate parametric yield specifications and assess their implications for valuation of average production history and crop revenue insurance products. The authors conclude that having yield specifications as an unexamined premise may lead to incorrect conclusions in other important areas of insurance research, such as policy rating and quantitative assessment of expected losses from different types of policies.

Leverage

Gloy and Baker (2001) argue that risk aversion and financial leverage are important when making risk-management strategy selections. The authors also show that the stochastic dominance approach with risk-free asset criteria reduces the number of risk-management strategies a manager must consider without making strong assumptions about risk preferences. Adding leverage was found to be a more efficient way to increase returns than reverting to a strategy with a greater mean and business risk.

Using data from U.S.-based food processors, Sporleder and Moss (2001) found leverage was negatively related to the amount of intangible assets, profitability, and investment autonomy. Their results suggest food processors view equity and debt not so much as alternative financing instruments and/or strategies, but as alternative governance structures, with equity providing greater decision-making discretion than debt. Sporleder and Moss report that managers prefer equity capital financing over debt.

Decisions about financial leverage can have major impacts on the long-run survival of agricultural firms. Given the level of business risk, the owner will choose a capital structure or a level of financial leverage which will maximize expected utility of returns to equity, subject to personal risk preferences. Risk-balancing issues as influenced by leverage are well documented in the literature (Gabriel and Baker, 1980; Barry and Baker, 1984; Collins, 1985). Using panel data from Kansas over the period 1973–1988, and assuming maximization of the expected utility of returns to equity, Jensen and Langemeier (1996) investigate optimal leverage and the factors affecting leverage. Based on their findings, leverage is affected theoretically and empirically by tax policy, risk, farm profitability, and growth rate in the value of assets.

The relationships among business risk (Gabriel and Baker, 1980), profitability (Collins, 1985), price supports (Featherstone et al., 1988), taxes (Moss, Ford, and Boggess, 1989), and financial risk constitute risk-balancing dimensions of agricultural policy. Risk balancing refers to the adjustments in the components of total risk (i.e., business risk and financial risk) resulting from an exogenous shock to the existing balance (Gabriel and Baker, 1980).

Ahrendsen, Collender, and Dixon (1994) extended the basic model of Collins and Barry (1986) and added to the dimensions of risk balancing through relationships among depreciation, investment tax credits, and financial risk. The authors concluded that policies (such as depreciation and investment tax credit deductions) which increase farmers' profits or decrease farmers' business risk may, in fact, induce farmers without constrained credit to increase financial risk through capital structure adjustments. However, as the authors point out, the adjustment process is likely to be slow.

The tax treatment of capital gains is a potentially important factor affecting investment in agriculture. Moss, Ford, and Boggess (1989) construct a theoretical model explaining the effect of the elimination of capital gains deduction on investment decisions in U.S. agriculture. Using aggregate U.S. data, their analysis shows that elimination of the capital gains exclusion raises optimal leverage levels and the probability of a negative rate of return to equity for all levels of risk aversion.

Equilibrium analysis under risk evaluates a firm's possible responses to changes in the risk characteristics of its environment. Barry and Robison (1987) employ equilibrium analysis under risk to analyze financial structure at the firm level. In particular, using the portfolio theory framework, concepts of business risk, financial risk, and risk balancing, they assess the possible responses in financial

structure to changes in a firm's operating environment and in the investor's risk attitudes. Their results show important linkages between theory and practice in financial responses to risk and provide general guidelines for implementing portfolio adjustments.

Liquidity and Financial Reserves

A study by Burghardt and Robison (1984) explains the application of a computer simulation model built to facilitate the examination of alternative risk-management strategies on agricultural firms' liquidity, financial stress, and investment management under uncertainty. Their model was designed to integrate financial strategies with production, marketing, and risk-management strategies of typical Midwest cash grain farms.

Chhikara (1986) developed a model based on the expected-utility paradigm to explain an agricultural firm's demand for cash and credit reserves (i.e., unused credit or borrowing power) as a response to risk. In general, he confirmed empirical support for the model when he tested it using data from Illinois farms. Chhikara found that liquidity value curves declined monotonically with debt levels, implying credit reserves quickly lost their liquidity value for financially stressed farms. Based on this result, credit reserves were of little use to distressed farms as a risk-management tool.

Finance theory suggests that increases in financial leverage raise the expected level and variability of returns on a farm's equity capital, provided the returns on assets exceed the cost of borrowing. Because risk attitudes (and expectations) may differ among farmers, it is plausible to expect a wide range of optimal financial structures. Gwinn, Barry, and Ellinger (1992) derive risk-efficient growth plans and financial structures for representative cash grain farms under a broad set of sources of risk and various levels of risk aversion. Farm size, asset structure, and debt level are shown to change significantly with risk-aversion levels and are consistent with empirical observations. Farmers with low levels of risk aversion, or even risk neutrality, will prefer higher debt-to-asset ratios and achieve larger operations, faster financial growth, and larger expected incomes.

Other "Within-Firm" Risk-Management Strategies

Singer (1998) discusses reasons why managers may "smooth" income, i.e., engage in activities to reduce the fluctuation of their firms' *reported* net income. An important potential reason is that income-smoothing may improve the perception of the firm's risk by providers of external capital (e.g., equity investors and lenders). Singer analyzes a special mechanism for smoothing income available to commercial banks—namely, the provision for loan losses. The provision for loan losses is the amount banks charge against current earnings to build reserves aimed at absorbing future loan losses. He found significant evidence that rural as well as urban banks used the provision for loan losses to smooth income. This finding is important from a regulatory standpoint because using the provision to smooth income is at odds with the regulatory guidelines for commercial banks.

Risk-Sharing Management Strategies

Insurance

The Federal Insurance Act of 1980 authorized an expansion of the insurance program to become the primary form of disaster protection for farmers. Insurance may protect farmers from yield shortfall and thereby stabilize income and provide liquidity when crop losses occur.

Leatham, Richardson, and McCarl (1985) evaluated a producer's choice of crop insurance and investigated the implications of this choice on the lender's performance.

The authors found crop insurance favors producers with higher levels of yield variability. The choice of crop insurance by producers depends principally on their expected insurance loss ratio and risk aversion.

Federal subsidies to crop insurance products have increased, thereby lowering premiums paid by farmers for insurance products. These changes were made with the goal of improving the attractiveness of crop insurance to farmers. Little direct evidence exists concerning the effects of crop insurance use on crop revenue risk, and still less work examines the relative performance across alternative insurance products (e.g., types and coverage levels) and across different yield risk conditions.

Schnitkey, Sherrick, and Irwin (2002) investigate the risk implications of a wide range of crop insurance products in actual farm contexts. Risk implications are analyzed by comparing gross revenue distributions without crop insurance to gross revenue distributions resulting from the inclusion of different crop insurance products. Findings indicate the group policies often result in average payments exceeding their premium costs. Individual revenue products reduce risk in the tails more than group policies, but result in greater reductions in mean revenues. Rankings based on certainty equivalent returns and low frequency VaRs (value-at-risk) generally favor revenue products. As expected, crop insurance is associated with greater relative risk reduction in locations with greater underlying yield variability.

The costs and benefits from using crop insurance may differ based on the design of the instrument chosen by the producer. Wang et al. (1997) study the relative performance of individual-yield and area-yield crop insurance programs. Performance is measured by farmers' participation rates and farmer welfare in an expected utility framework. Using a portfolio setting (producers have a variety of risk-management instruments including options, futures, government payments, and crop insurance), Wang et al. found that an insurance contract based on an area yield index is less expensive to implement and may have more attractive premiums than a contract based on an individual farm yield index.

An important aspect of insurance (and of other risk-management strategies as well) is that its use by a firm makes the firm more attractive to potential external providers of capital (e.g., lenders and external investors). In this regard, financial adversities experienced by the farm sector in the 1980s highlighted the close relationship between farm borrowers and lenders. It became very clear that both parties had a significant stake in actions which influenced the profitability, liquidity, and risk position of farm businesses. Pflueger and Barry (1985) analyzed the relationship between farmers' use of crop insurance and the cost and availability of credit from their major non-real estate lenders. Based on survey data and on the results from a simulation model, the authors found that, at least from the lenders' viewpoint, the use of crop insurance by a farm could reduce its business risk enough to allow higher financial risk arising from the greater amount of credit made available to borrowers. Pflueger and Barry concluded crop insurance may have considerable merit when combined with other management or policy actions that reduce indebtedness or increase revenues for highly leveraged, low-equity crop farms.

More recently, Seo, Leatham, and Mitchell (2003) used a principal-agent model to determine an external investor's preference for crop insurance and the farmer's production decisions. The authors further determined the optimal risk-sharing between the investor and farmers with crop insurance and external financing.

Hedging with Contracts Traded in Derivatives Markets

Because of the farm crisis that took place in the United States in the early to mid-1980s, much of the attention at the

time focused on the financial situation of farms and the lending sector. Government, researchers, and policy makers were interested in finding ways to reduce the burden of debt owed by farmers and bankers. Financial management became a very important issue, and along with it the tools to manage financial risk. The September 1984 meeting of Committee N-161 was dedicated to financial futures and options and their potential use in agriculture. Lins (1984) reported a rise in financial risk, through more borrowed funds and macroeconomic factors, during the early to mid-1980s. The author outlined various policy instruments affecting interest rate variability and parties who were affected by increased interest rate variability. Lins proposed interest rate futures and options as an effective mechanism for lenders and borrowers to offset their interest rate risk.

Solverson and Herr (1984) presented a development of futures markets and explained the basic terminology used by traders—especially by those trading financial futures. Heffernan and Lee (1984) outlined hedging strategies for Farm Credit System lenders. The authors described and analyzed the debt management program and then compared two hedging strategies. Solverson and Herr found interest rate hedging would allow the Farm Credit System banks and associations to broaden their range of services beyond the dominant variable rate loan. By hedging a portion of the debt portfolio, the Farm Credit System could offer borrowers fixed rates for at least some specified time period.

Drabenstott and McDonley (1984) discussed the issues surrounding the use of financial futures by agricultural banks in the early 1980s. They also reported data on the use of financial futures by agricultural banks obtained from a survey. The authors pointed out that agricultural banks were slower to incorporate futures into their risk-management strategies than urban lenders. Financial futures were found to be most effective when incorporated into a well-planned asset/liability management strategy. Based on their survey results, not many agricultural banks were using financial futures, but financial futures were effective tools to deal with interest rate risk. The survey also revealed that large banks were more likely to use financial futures, and small banks lacked expertise to become involved in financial futures.

Commercial banks have always encountered risks in their normal course of business. However, when interest rates are volatile (as they were in the early 1980s), there is an increased risk of mismatching interest-sensitive assets and liabilities. Drabenstott and McDonley (1984) employed an economic model of a rural bank to demonstrate the importance of hedging on bank performance. Findings showed that hedging the cost of borrowing when rates are rising enables banks to increase overall portfolio size and significantly raise earnings.

The use of derivatives by lending institutions was the focus of a study by Yang and Leatham (1996). They reviewed the use of interest rate derivatives by major lenders to agriculture, more specifically commercial banks, thrift institutions, and life insurance companies. They also discussed the benefits and risks of using financial derivatives by such institutions.

Hedging in financial futures markets can offset the dollar loss on the loan (additional interest cost due to rising rates) with a gain in the futures market. Leuck and Leuthold (1984) examined the use of hedging by grain elevators on variable rate debt and concluded grain elevator managers could reduce interest rate risk and the cost of debt by hedging borrowed debt in the financial futures market. Further, the authors found that hedging costs were usually greater for private grain elevators than for cooperative elevators because the cost of debt for the former was reflected by the prime rate and was more volatile than for cooperatives.

Financial futures are useful for hedging positions in situations in which there is symmetry of gains and losses. In the case of asymmetrical gains and losses, a conventional futures market hedge may only reverse the symmetry. Thus, risk would not be reduced efficiently, if at all. A potentially useful risk-management tool applicable to these cases is an option. Leatham and Baker (1984) discussed methods of using financial options by providing background information about options on financial futures and then illustrating a hypothetical hedging situation. The authors suggested that call options would serve banks and lenders better for fixed-rate loans.

Farmers' use of futures and options to hedge growing and stored crops can reduce price risk and decrease the variance on the returns to equity. Turvey and Baker (1988) argued that data from Ontario farms do not support the expected behavior of risk-averse farmers, as only 11% of farms used hedging. The authors examined alternative motivations, especially the liquidity motive, to farmers' use of hedging strategies. They found a direct correlation between relative risk aversion and hedging, and an inverse relationship between credit reserves and hedging. Results of their study supported their hypothesis that liquidity may be a motivation for farmers' use of futures and hedging.

Turvey and Nayak (1997) explored the relationship between hedging with futures and farm capital structure. They estimated a simultaneous hedging model of price, yield, and foreign exchange. In particular, they investigated the impact of the hedging decisions of a Canadian firm using U.S.-based price and yield futures on farm business, financial, and total risks. The authors developed a risk-minimizing hedge ratio for the joint hedging decisions, and concluded that jointly hedging price and yield can reduce revenue risk more than hedging only with price futures. Turvey and Nayak envisioned the possibility that revenue insurance/assurance programs provided by the government, or crop insurance provided publicly or privately, could be reinsured through effective hedging in Canada and the United States.

Yields and revenues obtained by crop producers have both systemic (drought and price drops) and poolable (localized yield shortfall) risks. Farmers cannot hedge the poolable or localized sources of revenue risk on speculative markets, and insurance companies will not accept risk which has a systemic component. As a result, a hybrid mechanism has evolved in U.S. crop insurance markets wherein the federal government agrees to accept the systemic risk so that private insurance companies will sell crop and revenue insurance to producers.

Mason, Hayes, and Lence (2001) estimated the total risk absorbed by the U.S. crop insurance industry and separated it into poolable and systemic components. They then used option pricing theory to value the reinsurance provided by the federal government when it absorbs this systemic risk. The authors also examined the possibility of using speculative markets in prices and yields to hedge the systemic risk accepted by the government. They concluded that risk reduction achievable by hedging is appreciable, but use of derivative contracts alone is clearly no panacea.

Production and Marketing Contracts

A study by Dodson (1996) focused on the potential implications of production contracts for risk management. He concluded the risk-return tradeoff for the contracted commodity is likely to be a major determinant of the use of contracts by farmers. For commodities like processed fruits, vegetables, and some specialty crops, Dodson argued that farmers engaged in contract output may not only be able to reduce their risks but also increase their profit margins. In contrast, for other farms such as those

engaged in hog production, contracts may only provide a means to reduce risk. Dodson's conclusions were based on his finding that crop farms with contracts were larger, had more equity, and enjoyed higher returns than crop farms without contracts, whereas poultry and hog farms with contracts had less equity, higher debt levels, and exhibited more financial stress than poultry and hog farms without contracts.

Leasing Inputs

The effects of interest rate volatility and tax regulations on the choice between lease and ownership of farm machinery was investigated by Pederson (1984) by means of a simulation model. Purchasing was found to weakly dominate leasing for risk-averse farmers in many scenarios, and leasing was the most risk-efficient choice for risk-preferring farmers. However, Pederson cautioned that results were quite sensitive to the future dynamics of interest rates.

In times of financial crisis in agriculture, greater emphasis has been placed on measuring farm financial performance. In much of the literature, the debt-to-asset ratio is used as an indicator of financial stress. Ellinger and Barry (1987) point out that tenure has significant implications for performance. Tenure is important because a considerable amount of land is operated by farms under various types of leasing arrangements. The authors evaluated the effects of farmers' tenure position on two key performance measures—profitability and solvency. Their findings reveal that higher land ownership is associated with lower accounting rates of return and lower leverage positions. As tenancy increases, rates of return on assets and leverage positions are consistently higher. Further, as tenancy increases, farm size as measured by acres also increases.

Leasing land for agricultural production is another way to reduce risk (Barry, Escalante, and Moss, 2002). The long-standing practice of share leasing farmland is increasingly giving way to cash leasing and to combinations of cash and share leasing (Reiss, 1984). The drivers of change primarily involve risk, income, managerial control, and land values issues facing farmers, landowners, and professional farm managers who represent landowners (Sotomayor, Ellinger, and Barry, 2000).

Barry, Escalante, and Moss (2002) conceptualized the risk-adjusted valuation of cash versus share leases for farmers and landowners, and tested their model using farm-level data from Illinois. In particular, the authors empirically determined how rental spreads between cash and share leases are related to risks and other farm characteristics. They concluded that non-risk factors are likely to be the primary determinants of the magnitude and sign of the rental spread, and point out that high cash rents may be a bidding strategy to control additional leased acreage and thus expand farm size.

External Equity

Advantages and disadvantages of resorting to external equity as a means to reduce risks and/or increasing capital were addressed by Lowenberg-DeBoer et al. (1987). Overall, they argued that external equity was not likely to be an economically viable strategy, because of its relatively high transaction costs and the potential distortion of management incentives. However, they stressed that their conclusions were limited by the small amount of research available regarding usage of external equity by farms, and by proprietary firms in general. Their study concluded with a long list of topics of relevance for future research in the area.

Off-Farm Income and Investments

Deregulation of financial markets in the late 1980s provided farmers with new opportunities to diversify their investments into off-farm financial assets. However, survey data on South Dakota farmers, collected and analyzed by Gustafson and

Chama (1992) in the early 1990s, revealed respondents had not taken advantage of the new investment opportunities. Most of the respondents' investments were concentrated in local savings accounts, checking accounts, and farm real estate. Few farmers held investments outside of the state, or held mutual funds, government securities, and common stocks. Respondents were primarily concerned with the yield and safety of financial assets, and stated that coping with emergencies and retirement were their main reasons for investment.

Financial responses to risk may include transferring risk outside the business—such as investing in nonfarm financial assets. By holding a portfolio of farm and nonfarm assets, farm households can diversify risk (Mishra and Morehart, 2001). Using national farm-level data from the U.S. Department of Agriculture, Mishra and Morehart investigated the factors affecting off-farm investment of farm households. They found operator's age, educational level, off-farm income, farm size, and household net worth were positively related to off-farm investment decisions. Further, increased on-farm diversification and higher debt-to-asset ratio reduced the likelihood of off-farm investment.

Monke, Boehlje, and Pederson (1990) employed historical data for 1960–1988 together with stochastic dominance analysis to investigate pre-retirement investment strategies for farmers, and off-farm investments in particular. Based on their results, almost all risk-averse farmers would favor a diversified portfolio over any single real or financial asset, but dominant portfolios typically involved just two or three assets.

Schnitkey and Lee (1995) reported that farmland accounted for a substantial proportion of the assets held by Ohio farmers in the early 1990s. They used historical data in a mean-variance portfolio framework to demonstrate that diversifying investments into off-farm financial assets (e.g., stocks and bonds) may allow farmers to achieve a better combination of expected return and variance of returns than portfolios comprised mostly of farmland.

Betubiza and Leatham (1990) also focused on agricultural firms' potential gains from diversifying into off-farm financial assets. Unlike Schnitkey and Lee, they looked at the dynamics of accumulating financial assets and at the implications of off-farm diversification on the firm's liquidity, leverage, and tenure. According to the results from their model, diversification into mutual funds would make farmers better off.

The results obtained by Schnitkey and Lee (1995), and Betubiza and Leatham (1990) were consistent with the findings reported by Lins, Kowalski, and Hoffman (1991). Based on the growing interest of institutional investors in farm real estate as a means to diversify their portfolios, Lins, Kowalski, and Hoffman assessed the diversification potential of farmland for portfolios dominated by U.S. stocks and bonds. Using historical data for 1970–1990 together with a mean-variance approach, farmland was found to offer good diversification potential for investors who held U.S. stock and bonds. Further, their results showed that diversifying into farmland allowed investors to achieve gains similar to those obtained by investing in foreign stocks.

Mishra and Morehart (2000) noted farmers may use off-farm investments to manage risks, as such investments may help in stabilizing income and providing for retirement and unexpected personal (e.g., health) expenditures. They reported that the ratio of off-farm investments to total assets for U.S. farm households increased from 18% in 1992 to 31% in 1999, showing off-farm investments are an important component of the investment portfolio of U.S. farm households. Specifically, the largest share of U.S. farmers' off-farm investments corresponds to retirement accounts, followed by stocks and mutual funds. Mishra and Morehart found that

off-farm investments tended to be higher for younger and more educated farmers, for farm households with greater off-farm income and total household income, for small and diversified farms, and for farms with lower debt-to-asset ratios.

Risk-Management Tools and Financial Performance

The 1996 Federal Agriculture Improvement and Reform (FAIR) Act shifted the dairy industry toward a more market-oriented pricing structure, with more input and output risk transferred back to dairy producers. Brinch, Stokes, and Weaver (1999) investigated the use of Multiple Peril Crop Insurance (MPCI), Income Protection (IP), and Group Risk Plan (GRP) insurance risk management strategies on the financial performance of dairy farms in Pennsylvania. Results of the study indicated risk management tends to marginally lower some measures of financial performance for dairy farms. This was especially true for production hedging, largely due to the more frequent resetting of hedges.

Agricultural Lenders and Risk Management

According to Collins and Barry (1986), loss sharing among Farm Credit System districts creates a free-rider problem.[5] They provided a framework to argue that a central entity could evaluate the riskiness of each district and adjust the cost of funds to each district so as to reflect its corresponding external costs. In this manner, costs of funds would be internalized and the free-rider problem would be eliminated. Collins and Barry also explained ways to determine risk premiums. They suggested that the calculation of the cost of funds which internalize the external costs of risk management for each district and create an actuarially neutral "insurance" fund hinged on the probability density function (pdf) of the rate of return on assets. Collins and Barry pointed out that implementation of their instrument required the estimation of the pdfs, and challenged future researchers to undertake this task.

In the mid-1980s, deregulation of interest rates, inflation and deflation, and agricultural recessions combined to destabilize the earnings of commercial banks. In response to this volatile financial environment, bankers employed various portfolio adjustments and assets and liability management strategies to reduce risk exposure and stabilize profits. The net interest margin (gross interest income less gross interest expense) conveys information on the bank management's effectiveness in allocating funds and controlling expenses.

Pederson, Pokharel and Coon (1986) examined the variability of bank interest income and how it related to bank management and portfolio characteristics. Banks with higher expected net interest margins were also found to exhibit greater systematic net interest income variability. Rao, Pederson, and Boehlje (1991) constructed an econometric model of bank investment and funding, and used it to simulate optimal asset-liability management decisions by means of a stochastic control program. When comparing the historical asset and liability decisions made by the Farm Credit Banks with the optimal decisions calculated from their model, the authors found that the former led to faster growth of assets and liabilities than the latter.

Belongia and Gilbert (1989) used data from agricultural banks for 1984–1988 to assess whether banks that failed over this period did so because of their risk-management strategies. They concluded failed banks were exposed to more risks than surviving banks, supporting the hypothesis that vulnerability to failure reflected management portfolio decisions.

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[5] Healthy districts are required to contribute reserves to distressed districts; thus the possibility exists for one district to impose external costs on others.

Issues for Future Research

As demonstrated by the preceding review, the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues (and its predecessors) has devoted significant efforts toward analyzing risk-management strategies in agriculture, and valuable insights have been obtained as a result. However, this area of inquiry is quite rich and there are important issues yet to be investigated. Our knowledge of risk management in agriculture has the potential to be greatly enhanced by future research in the following areas of inquiry, among others:

- *Contract Production.* Production under contract has emerged as the dominant production arrangement in the hog sector. There is little knowledge regarding the implications of contract production on risk management by both contractors and producers. Future research should explore the implications of contracting for lenders as well.

- *Recent Risk-Management Tools.* For example, farmers now have available a large menu of novel insurance products designed by the Risk Management Agency (RMA) (e.g., GRP, revenue insurance, income protection, whole farm insurance). Efforts are needed to assess the impact of these risk-management tools on the financial performance of farms, and on the risk-management strategies of lenders.

- *Investment Risks Associated with Contract Production.* Investment in new farm infrastructure (e.g., new buildings and equipment) has been spurred by production contracts. Future studies should analyze the extent of the risks associated with such investments on the face of changes in contract specifications.

- *Forward Contracting of Inputs.* Forward contracting of factors of production is a growing activity between the suppliers of inputs and the farmers who use them. Forward contracting inputs could aid planning and allow farmers to diversify purchases over time. Forward contracting of inputs also guarantees participating farmers an assured supply of inputs at a specified price. Studies should be conducted to evaluate the effects of this practice on the financial performance of farm businesses.

- *Reductions in Government Support.* Future farm bills are likely to include provisions to reduce government support of the farm sector, thereby significantly altering the risk-management environment faced by farmers. Studies assessing the impact of payment limitations on farm performance, asset values (land values in particular), and economic well-being of farms and farm households should prove to be valuable contributions.

- *Risk-Management Tools for Livestock Farms.* In recent years, the RMA has developed risk-management tools specifically designed to manage risks of livestock farms. For example, in 2003, the RMA introduced Livestock Price Insurance (LPI). Studies evaluating the use of LPI and its impact on the financial performance of livestock farms are warranted.

- *New Hazards.* Mad cow disease, bioterrorism, and avian flu are prominent examples of risks faced by agricultural producers which were unheard of just a few years ago. A thorough examination of the tools available to manage such risks and their impact on the financial performance of agribusinesses and lenders seems necessary.

- *Enhanced Production Flexibility.* The 1996 FAIR Act gave farmers greater flexibility to choose among crops to be produced. Studies are needed to investigate how this legislation has affected risk-management decisions at the farm level.

- *New Technologies.* New technologies may have an important impact on risk management. For example, cross-pollination of non-genetically modified (non-GM) crops with GM crops may greatly reduce the value of the former. Studies should be conducted to investigate whether recently introduced technologies have affected existing risk-management practices, and whether new risk-management tools need to be developed to cope with the new risks involved.

- *Off-Farm Income and Investment.* Off-farm income and investment have exhibited a positive trend over time. However, the amount of research devoted to them has not been commensurate with their relative importance. Studies focusing on the development of a greater understanding of off-farm income and investment patterns and opportunities should prove valuable.

- *Production Practices and Risk-Management Tools.* Some production practices (e.g., integrated pest management) may provide effective ways to manage risks, whereas other practices may require a careful choice of risk-management tools to be attractive. Competition versus complementarities in the use of production practices and financial instruments to manage risks clearly is an area worthy of research efforts in the future.

In summary, risk is a critical characteristic of production agriculture, and farms, agribusinesses, and lenders are all substantially exposed to various types of risks. Consequently, it is not surprising that substantial resources have been devoted to research regarding risk-management issues. The present study surveys the significant body of research on the topic generated by the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues, and its predecessors. For this purpose, risk-management strategies are classified into two main categories—"within-firm" strategies and "risk-sharing" strategies. Given the literature examined here and the recent developments that have occurred in the U.S. agricultural sector, the present study identifies a number of research topics worthy of attention for future research in the field. The hope is that such research endeavors will be as productive as the previous efforts reported here have proven to be.

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U.S. Macroeconomic and Tax Policy: Impacts on U.S. Farm Operations

Ted Covey, Ron Durst, and Jim Ryan

Abstract

Agricultural economists have generally concluded that macroeconomic and tax policy matters regarding the financial well-being of U.S. farm operations. Farm operations react more quickly and with greater response to both anticipated and unanticipated macroeconomic policy changes than do the commercial business operations, sometimes resulting in overshooting in the agricultural economy. In the early 1980s, the Federal Reserve's disinflationary policy and large federal budget deficits had disproportionately large effects on real agricultural interest rates. This paper concludes with a presentation of numerous potential researchable issues regarding macroeconomic and tax policy's impact on farm financial well-being.

Key words: net farm income, net worth, Policy Ineffectiveness Theorem, value added

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Approximately 30 years ago, Schuh (1974, 1976) stated that if there has been one major failure in the agricultural economics profession over the years, it has been the failure to grasp fully the macroeconomics of agriculture. Schuh attributed this failure to overemphasis on purely sector analysis in agricultural economics research, assuming a closed-state national economy, and fixity of exchange rates in the pre-Bretton Woods era. He argued that agricultural economics research needed to recognize the increasingly interdependent world of agricultural exports and floating exchange rates. Also addressing this issue, Brake (1974) asserted the overemphasis by agricultural economists on microeconomic analysis was the result of their academic training—i.e., microeconomic theory suggests relatively more easily testable hypotheses than does macro theory.

By the early 1980s, Gardner (1981) noted many economists had emphasized the importance of not treating the farm sector as a partial-equilibrium island. In his assessment of macroeconomics in crisis, Tweeten (1980a) predicted that economic well-being in the farm sector in the long run would depend more on federal taxation, spending, money supply, and trade policies than on traditional commodity programs. By the mid-1980s, agricultural economists had increasingly recognized that macroeconomic policies are at least as important to the U.S. agricultural economy as price supports and other farm sector-specific policies (Frankel, 1986).

Macroeconomic policy is the use of monetary and fiscal tools in order to achieve certain goals regarding the

nation's economy. These fiscal and monetary tools seek to influence the growth rates of the economy's aggregate demand and aggregate supply curves which determine output, price level, and employment. Fiscal policy involves tax rates and spending by the government. The most important federal taxes for farmers are the income tax, the self-employment tax, and estate and gift taxes. Monetary policy involves the U.S. Federal Reserve's use of the money supply to influence interest rates, inflation, and exchange rates.

Macroeconomic policies are designed in order to manage the nation's overall economy. Farm policy is concerned with the economic problems of a particular sector—*agriculture*. Consequently, macroeconomic policy can unintentionally supplement, offset, or even reverse the intended effects of our nation's farm policy.

Macroeconomic policy's impact on the financial well-being of farm operations can be measured using three bottom-line results obtained from the USDA's farm sector financial accounts: net value added, net farm income, and farm equity or net worth. Net value added is the residual after the value of agricultural sector production plus net government transfers is adjusted for inputs purchased and capital consumed. Reducing net value added by payments to hired labor, lenders, and non-operator landlords leaves net farm income. Farm sector equity or net worth is the difference between the farm sector's assets and liabilities (Covey, Johnson, Morehart, and others, 2005; Johnson, Perry, and Morehart, 1995).

Macroeconomic policy affects the farm operation's value added and net farm income through commodity prices, quantities demanded, and its costs of production. Macroeconomic policy influences the market value of farm equity through its effect on the market value of farm assets and liabilities. Taxes matter because it is after-tax rather than before-tax cash flows that are incentives to farm operator decisions and behavior. Federal tax policies have important effects on farm operations' profitability, the number and size of farms, the organizational structure of the farm sector, and the mix of land, labor, and capital inputs used in farming.

In a review of the literature regarding changing linkages between exchange rates, interest rates, and agriculture, Pederson, Stensland, and Fischer (1998) identified emerging challenges for agricultural lenders. Our paper reviews and summarizes the results of research published by agricultural economists regarding the impact of macroeconomic and federal tax policy on the farm operation's financial well-being. We look at federal tax policy's impact on farm operations from an indirect, macroeconomic perspective and its direct, microeconomic effects. Most research regarding taxes and agricultural finances has emphasized the latter.

In the first section, we present an overview of some of the major papers from the past 30 years focusing on the role of macroeconomic policy and taxes on farm operation finances. The second section offers research insights gleaned from the papers presented over the past 20 years at the annual meetings of the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues. The paper's final section discusses potential research issues regarding fiscal, monetary, and tax policy's impacts on the financial well-being of the U.S. farm operation that agricultural economists might consider for research over the next decade.

General Macroeconomic Policy Findings

Monetary Policy and the Farm Sector

Monetary policy's impact on agricultural finances has probably received most of researchers' attention. The Policy

Ineffectiveness Theorem, also known as the Rational Expectations Hypothesis, holds that macroeconomic policy designed to influence the U.S. aggregated demand curve will have no effects on real economic variables. According to the Money Neutrality Hypothesis, anticipated monetary changes have no real effects on agricultural economics variables, only unanticipated changes (i.e., shocks). Those holding this economic viewpoint would therefore expect that empirical research would fail to find evidence for macroeconomic policy's impact on farm operations' real financial well-being.

Frankel (1986) found that a decline in the money supply raised real interest rates, which depressed farm commodity prices more than proportionately to the decline in money supply. Findings reported by Chambers and Just (1981, 1982) indicate monetary factors have significant effects through the exchange rate on agricultural exports and prices for U.S. wheat, corn, and soybeans, especially in the short run. Tight monetary policies lowered agricultural prices and increased demand; however, upward pressure on the exchange rate seriously deteriorated U.S. exports. Inflation and changes in the real returns on alternative uses of capital were found by Just and Miranowski (1993) to be the major explanatory factors in farmland price swings and returns to farming.

Devadoss (1991) concluded that anticipated money supply growth does have a significant effect on farm output which is confined to the first year. The significant impact of unanticipated money supply growth persists over several periods because farm operators misinterpret the nominal movements as relative price changes associated with demand shift. In a subsequent study, Devadoss (1996) rejected the Policy Ineffectiveness Theorem for fruit and vegetable prices for both anticipated and unanticipated changes in money supply. However, other studies have concluded that monetary changes, whether anticipated or not, do not affect relative farm prices (Lapp, 1990; Isaac and Rapach, 1997).

In the mid-19th century, Cairnes predicted and showed that crude products such as agricultural commodities would respond more rapidly than manufactured products to monetary policy. Bordo (1980) confirmed this almost a century later, finding a much shorter lag length between monetary shocks and response time for agricultural commodities when contrasted to industrialized commodities. Devadoss and Meyers (1987) found U.S. agricultural prices respond faster than industrial prices to unanticipated money growth. Using Brazilian data for 1964–1981 under the usual monetarist ordering, Bessler (1984) reported that agricultural prices did not adjust faster than industrial prices to a shock in the money supply.

A number of agricultural economists have hypothesized that monetary policy changes may have greater impacts on farm than nonfarm business income. This greater responsiveness in income arises from the farm sector's relatively greater degree of product homogeneity and competitive market structure as well as greater reliance on longer-term real assets (e.g., farmland), all of which leads to greater price flexibility for agricultural commodities. Devadoss and Meyers (1987) concluded that the nonneutral effects of positive money supply shocks on relative prices benefit farmers because farm product prices increase relatively more than nonfarm product prices. As shown by Devadoss, Meyers, and Starleaf (1990), expansionary monetary policies, acting through exchange rates, interest rates, inflation rates, and income, favor the agricultural sector through an increase in farm exports, prices, and incomes.

Lins (1979) found expansionary monetary policies achieved greater gains in farm prices and incomes relative to nonfarm prices and incomes. Han, Jansen, and Penson (1990) argued that increased uncertainty about agricultural prices has been caused by increased uncertainty about money growth since 1979, and this increase is greater relative to the increased uncertainty in industrial prices.

Findings reported by Francis (1974) reveal substantially different short-term adjustments in the farm and nonfarm sectors to variations of monetary growth around a trend rate. However, the long-run adjustment by both sectors is about the same. Chambers (1984) documented that restrictive monetary policy used to lower inflation or strengthen the dollar lowered agricultural prices relative to the rest of the economy and lowered agricultural income, at least in the short run. However, Gramm and Nash (1971) found the agricultural sector to be as responsive to monetary policy as the nonfarm economy.

If monetary policy has greater impacts on flexible commodity prices relative to sticky nonfarm prices, agricultural prices could reasonably be expected to overshoot their long-run equilibrium levels during the economy's short-run adjustment to shocks (Andrews and Rausser, 1986; Rausser et al., 1986). Similar effects in the agricultural commodity markets can also result from overshooting in the exchange rate markets. Overshooting (undershooting) occurs when a price, in response to an unanticipated monetary shock, temporarily changes to a higher (lower) value than its longer-run equilibrium value. Noting that farm income is mostly influenced by changes in market prices, Saghaian, Reed, and Marchant (2002) observed that farm commodity prices' and incomes' relatively greater volatility in contrast to the nonfarm sector was due to overshooting. According to results noted by Dorfman and Lastrapes (1996), livestock prices overshoot and crop prices undershoot in the short run when monetary shocks (i.e., unanticipated changes in money supply) occur. In the short run, Falk and Lee (1998) found that farmland prices overreact to temporary shocks in macroeconomic influences, while in the long run, farmland prices are mostly explained by fundamental shocks.

The relative impact of inflation on farm incomes has been studied, particularly during periods of high inflation in the economy. Tweeten (1980b) provided evidence that inflation contributes to a "cost-price" squeeze or a declining ratio of prices received to prices paid by farmers. Chambers and Just's (1982) study of monetary policy and agricultural economics impacts suggested the burden of restrictive monetary policy necessary to reduce inflation may be unusually great for farm operations. Consistent with their research findings, Mishkin (1988) concluded farmers suffered more than the nonfarm sector from the Federal Reserve's disinflationary policy of the 1980s.

Contractionary monetary policies were found by Devadoss, Meyers, and Starleaf (1990) to have a substantial adverse effect on the farm economy. Their research covered a range of time periods and different price-level measures. However, Starleaf, Meyers, and Womack (1985) reported that farmers' flexible output prices in contrast to their relatively inflexible input prices made them net beneficiaries from unanticipated increases in inflation.

In other analyses, inflation was determined to impact farm operations' net worth. O'Carroll (1981) found growth rates of real net worth under inflation peaked at 3% to 7% inflation. At higher inflation rates, equity growth rates tended to decline. Cash-flow deficits were common at inflation rates greater than 6%. Moss (1997) concluded inflation accounts for about 82% of the dynamics in farmland values.

Fiscal Policy: Government Expenditures and Taxation

The effect on the agricultural economy coming from the fiscal side of macroeconomic policy has also been investigated, although not as extensively as with monetary policy. Lemieux (1987) found that budget deficits in 1982 and 1983 resulted in increases in agricultural real interest rates which were three to four times as large as the rise in real rates in the nonfarm sector. One possible explanation suggested by Lemieux for this

finding is the rigid pricing system of the Farm Credit System (FCS) which causes farm sector rates to be more responsive to changes in the federal deficit. In their investigation of the effects of fiscal policies on U.S. agriculture, Devadoss and Chaudhary (1994) established that systematic and unsystematic components of government expenditures affected real output of farm operations, thereby rejecting the ineffectiveness theorem for fiscal policy.

According to Hardesty, Carman, and Moore (1987), progressive marginal income taxes and deductibility of interest and depreciation expenses have significant impacts on farm firms' investment patterns in land and machinery as well as their methods of financing. Long (1990) examined the practice of "farming the tax code," in which accounting losses on agricultural investments are used to shelter other income from taxation.

Exploring the effects of a federal flat tax on agriculture, Wilson, Featherstone, and Ellfner (2002) noted the average income tax paid by farm households dropped about 21%, and under a 20% flat tax system 63% of Kansas farmers would pay lower taxes. The authors argued that larger and more profitable farms would be relatively better off in contrast to the current system. Further, a reduction in interest rates of 25% which would maintain real, after-tax rates would extend benefits to 90% of farm households.

Farm Operations' Financial Well-Being: Does Macroeconomics Matter?

Most research by agricultural economists has shown that macroeconomic policy does matter with respect to its impact on farmers' "bottom line." As reported by Starleaf (1982), activist, macroeconomic policies had substantive short-run influences on farm product price from 1948–1981 via their effect on domestic demand and the exchange rate. Bjornson (1995) determined that proper valuation of farm assets required incorporating the changing cost of capital caused by macroeconomic conditions and the dynamics of the business cycle.

Some earlier studies rejected the notion of a macroeconomic, farm financial linkage. Gardner (1976) noted that pre-World War II was an era in which the real agricultural incomes of rural-farm households experienced large variation arising from sharp changes in domestic demand for food due to booms and busts in the general economy.

Gardner (1976) found this relationship to have declined in the post-World War II era due to commodity supply functions which are becoming less cyclically sensitive and the generally milder post-World War II business cycles. While Gardner felt the growing importance of purchased inputs would create an increasingly closer link between the farm and general economies, he projected that variation in farm income would weaken over time due to improvements in farm operators' ability to adjust to disequilibria.

Claims that easy monetary policies would raise farm prices and lower farm interest rates were assessed by Doll (1958) to be unsubstantiated and even weakly contradicted by the data. Specifically, Doll argued that due to technology, the supply situation in American agriculture was dominating monetary policy, and thus farm prices declined despite strong demand during 1948 to 1958. As he noted, farm prices declined despite strong general economic activity and an average increase of about 2.5% annually in the money supply during this period.

Agricultural Finance Committee Findings

Research conducted by members of the Committee has addressed the effects of changes in macroeconomic and tax policy on the financial condition of participants in the farm sector.

Monetary and Fiscal Policy

Penson, Hughes, and Adair (1986) used a large-scale econometric simulation model (COMGEM) to examine the effect on net farm income and farm equity of two alternative farm program policy scenarios under a macroeconomic scenario similar to the first three quarters of 1985. The macroeconomic scenario was one of expansionary monetary (money growth of 8%–9%) and fiscal policy (high deficits assumed to remain at the 1984 level) for 1985 through 1990. The first farm policy scenario involved a continuation of the loan rate and target policy provision under the 1981 Agriculture and Food Act. The second farm policy scenario assumed adoption of the Reagan Administration's proposal for pegging loan rates and target prices to a three-year moving average of the market price for each program commodity.

Penson, Hughes, and Adair's simulation results suggested that the first farm policy scenario (continuation of the 1981 Act provisions) would fail to restore farm profitability for 1986–1990. Simulation results of the second scenario (adopting the Reagan Administration's proposed policies to sharply cut commodity price supports) showed substantially lower net farm income than under the 1981 Act scenario. This result is primarily due to a relatively larger decline in real cash receipts for crops. By 1990, cash receipts overall were projected to be lower than 1985 levels and 15% below those projected under the 1981 Act scenario.

The continued downward trend in real farm asset values and resulting loss in real farm equity under the 1981 Act scenario were found to be magnified by the scenario following the Reagan Administration's proposal. Capital expenditures are lower under the Reagan proposal's scenario, while depreciation would exceed capital expenditures under both farm policy scenarios. Real net farm income for the sector would be below Depression-era levels by 1990.

Findings reported by Moss, Baker, and Brorsen (1988) indicated changes in the federal budget surplus, money supply, real exchange rate, and growth in real GNP as a group had statistically significant effects on real corn and soybean prices in the 1980s. The impulse response function showed that reducing the budget deficit reduced real corn and soybean prices in the 1980s. This was a result of a deficit-led decrease in the real agriculture trade weighted exchange rate leading to lower foreign prices for American corn and soybeans. The authors' historical decomposition of forecast error gave further evidence that of all macroeconomic factors in the 1980s, changes in the budget deficit had the biggest impact on real corn and soybean prices. In contrast, the money supply, the real exchange rate, and growth in real GNP had little individual effect on real corn and soybean prices in the 1980s.

Inflation is also a concern. Specifically, its effects on commodity prices received by farmers may be relatively less than the prices farmers pay for their inputs, resulting in declines in net farm income over time. Based on his research over 1983–1990, Dubman (1991) concluded that input expenses and farm income are equally affected by inflation, and thus the impact on net farm income is relatively neutral, both for crop and livestock farmers.

Covey and Babula (1991) tested Fisher's hypothesis for interest rates for three different farm loan types (feeder cattle, other operating, and real estate) made by commercial banks for three different Federal Reserve districts (Chicago, Richmond, and Kansas City) from 1978 through 1989. Rates were found to increase from 41 to 58 basis points given a 100 basis point increase in inflation. Responses by interest rates to inflationary shocks were spread out over time for up to as long as 2.5 years. Within-region responses to inflationary shocks of different loan types were more similar in their pattern and magnitude than the same loan types across regions.

Longer-term rates were less responsive than shorter-term rates. This finding may reflect that farm and rural banks use a relatively more weighted average cost of funds approach to loan pricing than do large commercial banks, which could explain the relatively lengthy and inflexible response of farm rates.

Results of a study conducted by Featherstone, Goodwin, and Barkema (1993) revealed the longer-term macroeconomic rates (FCS bonds and 10-year T-bonds) are more appropriate leading indicators of future changes in farm interest rates compared to shorter-term macroeconomic rates (six-month T-bills). Comparing the time periods of 1976–1984 and 1984–1992, the authors found the strength of the relationship between the farm and Treasury yield curves had weakened over time, which they believe may be due to an inversion in the farm yield curve over the later period. They suggested this may be explained by a shifting in the perceived default characteristics or the cost structure associated with shorter versus longer maturity loans. The response of farm rates to shocks in money market rates was not highly aligned in the short run, but settled down and moved together in their long-run response.

Tax Policy

The Tax Reform Act (TRA) of 1986 produced significant changes in the tax laws affecting agricultural producers. Some TRA provisions affected all taxpayers, such as larger personal exemptions and standard deductions, and reduced tax rates. Farmers were more specifically impacted by changes related to business investment activities.

Gustafson, Barry, and Sonka (1987) evaluated the factors, including changes in tax law, thought to influence the machinery investment decisions of Illinois cash grain farmers. The study considered the Reagan Administration's proposed changes in tax code that would affect farmers—i.e., lower marginal tax rates, a repeal of the investment tax credit, and extended but inflation-indexed depreciation schedules. A sample of farmers was drawn from membership in the Illinois Farm Business Farm Management (FBFM) Association to participate in the study, which used an experimental method with simulated investment situations. After reviewing financial statements of the performance of their farms, the selected farmers were asked to make a series of investment decisions assuming different policy scenarios. In the tax reform scenario, farmers were expected to reduce investment in response to elimination of the investment tax credit (ITC). However, farmers reported that the ITC was not a significant factor in investment decisions since: (*a*) there were other more effective means of income tax averaging than purchasing machinery in high income years, and (*b*) most machinery purchase decisions were made as equipment was needed, usually prior to planting or harvesting, when annual income was still largely uncertain.

Mickey and Lins (1989) reviewed the tax alternatives available to farmers under the TRA: cash versus accrual accounting, expensing versus depreciating of capital assets, and the choice of depreciation method for depreciable assets. Their study sought to determine the combination of alternatives that should be selected to maximize expected after-tax income of farms varying by size, financial position (debt-to-asset ratio), and traditional capital asset replacement pattern. Three interrelated models were used to examine the relative effects of various tax provisions: a firm simulation model, a professional tax planning model, and a net present value model. Results suggested that differences in the net present value of after-tax cash flows for the best and worst choices for the various tax alternatives could be substantial.

LaDue, Casler, and Conrad (1988) examined the benefits to dairy farmers of favorable tax treatments which were lost under the TRA: the elimination of capital

gains treatment of livestock, investment tax credit, and immediate write-off of youngstock expenses, and the disqualification of dairy barns as special-purpose livestock structures on accelerated depreciation schedules. The study involved the calculation of short-run and long-run effects of the TRA on income taxes paid by a sample of New York dairy farms. Pro forma income statements and tax liabilities based on 1985 earnings were projected under previous and TRA laws for 1988–1997. Results of the study suggested the TRA would increase income taxes paid by most dairy farmers in both the short and long run. For the study group, income taxes would be 170% above 1985 levels (after all phase-ins had been completed) if income remained constant.

Comparing pre-retirement investment diversification strategies for farmers, Monke, Boehlje, and Pederson (1991) evaluated the effects of various income tax policies on optimal portfolio selection for a variety of investor preferences. A simulation model was used to calculate after-tax future value of investment strategies under various income tax environments. Results indicated investors would hold a greater proportion of their portfolios as capital assets under a proposal which taxes only real capital gains than they would under proposals which would exclude a portion (up to 30%) of capital gains from taxation. Simulation results demonstrated the significance of income tax deferral offered by individual retirement accounts (IRAs) and Keogh retirement savings plans as a preferred vehicle for acquisition of capital assets.

Elffner, Featherstone, and Cole (1999) examined the effects of a federal flat income tax on Kansas farmers. Using data from the Kansas Farm Management Data Bank and a tax survey sent to all 1994 members of the Kansas Farm Management Association, the study compared the tax liability of Kansas farmers under the existing federal system to that under a flat tax system. It also evaluated the fairness, the progressivity, and the winners and losers under a flat tax system.

The effects of a flat tax rate on tax liabilities were found to be progressive, i.e., federal tax liability increased at an increasing rate as farm profitability and farm size increased. The average tax paid by Kansas farmers would decline by 21% under the flat tax, with 63% of producers paying lower federal income tax.

The impacts of deferred income taxes on the farm sector balance sheet have also been analyzed in research reported to the Agricultural Finance Regional Research Committee. Ryan (2001) developed a modified cost basis balance sheet for the farm sector for 1950–1999 to better conform to Farm Financial Standards Council (FFSC) guidelines. Agricultural balance sheets have traditionally reported assets at current market values.

Construction of the modified cost basis balance sheet for the farm sector allowed implementation of FFSC guidelines: (*a*) to adjust market value balance sheets to include the deferred taxes that would be due on the liquidation of assets, and (*b*) to allocate market value equity, net of deferred taxes, between valuation and retained earnings/contributed capital components. The cost basis balance sheet was used to revise the farm sector market value balance sheet to reflect contingent tax liabilities, and to allocate equity into its component parts.

While tax treatment of capital gains has varied considerably through the years, capital gains have usually been treated favorably, relative to ordinary income. For simplicity in determining the deferred tax liability, Ryan (2001) assumed a capital gains tax rate of 20% to apply in all years. Capital gains are computed as the difference between market value and cost basis for real estate and machinery and motor vehicles, and the deferred tax liability on that gain is included in the liability portion of the balance sheet. The cost basis balance sheet permits decomposition of equity reported in the farm sector market value balance sheet into its component parts. Deferred taxes are subtracted from market value equity to

obtain a measure of equity net of deferred taxes. This equity measure is further divided into valuation and retained earnings/invested capital components.

The following two sections offer a discussion of issues in the areas of fiscal policy, monetary policy, exchange rates, taxes, and retirement where future agricultural economics research may contribute information useful for farm and macroeconomic policy.

Future Monetary and Fiscal Policy Issues

Operator Expectations

Investment and financial decisions made in the present by farm operators depend in part on their expectations of future economic values such as interest (discount) rates and cash flows. Today's farmer is better educated, more sophisticated, and far more informed (e.g., via the internet) than farmers in previous generations. There has been increasing reliance on contracts in farm production and marketing. The impact of macroeconomic policy, and the ability of the government to effect change through policy, may have been substantially altered.

Possible future research issues related to this topic include the following. How does macroeconomic policy impact the formation of farm operator expectations? Has improved education and access to information affected macroeconomic policy's impact on farmers' ability to form accurate and reliable subjective probabilities about future events? Has increased use of contracting changed the relative flexibility of farm and nonfarm price response to changes in fiscal and monetary policy?

Monetary Policy and Interest Rates

Interest rates impact farm operations through their effect on borrowing rates, savings rates, the market value of farm assets and liabilities, and investment discount rates. The Treasury yield curve does not have an easily obtainable counterpart for interest rates on farm debt; i.e., interest rates on non-real and real estate farm loans are not the farm equivalent to short- and long-term U.S. Treasury yields. Despite these differences, future research might consider whether changes in the Treasury yield curve affects interest rates and discount rates in the farm sector. What role do expectations of future monetary policy actions and interest rates have on farm operator investment decisions? How might the recent change in the chairmanship of the U.S. Federal Reserve impact interest rate levels and uncertainty in the farm sector? Would the adoption of rule-based monetary policies increase or decrease the ability of government policy to alter farm operator decisions?

Changes in interest rates impact net farm income and farm net worth when the totality of their effect on agricultural exports, imputed rent, interest expenses, and the market value of real estate and farm liabilities is simultaneously taken into consideration. Future research might consider evaluating the simultaneous impact of changes in interest rates on both net farm income and the market value of farm assets, liabilities, and net worth.

Budget Deficits

President George W. Bush has set a goal of cutting the budget deficit in half by 2009. Proposals to reform Social Security, fund the war on terrorism, and make expiring tax cuts permanent will be expensive. What impact will future deficits and deficit reduction have on the macroeconomic variables important to the farm sector's financial well-being?

Agricultural Forecasting

Gardner (1981) noted that ignoring macroeconomic linkages made forecasts of policy implications derived from agricultural economists' sector models look ridiculous in the 1970s. As shown by

Covey and Erickson (2004), USDA implicit forecasts of total assets in the farm business sector are improved when expectations of inflation are accounted for in the forecast model. Future research might consider how incorporating macroeconomic variables could be used to improve predictions of net value added, net farm income, and net farm worth.

Future Tax Policy Issues

Federal tax policies can have important effects on farm profitability, the number and size of farms, the organizational structure of the farm sector, and the mix of land, labor, and capital inputs used in farming. The most important federal taxes for farmers are the income tax, Social Security and the self-employment tax, and estate and gift taxes. With regard to each of these taxes, significant changes have either occurred over the last few years or are likely to be enacted in the near future. In most instances, the implications of these changes or proposed changes for the farm sector are not well understood.

We believe the following unanswered questions are of sufficient importance to warrant additional research. How do changing marginal income tax rates impact the supply of farm labor, investment, and output? What effect do changes in marginal tax rates have on the levels of tax revenues generated from farming activities and the tax liabilities of different farm cohorts (e.g., farm typologies)?

Federal Estate and Gift Tax Policies

Appreciation in land values, the increase in farm size, and the rising investment in farm machinery and equipment have increased farm estate values and taxes. Over the years, Congressional concern that these increased estate and gift taxes might cause the break-up of some family farms and other small businesses has led to the enactment of a number of targeted provisions to provide relief to farmers and other small business owners. Concern for the effects of the federal estate tax on farmers and other small businesses was the primary impetus for the changes enacted as part of the Taxpayer Relief Act of 1997, and a major objective of the 2001 phaseout and eventual repeal of the federal estate tax.

The current federal estate and gift tax system applies a unified tax rate structure and a cumulative lifetime credit to gifts and transfers of money and other property at death. Under the system, individuals can transfer a specified amount ($1.5 million in 2005, increasing to $3.5 million in 2009) in cash and other property without federal estate or gift tax liability as a result of the unified lifetime credit. The federal estate tax will be repealed in 2010. However, without further legislation, repeal will last only one year before the law reverts to the provisions in effect in 2001. Efforts are underway to make repeal permanent. Opponents of repeal argue that the primary beneficiaries are the very wealthy, and they support a substantial increase in the amount of property that can be transferred tax free coupled with a reduction in tax rates.

Regardless of the ultimate outcome of this ongoing debate, a number of important future research questions are presented. What is the scope of the tax? Are the investment and other decisions of a large share of farmers affected by the estate tax or is it limited to those who owe tax? What are the costs associated with activities related to planning for or reducing estate taxes? What share of farmers is required to file an estate tax return? How many will owe tax and how much of the estate is owed in tax? Are those who owe taxes faced with a liquidity problem or are there sufficient liquid assets to pay the tax, especially given the special payment options that already exist for farmers and other small business owners? What impact could the estimation of the step-up in basis rules have on the tax liability and ownership patterns of farm heirs? Finally, how might the changes influence estate planning, particularly with regard to the timing and the methods of transfer of the farm business to the next generation?

Federal Income Tax Policies: Influence on Land Values and Ownership

Land is the primary input in farming. Thus, the tax policies affecting investment in land are particularly important for the agricultural economy. Two provisions that have increased in importance in recent years are the ability to defer taxes on gains on business or investment property through a like-kind exchange and the tax incentives associated with the donation or sale of a conservation easement.

The increased demand for residential and commercial development near urban areas has greatly inflated land values in these areas. Despite the recent lowering of capital gains tax rates, landowners may still find it advantageous to defer taxation of gains from the sale of their properties for residential or commercial development. These sales frequently generate large gains which even at reduced tax rates can result in substantial capital gains taxes. For a landowner who wants to continue farming or stay invested in farmland, a tax-deferred exchange allows these taxes to be deferred until the acquired land is sold. If held until death and transferred to the next generation, capital gains taxes can be avoided completely due to the step-up in basis to current fair market value at death treatment.

Tax-deferred exchanges allow metropolitan area sellers to purchase much larger agricultural tracts in more remote regions, supporting farmland values outside of urban areas. The increased demand for land benefits those landowners looking to sell. However, the increased competition for land makes it more difficult for beginning farmers and those nearby landowners interested in expanding their own land holdings. How large of an impact has this had on land values well beyond the urban fringe? What is the effect on the cost of production for farmers in areas affected by this increased competition for land? Will this accelerate the trend to larger farms?

Increased tax incentives associated with the sale or donation of such easements, both with regard to federal income and estate tax policies as well as state tax incentives in some states, have increased the use of such easements. Are these easements a cost-effective way to preserve farmland? Can it be a useful tool to aid beginning farmers by reducing the cost of acquiring farmland? How might the benefits be targeted? Given the increased cost of land and the urban pressures exerted on farmland located near urban areas, these issues are certain to be of interest to those concerned with the preservation of farmland and facilitating the entry of young farmers into farming.

Fundamental Tax Reform

In recent years, the federal tax code has been used with increasing frequency to further a variety of policy objectives other than raising revenue. To reduce revenue loss, many of the recent changes in the federal tax code have been phased-in or are temporary. This often leads to additional changes and adds complexity to the federal tax system. President Bush made fundamental tax reform a priority policy initiative and appointed a commission to make recommendations for reform. The commission has been directed to develop recommendations on options to reform the tax code to make it simpler, fairer, and more pro-growth.

While enactment of either of the reform options recommended by the commission in the near term may be a long shot, any major overhaul of either individual or business taxes could have important implications for farmers. A number of questions regarding the impact on the farm community will need to be answered. What are the most important features of the current federal income tax system for farmers? How might various reform proposals affect farmers? If enacted, what are the implications of the new system for compliance and tax burdens, farm structure, and asset values, especially land? Finally, given the

importance of farm exports, what might be the impact on the competitive position of U.S. farmers?

Retirement

The approaching retirement of the baby boom generation has focused attention on possible reforms in Social Security. More than 25% of farmers are at least 65 years of age, in contrast to 3% of the overall U.S. labor force. In 1999, Social Security accounted for 13% of income for those farm operators who received Social Security (Mishra, Durst, and El-Osta, 2005). Some of the proposed changes currently "on the table" regarding Social Security reform offer future researchable issues for agricultural economists concerned with the short- and long-run impacts on farm operations' financial well-being.

Proposals to reform Social Security include: increasing the cap or subjecting all earnings to the Social Security Payroll Tax, progressive indexing, increasing the initial retirement age, moving toward personal accounts, cutting benefits, accelerating the increase in the retirement age for full Social Security benefits, lengthening the computation period for Social Security benefits, reducing cost-of-living adjustments in Social Security benefits, or simply doing nothing. Each of these issues offer potential research projects for agricultural economists that may help policy makers anticipate the future possible consequences on the financial well-being of farm operations.

Summary

We propose that macroeconomic and tax policy's impacts on farm operations are best measured through farm sector value added, net farm income, and farm net worth. Past research by agricultural economists has generally concluded that the macroeconomic and tax policy matters with regard to financial well-being of U.S. farm operations. Farm operations react both more quickly and with greater response to macroeconomic policy changes than do the commercial business operations, sometimes resulting in overshooting in the agricultural economy.

Both the Federal Reserve's disinflationary policy and large federal budget deficits had disproportionately large effects on real interest rates in the farm sector. The Policy Ineffectiveness Theorem was generally rejected—farm operators respond to both anticipated as well as unanticipated macroeconomic changes, although the anticipated changes had shorter-term effects. Research by the Agricultural Finance Committee has generally upheld the real financial impacts resulting from the linkage between farm operations and macroeconomic policy. The Committee has published considerable work which indicates the significance of federal tax policy.

Our paper concludes by proposing issues future researchers may consider regarding the impact of macroeconomic and tax policy on the financial well-being of U.S. farm operations. These issues cover operator expectations, the role of interest rates, budget deficits, agricultural forecasting, federal estate and gift taxes, federal income taxes, fundamental tax reform, and retirement.

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Research on USDA Farm Credit Programs: Past, Present, and Future

Bruce L. Ahrendsen, Charles B. Dodson, Bruce L. Dixon, and Steven R. Koenig

Abstract

Federal farm credit programs currently administered by the USDA were initiated in the early 1900s to help the farm sector cope with natural disasters, and these programs have continued to evolve. There has been a rich history of research analyzing USDA farm credit programs and the effects they have had on farmers, ranchers, and credit markets. This paper highlights past research and offers a view of the future direction of research on federal farm credit programs.

Key words: direct farm loan, farm loan guarantee, Farm Service Agency, federal farm credit program

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Federal credit programs attempt to resolve imperfections in credit markets and address any concerns about social inequities (LaDue, 1995; Executive Office of the President, 2005). Information asymmetries and imperfect competition represent examples of perceived market failures which led to the initial establishment of federal farm credit programs, such as those currently administered by the U.S. Department of Agriculture (USDA).

Information asymmetries can make it difficult for farmers to demonstrate their creditworthiness to lenders. Also, access to financial services among farmers and those residing in rural areas has been perceived to be more limited than in urban areas, making imperfect competition in farm loan markets more likely. Consequently, creditworthy farmers may have been unable to obtain credit at reasonable rates and terms.

Federal farm credit programs and policies seek to fill any credit gaps by increasing the supply of credit at reasonable rates and terms and by directing loan funds toward particular groups consistent with certain policy objectives. Past research has concentrated on analyzing the effects these subsidized credit programs have on farmers, ranchers, and other credit providers, how well the programs meet their objectives, and the appropriate role of subsidized credit programs.

The primary federal credit programs discussed here are farm loan programs

administered by the USDA's Farm Service Agency (FSA) and its predecessors.[1] These programs have substantial direct costs which accrue to the federal government. The cooperative Farm Credit System (FCS) and the privately owned Federal Agricultural Mortgage Corporation (Farmer Mac) have much larger loan volumes than FSA, but, since the FCS and Farmer Mac are government-sponsored enterprises (GSEs), there are no regular direct costs accruing to the federal government. Therefore, these GSEs are not the focus of the study presented here.

Other federal credit programs with less prominent roles in serving agriculture, such as those administered by the Small Business Administration, the Commodity Credit Corporation, and Rural Business and Cooperative Service, are not discussed here because of their limited or specialized objectives. State-sponsored farm credit programs have also emerged as a source of credit since the 1970s. However, their level of funding is far less than FSA's and their scope is more limited (Wallace, Erickson, and Mikesell, 1994). Still, the existence of state-sponsored programs may indicate deficiencies in federal credit programs, and therefore will be briefly discussed.

The next section briefly describes FSA. The subsequent section highlights the legislation and policies that have shaped FSA farm credit programs. A section is then provided which reviews the research on FSA and state farm credit programs resulting from the regional research projects concerned with agricultural finance issues. Next, future directions for research on federal farm credit programs are considered, followed by concluding comments provided in the final section.

[1] FSA was formed in 1994 and was preceded by the Resettlement Administration (1935–1937), Farm Security Administration (1937–1946), and Farmers Home Administration (1946–1994).

Farm Service Agency

Farm loan programs administered by FSA are designed to provide credit to family farms unable to obtain credit from conventional sources at reasonable rates and terms despite having sufficient cash flow to repay and an ability to provide security for the loan (Dodson and Koenig, 1999). FSA's loan programs provide short- to intermediate-term farm operating (OL) loans, long-term farm ownership (FO) loans, and emergency (EM) loans to help farmers recover from natural disasters, as well as other minor loan programs.[2]

FSA delivers subsidized credit to farm borrowers through two primary mechanisms: direct loans and loan guarantees. Direct loan programs are funded through FSA and are serviced by local FSA staff, whereas guaranteed loans are funded and serviced by commercial lenders, but guaranteed (typically at a rate of 90%, but as high as 95% for certain loans) by FSA against default.

Although FSA only had approximately 3% of the farm debt market and guaranteed another 4% in 2004, it has a larger presence in some geographic regions and among certain borrower groups. Also, FSA loan programs accounted for over 16% of the total farm debt market as recently as 1987, during a period of farm financial stress (USDA/ERS, 2003). In the five fiscal years beginning in 2000, average annual FSA farm loan program lending volume was $3.5 billion, with 73% of this volume being supplied through loan guarantees.

In addition to serving the general category of family-sized farms, federal legislation compels FSA's direct and guaranteed OL and FO lending programs to target its lending resources to specific subgroups falling under the family farm umbrella.

[2] For more information on FSA loan programs, refer online at http://www.fsa.usda.gov/dafl/default.htm (accessed August 28, 2005).

These groups are socially disadvantaged (SDA) and beginning farmer applicants. An SDA farmer is one of a group whose members have been subjected to racial, ethnic, or gender prejudice because of their identity as members of the group without regard to their individual qualities. A beginning farmer applicant is an individual or entity which, in addition to meeting all other general eligibility criteria, has not operated a farm or ranch for more than 10 years and, for FO loan purposes, has at least three years of experience operating a farm, but does not own a farm greater than 30% of the median farm size in the county.

Historical Perspective

The FSA was created in 1994 from a combination of agencies with credit programs that have a long historical legacy. Direct federal intervention in farm credit markets dates back to 1918 (Figure 1), when Congress authorized federal low-interest loans to farmers who had suffered losses due to floods and droughts in designated areas and were unable to obtain credit elsewhere (USDA/FmHA, 1989).[3] Emergency farm loans were sporadically authorized until 1931, when they became nationally available on a permanent basis.

The concept of supervised credit was initiated in 1934, when the Rural Rehabilitation Division was created with the responsibility of providing government loan programs for smaller farms in which the borrower would agree to operate the farm under a farm plan developed with the help of the Division's county representative (Brake, 1974). A primary objective of these and subsequent federal farm loan programs of the period was to help farm families remain on their farms or reestablish themselves in farming.

[3] Collender and Koenig (1998) offer an excellent discussion of the history of direct and indirect federal intervention in agricultural credit markets.

In 1935, supervised credit was continued when the Resettlement Administration was created to provide short-term loans to low-income farm families based on a farm and home plan that had been designed by the family and the county representative. In 1937, the Farm Security Administration took over these responsibilities and also focused on providing supervised long-term credit to farmers who could not obtain credit elsewhere.

Following the end of World War II, federal farm credit programs were reconfigured and delivered via a new agency, the Farmers Home Administration (FmHA). The new agency's farm loan programs shifted away from the welfare orientation of the Great Depression to one which provided supervised operating and farm purchase credit to family-sized farmers unable to obtain commercial credit, but who could eventually become economically viable and eligible for commercial credit (Barry, 1995).

While the scope of FmHA farm lending grew somewhat after World War II, the credit programs accounted for a relatively small share of total U.S. farm debt. It was not until the 1970s that the credit programs were used to more broadly assist farmers during periods of low farm income or financial stress. Congress relaxed eligibility requirements, raised lending limits, created new loan programs, and increased annual lending authorities for FmHA programs during the period (USDA/FmHA, 1989).

The Rural Development Act of 1972 expanded the reach of the agency's credit programs and authorized guaranteed loans for the first time. During the 1970s, Congress also authorized new emergency farm lending programs administered by FmHA and by the Small Business Administration.

The Agricultural Act of 1978 introduced the Economic Emergency (EE) loan program, which provided direct or guaranteed loans to farmers experiencing shortages of credit from regular sources or

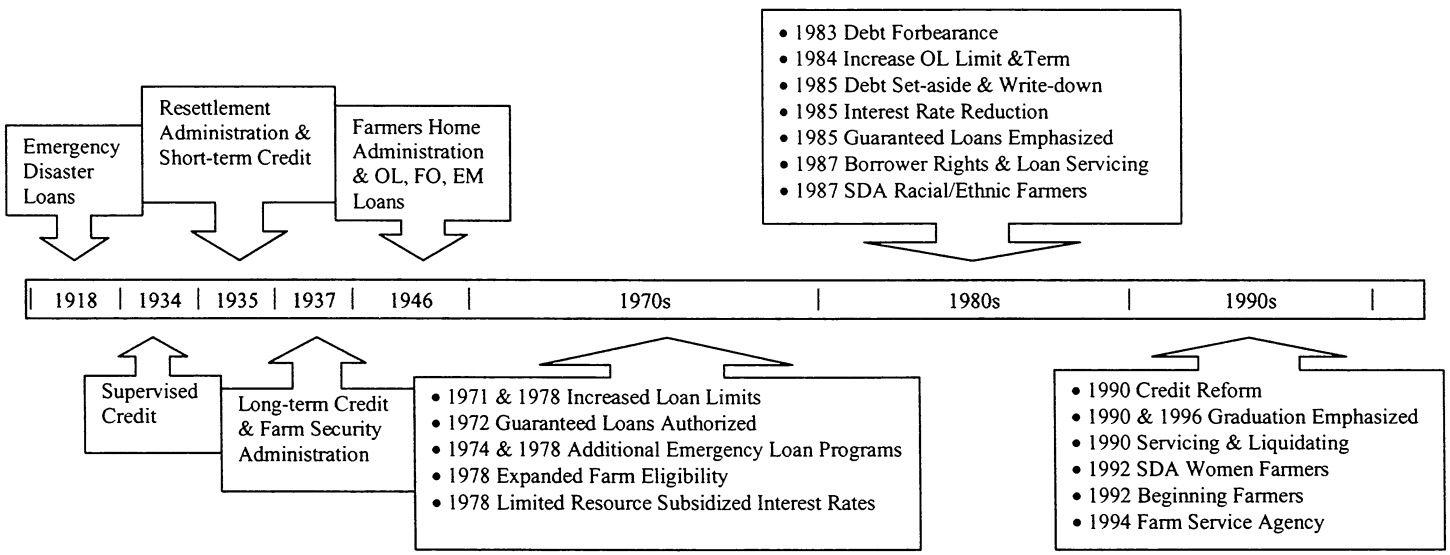

Figure 1. FSA Farm Loan Program Development

who were experiencing a cost price squeeze in their farming operations (Dodson and Koenig, 1997). These emergency lending programs greatly contributed to the inflation-adjusted new farm loan volume of FmHA, which increased from just $2.5 billion in fiscal 1970 to $16.8 billion by fiscal 1979. This acceleration in lending activity resulted in a much greater presence of federal lending programs in rural credit markets and led to further discussions on the appropriate role of farm credit programs (Barry, 1985; LaDue, 1985).

Federal credit program lending authorities were trimmed in the early 1980s, and by the mid-1980s a shift from direct lending to guaranteed lending was underway. But, during this period, the farm sector experienced widespread financial stress and federal credit programs once again were used to assist the ailing farm sector (Stam et al., 1991). Defaults on commercial farm loans rose sharply, leading to massive farm loan write-offs and eventually causing scores of farm lenders to fail or exit farm lending. Federal financial assistance for the cooperative FCS came with the passage of the Agricultural Credit Act of 1987, which also created the privately owned Farmer Mac with a mission of providing greater liquidity to farmland mortgage markets.

The federal government's response to the widespread financial stress emphasized a number of policy initiatives, including the restructuring of debts through farm loan mediation and a new, temporary chapter for farmers to the U.S. Bankruptcy Code.[4] Direct and guaranteed farm loans swelled as many commercial lenders retreated from farm lending. As a result, FmHA direct farm loan program's share of total U.S. farm debt rose from under 6% in 1977 to a high of more than 16% ten years later. For some regions and farm types, FmHA became the primary credit source.

[4]The U.S. Bankruptcy Code temporary chapter, Chapter 12, was made permanent in 2005.

The high-risk lending of the 1970s coupled with the farm financial stress of the 1980s led to record direct farm loan program defaults and losses. Delinquent payments as a share of total outstanding FmHA direct farm loan volume soared from just 3% in the 1970s to a high of 34% in fiscal 1989. A number of policies were undertaken during the late 1980s to address FmHA farm loan defaults and to forestall farm failures. Ultimately, the 1987 Act provided a comprehensive set of borrower rights and loan servicing procedures to restructure, write-down, or write-off delinquent FmHA loans in an orderly fashion (USDA/ERS, 1991).

The Food Security Act of 1985 (and the prior year's Congressional appropriations) placed greater emphasis on guaranteed lending as opposed to direct lending. The Federal Credit Reform Act of 1990 required all federal agencies to accurately measure the true costs of lending programs by budgeting for the expected net loss to the government during the year the loans are made or guaranteed. Prior to credit reform, the costs of loan defaults and guarantee claim payments were reflected in the budget years after loan disbursements and guarantee commitments had been made.

As a result of credit reform, funding for federal credit programs became more susceptible to budget constraints. This hastened the shift from the relatively more costly direct loan program to loan guarantees. As a consequence of the increased emphasis on guaranteed loans, direct loan obligations as a share of total obligations dropped from 98% in fiscal 1983 to 25% in fiscal 2004 (USDA/ERS, 2003; and FSA records).

With an improving farm economy at the end of the 1980s, new FmHA lending began to decline. In the 1990s, an emphasis was placed on servicing and liquidating loans made under the lending policies of the 1970s and 1980s. The Food, Agriculture, Conservation, and Trade Act of 1990 and the Federal Agriculture Improvement and Reform Act of 1996

placed emphasis on graduation of borrowers to conventional credit sources and narrowed certain eligibility rules to receive credit.

In 1994, administration of USDA farm loan programs was transferred to the newly created FSA. As a result of loan settlements, greater emphasis on graduation, and narrowing of eligibility criteria, direct program borrower cases[5] fell from over 455,000 in the mid-1980s to under 104,000 by the end of fiscal 2004. As more lending resources shifted to guaranteed lending, guarantee cases rose, but in recent years have remained at about 50,000 cases. With relatively stable lending authorities, FSA's presence in farm credit markets has continued to shrink since 1999, especially in direct lending which now accounts for just 3% of total farm debt.

While legislation in the late 1980s and 1990s refocused federal lending back on serving family farms, a special emphasis was placed on specific groups of individuals deemed as underserved by farm credit markets. The Agricultural Credit Act of 1987 required that annual agency lending authorities be set aside or targeted for use by socially disadvantaged (SDA) farmers. SDA farmers initially included farmers who may have been subject to racial or ethnic prejudice because of their identity as members of a group without regard to their individual qualities. Women were added to the SDA definition and the targeting requirements were applied to guaranteed loan programs by the Agricultural Credit Act of 1992. The 1992 Act also targeted agency lending to beginning farmers.

By fiscal 2004, approximately one-third of direct and guaranteed farm loan program obligation volume went to either SDA or beginning farmer applicants. As a percentage of total funds loaned, the direct farm ownership FO program was the most highly used program by SDA and beginning farmers. In fiscal 2004, 80% of direct FO obligation volume went to these two targeted groups.

Literature on FSA Farm Credit Programs

The north central regional research project NC-1014, "Agricultural and Rural Finance Markets in Transition," and its predecessors have a rich history of research related to FSA farm credit programs.[6] For instance, Dodson (2000) presented a regional analysis of FSA guaranteed and direct loans, problem loans, emergency loans, and guaranteed lenders. And more recently, Dodson and Koenig (2003) presented an analysis of the regional variations in the usage of FSA's farm loan programs.

The research reviewed in this section primarily draws from the proceedings of regional research projects for 1984–2004. The studies are grouped into three areas consistent with objectives of federal farm credit programs: minimize credit market failures, provide a farm financial safety net, and help underserved segments of farm credit markets. Research on state-sponsored credit programs is an additional area of study that has implications for federal farm credit programs, and is also reviewed here.

Credit Market Failures

Federal guarantees have been the primary instrument used by FSA to contend with credit market failures throughout the existence of NC-1014 and its predecessors. Herr (1991) was one of the first contributors at the regional research projects to study the implications of utilizing loan guarantees rather than

[5] The number of active cases overstates the number of borrowers since cases are duplicated when borrowers have loans under two or more different direct farm loan programs.

[6] In this section, FSA will be used to refer to FSA (1994–current) and/or FmHA (1946–1994) farm loan programs, depending on the time period of the study reviewed.

providing direct loans. Herr developed models incorporating lender and borrower behavior to contrast the credit market response to loan guarantees versus direct loans. He concluded that a continuation of the shift by FSA from direct to guaranteed loans would substantially constrain FSA's impacts on certain groups of borrowers because of structural differences between the programs. Based on the findings of Herr's analysis, converting FSA direct loan borrowers to the guaranteed loan program would likely be a slow process since many FSA direct borrowers would be unlikely to meet the profitability and risk standards of conventional creditors even with the presence of a guarantee.

Sullivan (1993) attempted to determine the effects of local bank market structure, as measured by competition and ownership characteristics, on borrowing costs for FSA guaranteed operating loans. Although increased financial market competition lowered farm loan interest rates, Sullivan concluded the overall impacts on borrowers were not large. No evidence was found suggesting local or non-local bank ownership affect borrower costs.

Sherrick (1993) developed a valuation model of loan guarantees which was used to compare the FSA and Illinois Farm Development Authority loan guarantee programs. He noted that the magnitude of the contingent liability generated by the guaranteed loan programs is potentially quite high. The analysis could be used to consider how various levels of initial collateral, fees, and subordinated ratio or guarantee percentage affect value.

Kalbus and Lee (1993) provided another study concerned with FSA loan guarantees. They surveyed commercial bank and FCS loan officers about their experiences with FSA loan guarantees and the Ohio Linked-Deposit Program. While both programs generated benefits, Kalbus and Lee found loan officer time commitment was high for FSA guarantees: 12 to 16 hours per borrower. They indicated the program could be improved by simplifying the application procedures, quickening the response time to applications, and lessening the loan servicing requirements.

Research from the regional projects was also concerned with lenders who used FSA loan guarantees. Koenig and Dodson (1998b) examined participation in FSA's guaranteed loan program by FCS. They found considerable variation in program use across and within FCS districts. FCS lenders who were smaller or had higher concentrations of lending risk were more likely to use loan guarantees.

Dixon, Ahrendsen, and McCollum (1999) identified factors associated with FSA loan guarantee use and loss claims among Arkansas commercial banks. The probability of banks using FSA guarantees was found to increase with higher shares of agricultural loans in their portfolio. The authors also found that the probability of banks using FSA guarantees increased with higher levels of farm income variability relative to mean farm income, suggesting guarantees were used to manage risk. Banks with FSA approved or certified lender status and banks with higher deposit concentrations in their county were more likely to use loan guarantees. Interestingly, approved or certified lender status was not related to loss claims activity. Loss claims on operating loans were more likely for banks in counties with higher proportions of farm revenue from crops.

Koenig and Sullivan (1993) studied the characteristics of FSA guaranteed loans in default and compared them with non-defaulting FSA loans. Their results suggested defaulting borrowers were more highly leveraged and had lower profit margins than non-defaulting borrowers. In addition, defaulting loans were concentrated regionally (Delta and Southern Plains), had less collateral, were larger in size, and had a higher guarantee rate than non-defaulting loans.[7]

[7] During the period analyzed by Koenig and Sullivan, FSA provided some guarantees of less than 90%.

Farm Financial Safety Net

Federal farm credit programs have traditionally been used to aid financially stressed farms, particularly during economic downturns and periods when losses are incurred from natural disasters (Koenig and Doye, 2001). Although most federal aid to farmers is transferred through other programs, farm loan subsidies delivered through FSA are still an important component of the farm financial safety net. Specific forms of the subsidy provided through federal credit programs, including loan losses and interest, were discussed by Lieblich (1985).

Dodson and Koenig (1999) examined the vulnerability of FSA's farm loan portfolio to an economic downturn. Although most FSA farm borrowers appeared resilient, many were still financially vulnerable. Those borrowers exhibiting greater vulnerability were wheat and barley farmers, borrowers with emergency loans, new borrowers, and those with large FSA loans. These groups were found to be less solvent than other groups, and therefore less likely to withstand a period of operating losses or a significant decline in real estate values, which would result in these borrowers becoming insolvent and FSA incurring loan losses.

Various farm loan programs have included interest subsidies, which are intended to allow more farmers to qualify for direct or guaranteed loans. One of these programs has been the interest assistance program for loans guaranteed by FSA. Ahrendsen et al. (2004) provided a descriptive analysis of interest assistance use at the borrower level for fiscal years 1985 through 2002. They noted differences in usage by geographic region, borrower type, lender type, interest rate differential, percent guarantee, and the status of the loan as to whether a loss claim was paid or the loan remained active. Koenig and Dodson (1998a) showed that interest rate subsidies were less effective in improving borrower income and financial performance when market interest rates were relatively low.

Due to high loan losses and interest subsidies in the form of below market interest rates, emergency EM loans have historically been a very costly component of FSA loan programs. Yet, there has been little research evaluating this program's effectiveness. Hughes and Lins (1990) simulated the interaction among federal crop insurance, disaster payment, and FSA emergency loan programs for a typical Illinois grain farm. The existence of emergency loans and disaster payments was commonly thought to be a strong deterrent to federal crop insurance participation by farmers. However, for the 1979–1988 period, their simulation results indicated that the net effect of emergency loans and disaster payments on the decision of whether or not to purchase crop insurance was minor.

Comparing nonfarm debt levels of FSA direct borrowers with consumer debt of all households in the United States, Dodson and Koenig (2004) concluded that while the nonfarm debt burden of FSA direct borrowers was relatively high, their nonfarm debt was not increasing as fast as consumer debt had increased for the average U.S. household since 2000. Although nonfarm debt levels for FSA direct borrowers appeared manageable, their ability to service nonfarm debt was heavily dependent on nonfarm income.

Helping Underserved Markets

Despite increased emphasis on guarantees, the FSA direct farm loan program remains an important credit source for some farm groups. Much of the funding for the program is targeted to help what are perceived to be underserved markets. For instance, FSA is required to target a portion of its direct (and guaranteed) operating and farm ownership loan funds for use exclusively by socially disadvantaged (SDA) applicants. FSA considers SDA applicants to include women, African Americans, American Indians, Alaskan Natives, Hispanics, Asians, and Pacific Islanders. Also, 35% of direct operating and 70% of direct farm ownership allocations are targeted to

beginning farmers. Beginning farmers are perhaps the most likely group of farmers to be denied credit from conventional creditors since they have little experience, no track record, and often little equity.

Dodson and Koenig (2002) examined regional variation in demand for FSA direct farm loan programs. Their results suggested counties with the highest level of demand for FSA loans are more likely to have fewer alternative lenders, greater farm financial leverage, lower per capita incomes, and higher concentrations of targeted populations including family-sized, beginning, and SDA farmers.

Mehdian et al. (1987) found the overall efficiency of southern Illinois cash grain farms with FSA debt was less than the overall efficiency of a peer group of farms with credit from conventional sources. This result implied the credit market was able to distinguish between efficient and inefficient farms in general. However, the authors noted that some FSA borrowers may have been efficient enough to have qualified for conventional credit while other FSA borrowers may have been so inefficient that the likelihood of their financial success was limited, even with subsidized credit.

Investigating the lender-borrower choice of farm credit by estimating binomial logit models, Dodson (1996) found strong evidence that FSA direct borrowers were less likely to obtain credit from conventional sources because of their limited equity. However, there was no evidence to support the hypothesis that FSA direct loan programs specifically serve young farmers. Many FSA borrowers were older farmers who had held their loans for many years.

The effectiveness of FSA programs in targeting annual lending resources to small family-sized farms, racial/ethnic minorities and women, and beginning farmers was assessed by Dodson and Koenig (2000). They concluded FSA was generally effective in targeting direct lending. New FSA direct operating loans and farm ownership loans were targeted to small family-sized farms. Racial/ethnic minorities were found to be highly reliant on FSA direct loans in many counties. Although women were the largest single SDA group, they were less reliant on FSA direct loans than other SDA groups. Dodson and Koenig offered possible explanations for this finding. For example, women farmers' financial and ownership structures may be different. In some instances, they may have acquired the farm after the death of their spouse.

In addition to targeting funding allocations for FSA's traditional direct farm loan programs to help underserved groups, FSA has special direct farm loan programs dedicated to beginning farmers as required by the Agricultural Credit Improvement Act of 1992. Ahrendsen et al. (1995) evaluated the effects of these beginning farmer loan programs on Arkansas and Texas representative farms using a simulation model. They reported that the assistance provided through FSA beginning farmer loan programs improved the financial performance of the simulated farms. However, the assistance may not have been necessary for an Arkansas broiler/cow-calf farm and may not have been enough for an Arkansas rice/soybean farm. For an eastern Texas cotton farm and a southern Texas corn/cotton/sorghum farm, the effectiveness of the FSA beginning farmer loan programs depended on nonfarm income levels and economic conditions.

More recently, Dodson (2003) studied the risk of issuing FSA guarantees on contract land sales to beginning farmers as called for by the Farm Security and Rural Investment Act of 2002. Under the proposal, FSA would be allowed to provide guarantees of land contracts and owner-financed mortgages or deeds of trust. Dodson concluded these guarantees would only enable a limited number of additional beginning farmers to acquire farmland. The losses associated with issuing land contract guarantees would likely be much greater than losses experienced in guaranteeing commercial lender loans

since farmers utilizing seller-financing had greater debt, less cash flow, less equity in real estate, and less solvency than farms utilizing regular FSA guarantees. However, Dodson found that guaranteeing the payment of one or two annual installments to the seller rather than guaranteeing the entire principal may reduce the risk of land contract guarantees such that the losses would not be notably greater than losses in the regular guarantee program.

State-Sponsored Farm Credit Programs

Many states also sponsor farm credit programs. Wallace, Erickson, and Mikesell (1994) surveyed state program managers to document and profile the various state-sponsored programs.[8] The survey responses indicated six reasons for providing farm credit programs:

1. assisting farmers through a period of extreme financial hardship;
2. making farmers eligible for additional financial credit assistance, possibly a bank loan or participation in a federal program;
3. assisting successful entry into farming by beginning farmers;
4. promoting innovation or diversity through new and nontraditional crops;
5. encouraging implementation of environmental technologies to comply with stricter land use requirements; and
6. strengthening a major agricultural subsector, particularly through incentives to modernize.

Wallace, Erickson, and Mikesell noted that the motivation for enactment of state-sponsored credit programs may be based on public opinions, economic conditions, and political realities. Several, although not all, of the reasons for state-sponsored farm credit programs are consistent with the objectives of FSA farm loan programs. Wallace, Erickson, and Mikesell found beginning farmer programs were among the most prevalent and most active of state-sponsored credit programs.

The existence of these programs and other state-sponsored credit programs may be an indicator of deficiencies in federal farm credit programs. Research on the successes as well as failures of state-sponsored programs may have important implications for changes to federal farm credit programs. Such research might also reveal if state-sponsored programs substitute, supplement, or complement federal programs.

Future Research on Federal Farm Credit Programs

From a broad policy perspective, research should provide policy makers and managers of federal credit programs with information which can be used to improve credit market efficiency. To be economically justified, credit programs should address market failures. But, recent advances in information technology, changes in financial markets, and structural changes in farming may have reduced market imperfections.

Future research should consider how these ongoing changes affect the role of federal credit programs in agriculture. Cost-effectiveness requires that credit programs should utilize the best available information. As a result of recent advancements in information technology, the task of analyzing statistical trends in lending is more easily accomplished than ever before. Future researchers will have a greater ability to provide policy makers with information that can increase the benefits and lower the costs associated with federal farm credit programs.

[8] A description and listing of farm credit programs sponsored by states is available online at http://www.stateagfinance.org/types.html (accessed August 28, 2005).

Impacts of Structural Changes on Farm Credit Markets and the Need for Federal Farm Credit Programs

Structural changes in farm credit markets have occurred because of advances in information technology, deregulation of financial markets, and adjustments in the farm sector. The impacts of these structural changes call into question the future direction and need for federal farm credit programs.

Advances in Information Technology

Technological advances have significantly reduced the cost of processing loan applications by facilitating the gathering and processing of information and lowering of transaction costs. As is the case with most nonfarm lenders, farm lenders now have access to large databases, powerful computers, and sophisticated analytical models. These advancements enable lenders to evaluate lending risk more objectively and accurately.

Improvements in market performance resulting from technological innovation, however, may not be uniform across all borrower groups or regions. The benefits of information technology tend to be greatest among homogeneous borrowers with standard characteristics. Credit scoring, for example, is widely used for home and consumer loans, but its application in agriculture has been limited. While advances in information technology may be expected to increase credit availability among more creditworthy applicants, there are concerns that higher risk borrowers will be more likely to be denied (Executive Office of the President, 2005, p. 86).

A better understanding of how lenders may use information technology to expand and filter their customer base is required. Further research is needed on the impacts of information technology, such as credit scoring, on private lenders' abilities to serve groups that may have traditionally been served by federal farm credit programs.

Financial Deregulation

Deregulation, resulting from the Riegle-Neal Interstate Banking and Branching Act of 1997 and the Financial Services Modernization Act of 1999, has increased competition by removing geographic and industry barriers. Historically, geographic restrictions have been a major barrier that limited competition in the banking sector, especially in rural areas. The Riegle-Neal Act removed geographic restrictions, allowing many financial institutions to offer services nationwide. The Financial Services Modernization Act, combined with advanced communications and information processing technology, has enabled nonbank financial institutions to become more important sources of credit. Consequently, internet-based financial intermediaries have further reduced the importance of physical location (Executive Office of the President, 2005, p. 86). These developments should increase credit availability among all farmers, especially those in more remote regions.

While deregulation has hastened the consolidation of banking institutions, the number of banking offices or branches in rural regions has increased since the 1980s (Kilkenny and Jolly, 2005). Still, Kilkenny and Jolly suggest that an apparent absence of lenders in many rural areas indicates there is additional room for competition in some rural markets.

The impact of bank consolidation on bank loan portfolios was found by Ahrendsen, Dixon, and Lee (1999) to depend to a large extent on the lending philosophy of the acquiring bank, such that a consolidated bank may deemphasize farm loans at the acquired bank. Therefore, competition for farm loans may actually decrease in a local market following bank consolidation and the demand for federal credit programs may increase.

Future research should develop a better definition and measure of competition. For instance, previous studies have measured bank competition based on the number and deposit shares of banks in a

given region. However, the mere presence of a bank or the ability of a bank to competitively attract deposits does not necessarily mean it is active in making farm loans.

Related to this issue, future research should seek to provide a better understanding of how deregulation has affected the competitiveness of local farm loan markets. Is there any evidence that the expansion of bank offices in rural regions has affected either credit availability or lending terms for farmers? Future research should also seek to explain the apparent absence of lenders in some rural areas. While past studies have documented the growth in lending by nonbank financial institutions, little is known about their lending practices. Research is needed to address how the presence of these nontraditional lenders affects farm credit availability among borrower groups who traditionally have been served by federal farm credit programs.

Structural Changes in Agriculture

Farming has undergone significant structural change. Commercial farms are becoming fewer and more complex. The farm customer base is changing profoundly in terms of the traditional domain and boundaries with respect to geography, line of business, product/service needs, business model, asset control, and utilization and buying behavior (Boehlje and Gray, 2005).

Alliances, contractual relationships, joint ventures, and interlocking ownership arrangements are becoming increasingly common among commercial farms (Klinefelter and Penson, 2005). Evaluating the creditworthiness of these complex organizations will require a level of technical expertise not possessed by some rural lenders. A combination of unique characteristics and geographic isolation may result in some larger commercial farms facing less competitive credit conditions.

Meanwhile, small farms remain a very prevalent component of the rural landscape. Small farms increasingly are hobby or lifestyle type farms characterized by a reliance on nonfarm income and large investment in the farm residence. Their credit needs are more consumer-like in nature. Many lenders appear to be serving these farms. For example, the largest FCS association, FCS of Mid-America, currently offers a product targeted to part-time farmers entitled "Country Line," which provides a flexible line of credit for amounts as little as $10,000. Consequently, small farms which may have once been considered underserved may now have ample access to credit while complex commercial farms may have a greater need for federal credit programs.

Unlike commercial farm lenders, FSA farm loan programs are more limited in their ability to deliver credit products that meet the needs of specific farm businesses in a timely fashion. This is largely a function of statute and regulatory issues. For example, commercial farm lenders commonly advance monies for farm operating expenses through lines of credit designed to meet specific producer needs, whereas FSA is more limited in its ability to provide such flexible loan contracts. Possible future research topics could address how the ongoing structural changes in agriculture and credit usage may affect the need for federal credit assistance and the types of credit products necessary to meet those needs.

Impacts of Federal Farm Credit Programs on Economic Efficiency

For a credit program to improve overall economic efficiency, benefits must exceed costs. This partially depends on the ability of program managers to identify borrowers most likely to benefit from federal credit programs. Economic efficiency also depends on the ability to minimize the subsidy, administrative, and indirect costs associated with program delivery. For policy makers or program managers to adequately evaluate and improve a program's economic efficiency, reliable

information is needed on the benefits and costs associated with FSA's direct and guaranteed farm loan programs.

Benefits

Determining whether federal credit programs reach the intended populations and whether they have any impacts on a farmer's financial well-being represents a potential research area. For example, longitudinal studies comparing the long-term financial performance of federal farm credit program borrowers with cohorts of similar farmers who did not receive direct or guaranteed loans would provide indications of program benefits. Does the provision of federal credit appear to have any effect on the targeted farmer's ability to remain in farming, or the ability to grow the farm business?

Subsidy Costs

The two largest components of subsidy costs in federal farm credit programs arise from loan losses and interest subsidies. Reducing loan losses is an important tool for increasing a credit program's economic efficiency although, perhaps, at the expense of serving farmers least likely to get credit elsewhere. Further research identifying factors influencing loan losses and defaults for FSA direct and guaranteed loan programs could enable FSA farm loan managers to better manage credit risk and hence improve program performance.

Interest subsidies can represent a large portion of the total subsidy cost of a government loan program. In recent years, interest rate subsidies have represented as much as 75% of the total subsidy for guaranteed loans. The high cost of interest rate subsidies makes it difficult for federal credit programs to be economically efficient. An improved understanding of the effect of these subsidies on the long-term financial viability of recipients is needed. For instance, do interest subsidies significantly increase the likelihood of farmers successfully repaying their loans?

Indirect Costs

Some aspects of federal credit programs can create distortions, thereby reducing overall economic efficiency. More research is needed as to the externalities and market distortions created through federal farm credit programs. Federal credit programs that have little to do with market imperfections may be counterproductive or ineffective. Since the federal government is unlikely to have any cost advantages in lending, any substitution of federal lending for conventional lending would decrease economic efficiency. Moreover, the easy credit terms associated with federal credit programs can result in capital overinvestment and overuse of credit by individual firms which, in turn, can result in higher input prices. Future research, for example, could give consideration to the impact of credit terms and availability on land and machinery markets. And finally, do federal credit programs result in any displacement of conventional lending?

Administrative Costs

Administrative or delivery costs are represented primarily by the salaries and other overhead expenses associated with making and servicing direct and guaranteed loans. Specific research of alternative delivery mechanisms could provide program managers and policy makers helpful information with which to increase economic efficiency by lowering administrative costs.

The administrative cost associated with guaranteed lending is much lower than for direct lending, thus making the guaranteed delivery system more attractive as public resources become scarce. As a result, direct lending has been mostly limited to serving specific groups, such as beginning or socially disadvantaged farmers. However, direct subsidies, such as grants, are generally considered more effective and less distortional than direct loans for purposes of assisting such groups (Executive Office of the President, 2005).

Further research could consider the economic trade-offs between direct grants and direct loans. For example, could FSA achieve the same impact by providing smaller one-time grants rather than direct loans?

FSA currently delivers credit to farmers through 2,400 FSA county offices located in 50 states. While it may be possible to design a delivery network that reduces costs, little is known about the spatial relationship between lenders and borrowers. Further research could examine the importance of proximity between the lender and borrower in delivery of federal farm credit programs.

Concluding Comments

Federal credit programs attempt to resolve imperfections in credit markets and address concerns about social inequities. FSA operates direct and guaranteed loan programs to address these objectives for the farm sector. FSA's guaranteed farm loan program is focused on resolving imperfections in credit markets that may exist because of information asymmetries and imperfect competition. FSA's direct farm loan program annual lending authority is more focused on addressing concerns of social inequities, and hence a higher share of this lending serves to redistribute resources from taxpayers to groups deemed to be disadvantaged, such as beginning and socially disadvantaged farmers.

Structural changes in agricultural production and advances in financial credit markets have called into question the role the federal government should play in the future and the direction federal farm credit programs should take. As agricultural production has consolidated in the hands of fewer and larger producers, the government's traditional role in overcoming information asymmetries associated with large numbers of small producers and resolving imperfections in local and regional credit markets may have become less important. Technology advances in lending and structural changes in credit markets have and will continue to influence the need and role for federally subsidized farm credit. Research is needed to evaluate the effects of these changes on the traditional role of FSA. Research is also needed to evaluate if farmers who have previously been served by conventional creditors are no longer being served as structural adjustments in farming and credit markets continue to occur.

Ongoing federal farm credit programs represent a substantial cost to the U.S. government, with delivery and subsidy costs totaling over $5 billion for loans made during the 13 fiscal years ending in 2004. Although some research has been conducted on loan loss and interest subsidy costs, more focus is needed on ways for federal farm credit programs to serve their objectives while minimizing administrative and subsidy costs. Also, additional research on the indirect costs from the effects of federal programs on private capital markets is important. Finally, research exploring the benefits of federal farm credit programs is a vital area for study. This collective area of research will serve in the future evaluation of the economic efficiency of federal farm credit programs.

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Structure, Performance, and Risk Management of Financial Institutions

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Abstract

The performance, management, and risk exposure of financial institutions operating in rural and agricultural markets determine the cost of agriculture's ongoing access to financial capital. The evolution of general banking and agricultural finance research contributions in the structure, performance, and risk management of financial institutions lending to agriculture and providing financing to rural markets is described and discussed in this paper. A summary of future research priorities in each of these areas is also provided. Ongoing regulatory change, institution consolidation, financial innovations, and the changes occurring in the agricultural sector drive research opportunities in this area. Ongoing research will be critical to maintain efficient rural financial markets that can provide consistent and competitively priced credit for rural America.

Key words: Basel II, consolidation, economies of scale, economies of scope, inefficiency, regulation, risk management, risk measurement

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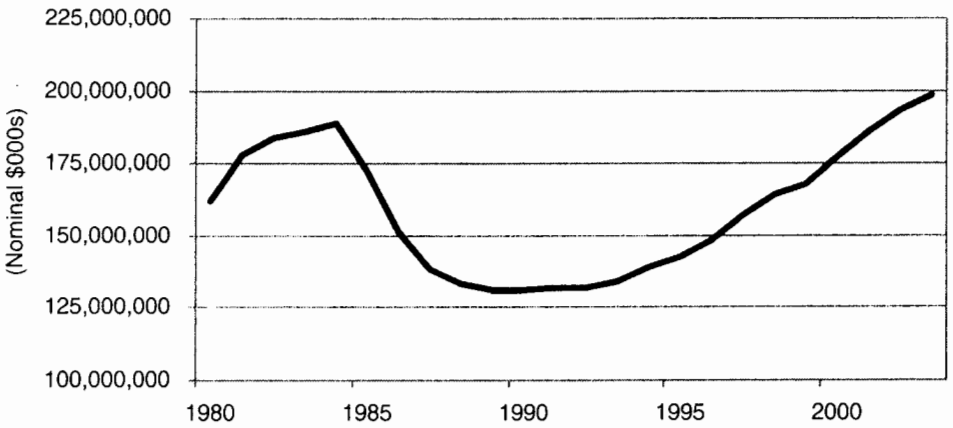
Agricultural financing operates within a competitive global network of integrated national, regional, and local financial markets. The performance, management, and risk measurement of the institutions operating in these markets determine the cost of agriculture's ongoing access to financial capital. In 2005, total farm debt was expected to exceed $213 billion (Figure 1) and will continue to be a critical factor for agricultural producers.

In the past, major drivers of historical change have included market regulation, competition, technology, financial innovation, and changing structure of agriculture. Thus, understanding the trends, historical context, and operational relationships of these drivers will provide a foundation and landscape for future research and ongoing policy implications.

The scope of this review primarily considers theoretical and applied research addressing institutions financing agricultural and rural financial markets. The genesis of the underlying theories and methods often originates in the general banking literature. This paper reviews the evolution of general banking and agricultural finance research contributions in the structure, performance, and risk management of financial institutions lending to agriculture and providing financing to rural markets. Reviews of credit risk management and particular studies relating to public credit agricultural lending programs are not a specific focus of this study. Explicit reviews of the prior research in these two areas are provided elsewhere in this journal issue by Gustafson, Pederson, and Gloy (pp. 201–217), and by Ahrendsen et al. (pp. 165–181).



Source: USDA/Economic Research Service (2003).

Figure 1. U.S. Farm Debt, 1980–2003

This paper is separated into a brief chronology of the regulatory changes that have occurred over the past 25 years and a review of historical research across the following three areas: (*a*) structure and competition in rural financial markets, (*b*) performance of financial institutions, and (*c*) risk management of financial institutions. Finally, a summary of future research priorities in each of these areas is provided.

Regulatory Environment

Much of the research regarding financial institutions was precipitated by policy changes or potential regulation changes within rural market financial institutions. The context and timing of this research can be better understood by first summarizing the major regulatory events. Table 1 provides a brief chronology of the key historic regulations that motivated much of the research reviewed in this paper.

As observed from Table 1, the history of regulatory change can be broadly grouped into four categories: (*a*) responses to institutional stress conditions (Agricultural Credit Act of 1987, Financial Institutions Reform, Recovery, and Enforcement Act of 1989); (*b*) geographical expansion regulations (Community Reinvestment Act of 1977, Riegle-Neal Act of 1994); (*c*) product authorities expansion (Farmer Mac, DIDMCA, Gramm-Leach-Bliley Act of 1999, Federal Home Loan Bank), and (*d*) risk management regulations (Basel I and II, Farmer Mac, Farm Credit System Insurance Corporation). The body of research reviewed in subsequent sections is largely based on work used to aid policy discussions or prepare a response to these regulatory changes.

Structure and Competition in Rural Financial Markets

Changes in market shares of the major institutions providing debt capital to the agricultural sector are shown in Figure 2. The major shift in structure occurred in the 1980s shortly after the major financial stress period in agriculture when commercial banks increased their emphasis on farm real estate lending. The commercial banking industry and Farm Credit System (FCS) both underwent considerable consolidation. Figure 3 depicts the reduction in the number of institutions. The number of Farm Credit System institutions decreased nearly 90% from 1980 to 2005, while commercial and

Table 1. Historic Chronology of Significant Regulations Impacting Rural Financial Markets

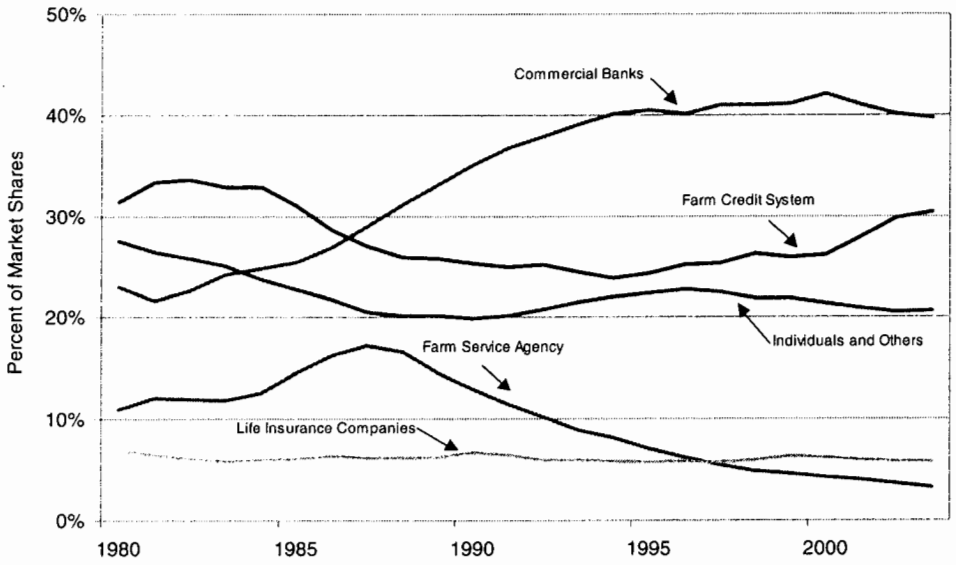
1977	The Community Reinvestment Act: Enacted to encourage depository institutions to help meet the credit needs of the communities in which they operate.
1980	Depository Institutions Deregulation and Monetary Control Act of 1980 (DIDMCA): Among other items, begins phase-out of interest rate ceilings on deposits and raises deposit insurance ceiling to $100,000.
1987	Agricultural Credit Act of 1987: To alleviate stress in the Farm Credit System, $4 billion of U.S. Treasury-guaranteed bonds were authorized by Congress, of which $1.26 billion is issued to aid restructuring.
1988	Farm Credit System Financial Assistance Corporation (FCSIC) created by the Agricultural Credit Act of 1987; chartered in 1988.
1988	Farmer Mac established by the Agricultural Credit Act of 1987.
1988	Basel I issues the original international bank capital accord that established international consistency of capital regulations.
1989	Financial Institutions Reform, Recovery, and Enforcement Act of 1989 (FIRREA): Intended to restore the public's confidence in the savings and loan industry.
1990	Farmer Mac authorized to act as a Certified Facility with respect to Guaranteed Portions of USDA guaranteed loans.
1991	Amendments required FCA to develop and issue a risk-based capital stress test for Farmer Mac that would establish regulatory capital requirements.
1993	FCSIC fully operational; Farm Credit System develops specific schedule to repay assistance.
1994	Riegle-Neal Interstate Banking and Branching Efficiency Act: Permits adequately capitalized banks in any state; in 1997, allows interstate mergers between adequately capitalized and managed institutions.
1996	Amendments authorize Farmer Mac to guarantee securities without a subordinated interest, and to purchase agricultural real estate and rural housing loans directly, as a pooler.
1999	Gramm-Leach-Bliley Act passed. Community Reinvestment Act modified. Includes provisions to allow for affiliations among banks, securities underwriters, and insurance underwriters. Also expanded collateral that members of Federal Home Loan Banks could use in obtaining an advance. In addition to traditional mortgage loans, banks can now put up rural, agricultural, and small business loans as advance collateral.
2004	Central bank governors endorse the publication of Basel II, an updated capital adequacy framework for international banks.

agricultural banks declined 47% and 59%, respectively.[1]

A similar restructuring took place within other agricultural funding sources, such as life insurance companies and the Farm Service Agency (FSA). The number of life insurance companies providing farm mortgage loans fell from twelve in the 1980s, to seven in 1995, and then to six in 1996, while their amount of debt held declined from $12.9 billion to roughly $9.6 billion [Stam, Koenig, and Wallace, 1995; U.S. Department of Agriculture/ Economic Research Service (USDA/ERS), 2002]. The life insurance companies still active in the lending market generally provide large agribusiness, timber, and specialty enterprise loans rather than small or medium sized farm mortgages.

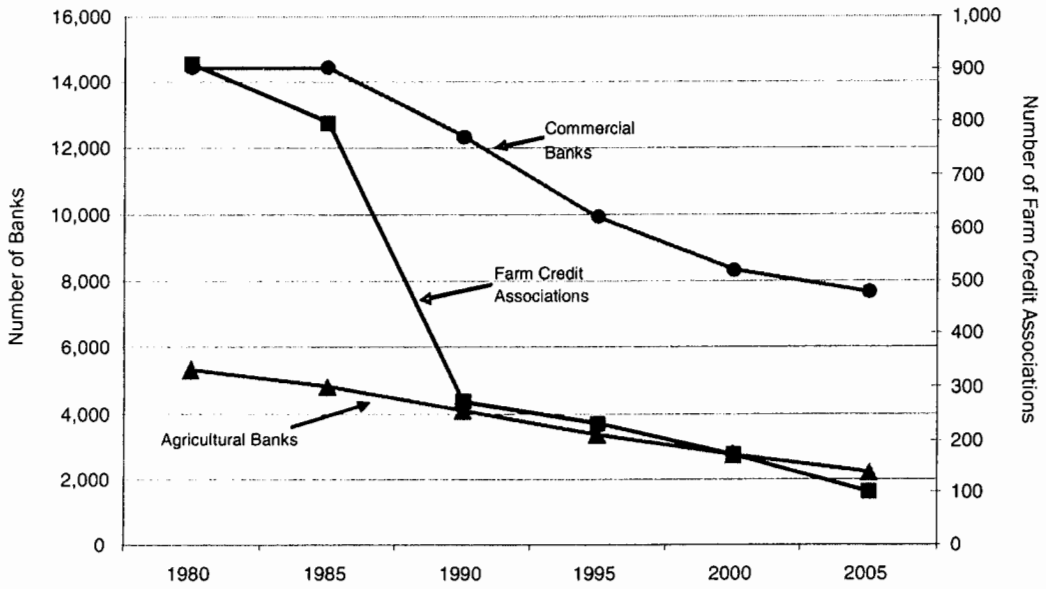
The FSA has been an important credit source for farmers who are unable to obtain commercial credit, providing direct and guaranteed loans to this group; however, market share of total farm debt for FSA has also declined since the late 1980s. In 2002, FSA supplied less than 4% of total farm credit through its direct farm programs and less than 4% through its guaranteed farm loans (USDA/ERS, 2002).

[1] Agricultural banks are defined as banks with agricultural loans to total loans exceeding the unweighted average of all commercial banks in a specific year.



Source: USDA/Economic Research Service (2003).

Figure 2. Market Shares of Total Farm Debt, 1980–2003



Sources: USDA/Economic Research Service (2005), FDIC, Farm Credit Administration.

Note: Agricultural banks are defined as banks with agricultural loans to total loans exceeding the unweighted average of all commercial banks in a specific year.

Figure 3. Number of Commercial Banks and Farm Credit Associations, 1980–2005

Banking Literature on Structure-Conduct-Performance

The literature on bank market structure is extensive. Market structure studies have applied what is known as the *structure-performance hypothesis* to the banking industry. Within this construct, there are two distinctive views for the structure-performance relationship—the *market power hypothesis* and the *efficient structure (ES) hypothesis*. The market power hypothesis can be further separated into the traditional *structure-conduct-performance (SCP) hypothesis* and *relative market power (RMP) hypothesis*.

The SCP hypothesis views market structure as the primary determinant of the conduct and performance of banks operating in that market. The notion assumes that the higher the market concentration, the greater the possibility firms in the market are involved in effective collusion. As a result, price setting tends to favor the consumer less, which leads to lower deposit rates or higher loan rates. The general conclusion of the SCP hypothesis posits that structure is an important determinant of performance, and consequently, increases in concentration lead to higher loan rates, a reduction in service, and higher bank profits. Conversely, policies leading to a de-concentration of markets will bring lower prices for financial service, less monopoly rent, and little or no loss in productive efficiency. The SCP relationship has been tested empirically by estimating measures of bank performance as functions of the local market concentration and other hypothesized variables (Pozdena, 1986; Clark, 1988; Berger and Hannan, 1989; Hannan, 1991).

A comprehensive review of bank market structure and performance until the mid-1980s can be found in Gilbert (1984). This text reviews 44 empirical studies that tested the influence of market structure on depository institutions' performance measures between the 1960s and 1980s. Gilbert concludes that the results do not consistently support or reject the SCP hypothesis. He criticizes the structure-performance literature, questioning its inappropriate theoretical framework and methodological problems. Even though a significant structure-performance relationship does appear, it is not clear whether the relationship results from the collusive behavior of banks—the critical assumption on which current U.S. banking antitrust policy rests.

The RMP hypothesis asserts that only firms with large market shares and well-differentiated products are able to exercise market power in pricing these products and still earn higher profits. The positive coefficient estimate for market share and an insignificant coefficient for concentration justify acceptance of RMP (Shepherd, 1986; Rhoades, 1985).

The ES hypothesis suggests that firms' performance determines market structure, i.e., efficient firms increase in size and market share because they have the ability to generate higher profits, which usually lead to higher market concentration. Thus, the positive relationship between profits and concentration is explained by lower costs achieved by superior efficiency. Empirical studies of the ES hypothesis have sought to capture firm-specific efficiency by employing a market share variable. The hypothesis is validated if bank performance depends on market share regardless of the degree of concentration in the market (Demsetz, 1973; Smirlock, Gilligan, and Marshall, 1984; Smirlock, 1985; Smirlock and Brown, 1986; Whalen, 1987; Jackson, 1992).

General bank industry research has evolved considerably from the mid-1980s through the present. Berger et al. (2004) review 112 articles to provide a synopsis of the changes in literature on concentration and competition. They conclude that the literature has tested several models of competition, the measures of conduct and performance have expanded, more dynamic analyses have been performed, and research has expanded toward a more international orientation which now includes developing countries.

Berger et al. cite other work in a special issue of the *Journal of Money, Credit, and Banking* that contributes to the literature by examining the impact of bank concentration, regulation, ownership, and institutional development on financial stability, net interest margins, and access to financing. Much of this work contains international components, including developing countries and cross-country issues, and it offers new measures of competition. Berger et al. conclude the more recent research illustrates the general principle that different types and structures of banks are affecting the competitive conditions of delivery of banking services.

Concentration Issues: Agricultural Lenders

As noted in the previous section, the general banking literature provides little evidence to support the assumption that concentration induces collusion and generates monopoly rents in concentrated markets. However, many of these studies do not explicitly include rural markets which tend to be quite concentrated.

The Herfindahl-Hirshman Index (HHI) is a frequently used concentration measure employed by academics and the Department of Justice. It is computed by taking the market shares of deposits for each firm in a market, squaring each, and then summing the squared shares. The Department of Justice defines a concentrated market as having an HHI greater than 1,800. Barry and Ellinger (1997) report that the average HHI for completely rural counties exceeds 5,000. Price discrimination and distance barriers to entry in rural markets may result in less than optimal levels of credit extended in rural areas (Kilkenny and Jolly, 2005). Rural-based financial institutions may be able to price-discriminate without losing their rural customers, because other lenders are effectively too far away (Degryse and Ongena, 2005).

Collender and Shaffer (2003) posit small, local banks behave differently from larger and nonlocal banks due to superior access to local information, greater commitment to local prosperity, and differences in technology or risk management related to bank size. Moreover, in noncompetitive geographic markets, local banks may behave differently both because they have some protection from competition and because their lending options are limited. The authors' research suggests farming-dependent county income growth is sensitive to local bank firm concentration. They also suggest agricultural credit demands may crowd out nonfarm demands for bank loans in farming-dependent counties. For other rural counties, however, the empirical results showed mergers or acquisitions of local banks by nonlocal banks did not necessarily impair local economic growth and at times provided benefits to local rural markets.

Consolidation Issues: Agricultural Lenders

Consolidation has initiated and necessitated many changes in banking over the last 25 years. Possible positive effects of consolidation include increases in operating efficiencies; geographic and product risk diversification; and the availability of new customer products, features, capabilities, and alternative delivery systems. A central concern regarding consolidation of agricultural lenders is the impact on the flow of funds to or away from farmers and others in the sector (Levonian, 1996). An additional important concern is whether credit gaps will result from institutions that are disinterested in agriculture or specific segments of agricultural borrowers. Another consolidation issue relates to the historical value of lending relationships in agricultural lending and the impact consolidation has on maintaining these relationships.

The first large wave of banking consolidations occurred from 1987–1994 (LaDue and Duncan, 1996). LaDue and

Duncan argue that the long-term effects of banking consolidation may be different than the short-term effects due to the impact of the "treatment cycle" for acquired banks. Agricultural banks consolidated at approximately the same pace as commercial banks, but rural banks acquired during this period tended to have lower proportions of agricultural loans to total loans. This trend suggests agricultural-oriented banks were not initial merger targets (Neff and Ellinger, 1996; Ellinger, 1994).

Using the same panel data, Featherstone (1996) observes that the share of agricultural loans at acquired banks did not decrease after acquisition. Further, banks with greater percentages of agricultural loans tended to be acquired by banks with larger percentages of agricultural loans. These results do not imply short-run concerns for farm credit availability; however, they fail to measure long-term impacts resulting from changes in the economy and management shifts requiring long-run lending priority adjustments.

Barry and Pepper (1985) report a positive relationship between bank holding company (BHC) affiliation and the loan-to-deposit ratio using a sample of rural banks. A study by Gilbert and Belongia (1988) focuses on diversification and agricultural lending. Using a paired sample of affiliated and independent banks in a 10-state region, the authors found a negative relationship between holding company affiliation and the agricultural loan ratio for rural banks. The results of their study are confirmed and generalized to a broader sample of banks by Laderman, Schmidt, and Zimmerman (1991). Both of these studies support the supposition that banks, through mergers or regulatory freedom, alter asset mixes to reduce risks.

Based on findings by Ahrendsen, Dixon, and Lee (1999), if the acquiring bank has a larger concentration of assets in agriculture than the acquired bank, acquisition has a positive impact on agricultural lending. Because most acquiring banks have smaller agricultural loan concentrations than acquired banks, the authors also conclude other lenders are likely to fill credit gaps that develop.

Lence (1997) provides a review of the structural development in commercial banking from 1980 through the mid-1990s. He summarizes the changes into the following eight major structural categories/patterns: (*a*) steady consolidation; (*b*) reduction in the total number of banks; (*c*) mergers accounting for most of the reduction in total bank number; (*d*) most (but not all) mergers involving larger banking organizations acquiring small banks; (*e*) a decline in the number of banking organizations due to the disappearance of independent banks; (*f*) an increase in the number of bank holding companies due to an increase in the number of bank holding companies that control only one bank; (*g*) large increases in branch, office, and ATM numbers; and (*h*) greater national concentration but not greater local market concentration.

Lence further discusses these changes, examining explanations of economic forces and government action, as well as their effects on financial intermediaries, borrowers, depositors, taxpayers, and economic activity as found in the literature. Regarding empirical work through the mid-1990s, Lence concludes that the areas of bank efficiency, market power, and portfolio diversification have been studied thoroughly and with generally consistent results. Finally, he suggests that research in other areas (managerial incentives to increase banking organization size, effects of recent changes in banking structure on taxpayers, government actions as causes of structural changes) could make notable contributions.

Small banks tend to lend proportionally more to small enterprises in agricultural and nonagricultural markets. However, some general studies report reduced small business lending following merger and

acquisition activities (Berger, Goldberg, and White, 2001). The changing structure of banking and new credit delivery technologies expose the importance of relationship lending in agriculture. Relationship lending is a key issue in agricultural lending, especially for traditional family-size farm operations.

Barry, Ellinger, and Moss (1997) observe an inverse relationship between competition and borrower loyalty. Evaluating bank characteristics against lending terms, Bard, Barry, and Ellinger (2000) found little evidence about bank consolidation's impact on agricultural lending. Akhavein, Goldberg, and White (2004) report that relationships, as measured by the length of tenure of farm operators, are positively related to lending, and de-novo banks tend to lend to small farms. However, the tenure of the farm operator and farm income variables are aggregated at the state level. Use of more disaggregated data could help clarify these findings.

Consolidation Issues: Farm Credit Services

Freshwater (1996) provides a discussion of issues related to competition, function, governance, structure, and consolidation for the Farm Credit System. He describes a diminishing market and new forms of competition from non-conventional sources of credit. Freshwater notes that as competition increases, customer loyalty becomes more critical to success. If customer loyalty is sufficient for success, then the Farm Credit System may be able to differentiate its services enough to remain competitive. Consolidation has provided competitive benefits for the Farm Credit System. Freshwater concludes that effective borrower/owner governance, effective management of inter-unit competition, and service within parts of rural America which have limited credit access will help the Farm Credit System preserve its Government-Sponsored Enterprise (GSE) status.

In the summer of 2004, Rabobank made an unprecedented offer to purchase the Farm Credit Services of America (FCSA) Association. The directors stated the primary benefits of the deal included: (*a*) a broader set of financial products and services, (*b*) a competitive cost of funds, (*c*) a cash payout, and (*d*) an opportunity to serve a broader range of households and businesses.

The concerns of opponents to this purchase offer included: (*a*) most of the proposed services were similar to FCSA; (*b*) patronage programs could be augmented to share in the cash earnings; (*c*) the cash offer was too low; (*d*) a territorial gap would result in the exit of an association; (*e*) other associations could follow and create a large disruption in the Farm Credit System and ultimately, rural financial markets; (*f*) Rabobank may not be committed to agriculture; and (*g*) loss of local control of the Association would occur (Jolly and Roe, 2005). Although the Rabobank offer was not accepted, it raised many concerns about the motivations for the transaction, the equitability of the purchase price, the role of unallocated retained earnings (UREs) at FCS associations, and whether a sale of a Government-Sponsored Enterprise is in the public interest (Barry, 2004).

Efficiency and Performance of Financial Institutions

The changing structure of agricultural lenders has initiated additional studies on the scale, scope, and inefficiencies present among FCS and banking institutions. Numerous banking studies on scale and scope were performed in the early 1980s. Clark (1988) reviews previous studies measuring economies of scale and scope for commercial banks, credit unions, and savings associations. While overall economies of scale exist at low levels of input, Clark notes there is inconsistent evidence of economies of scope and minimal evidence of cost complementarities.

Featherstone and Moss (1994) estimate a cost function and three input demand equations with and without imposing curvature using data for agricultural banks. Their results are consistent with Clark's (1988) conclusion that economies of scale are exhausted at $60 million, and economies of scope do not exist.

Since studies such as those cited above indicated that economies of scale would become exhausted at lower levels of input/output, efforts to measure production efficiency across different institutional demographics accelerated. The special edition of the *Journal of Banking and Finance* (1993) offers a comprehensive review of inefficiency research on financial intermediaries.

In addition, Ellinger and Neff (1993) provide a review of issues and approaches in inefficiency analysis of agricultural banks. The dimensions addressed in their study include: (*a*) estimation approach—parametric vs. nonparametric, (*b*) data sources, (*c*) cost or profit frontiers, and (*d*) bank output and input definitions. These issues were found to substantially impact the resulting inefficiency measures.

Using seemingly unrelated regression, Zhu, Ellinger, and Shumway (1995) estimate the environmental variables impacting inefficiency. Their results show that effects on input and output inefficiency measures lack consistency across all measures of bank inefficiency. While increasing bank size, profitability, and holding company affiliation are related to total inefficiency, the impact on input or output inefficiency is inconsistent.

Chein, Leatham, and Ellinger (1994) estimate scale economies and cost efficiencies for Farm Credit direct lending associations using a stochastic frontier approach with panel data from 1988–92. Their findings reveal that Production Credit Associations (PCAs) and Federal Land Credit Associations (FLCAs) show larger scale economies than Agricultural Credit Associations (ACAs), suggesting the ACA would benefit from restructure. (Most FCS direct lenders in 2005 are ACAs.) Chein, Leatham, and Ellinger found no consistent evidence of cost efficiencies by size.

Risk Management of Financial Institutions

Agricultural lenders' ability to utilize financial innovations for risk management plays a large role in determining sustainability and competitiveness in agricultural financial markets. Advancements in credit risk management and measurement at the loan and portfolio levels have received considerable attention and are discussed in a separate paper in this journal issue (see Gustafson, Pederson, and Gloy, pp. 201-217). Interest rate, liquidity, and funding risks facing agricultural lenders generally reflect changes that have occurred in the regulatory environment and economic arena. Previous agricultural finance research has explored how lenders manage and measure these risks. Additionally, interest rate, liquidity, and funding risks likely exert significant influence on capital adequacy, and as such, they will continue to play an important role in the profitability and performance of agricultural lenders and in research.

Funding and Liquidity Risks

The supply of loanable funds at community banks has been impacted by the changing structure of agriculture and the declining number of rural customers—a critical source of deposits. Dis-investment of bank deposit funds into higher return stock and mutual funds in the 1990s also depleted the supply of loanable funds. Electronic fund transfers, automated teller machines, online banking services, and other technological advances have reduced the necessity for local depository functions and increased competition and funding costs. Changes in the source and cost of funds may increase a bank's exposure to interest rate and liquidity risks.

Community banks' dependency on local markets can act as both a strength and a weakness over a bank's business cycle. Consequently, reliable access to nonlocal sources of funds is absolutely critical. The Seasonal Borrowing Program at the Federal Reserve is rated by Barry and Ellinger (1997) as one of the important historical tools available for commercial banks to manage liquidity. Numerous initiatives in the past have permitted banks access to GSEs in various forms, yet Barry and Ellinger note that banks have only partially utilized these services historically. Currently, the Federal Home Loan Bank (FHLB) and Farmer Mac provide GSE access to community banks. While banks have made only moderate use of Farmer Mac, FHLB use has increased, though it is not clear if there has been a resulting increase in capital flows to agriculture.

The Enterprise Resource Bank Act of 1996 has helped improve access to funds for commercial banks because it has (*a*) relaxed the membership eligibility conditions for advances from the FHLB Board, (*b*) broadened the collateral requirements on advances, and (*c*) lifted the 30% cap on advances by FHLBs to commercial banks.[2] As observed by Dolan and Collender (2001), since direct access to financial markets is associated with high fixed costs, advances from FHLBs are attractive to small banks. Furthermore, FHLBs are aware that their advances are an attractive alternative to Farmer Mac funds because of the restriction imposed by the Farmer Mac securitization program. In addition, because small banks must compete for FCS funding with farm associations that own FCS banks, FHLB advances become an even more attractive alternative. Dolan and Collender found that larger banks and banks affiliated with a bank holding company borrow from FHLBs, as well as banks with higher interest rate and liquidity risk and lower credit risk.

[2] The FHLBs are Government-Sponsored Enterprises (GSEs) and sell consolidated agency securities in the financial markets, with essentially the same pricing arrangements as securities sold by the Farm Credit Banks. To receive advances, commercial banks must become members of the FHLB by purchasing stock in their district bank.

Interest Rate Risk

Financial institutions use gap, duration, and simulation analysis to measure and manage their interest rate risks. When interest rate ceilings on deposits were removed during the volatile interest rate periods of the 1970s and 1980s, agricultural lenders were exposed to increased interest rate risk. The research effort charting these changes has focused on understanding how various agricultural lenders manage higher interest rate risk exposure.

For example, Barnard and Barry (1985) quantify the impact of deposit interest rate deregulations on small agricultural banks using a quadratic programming model which incorporates both risk and market imperfections. Parameter variations help in the analysis of portfolio adjustments resulting from improved matching of liabilities with non-loan assets, adoption of floating loan rates, and increased interest rates on loans. In conclusion, for agricultural banks to cope with this riskier environment, they must accept greater portfolio risks, adopt more conservative portfolios, or manage interest rate risks more vigorously.

Ellinger and Barry (1989) report that agricultural banks manage most of their interest rate risk on balance sheet. Despite the fact that agricultural banks, on average, had gap ratios close to a potentially stabilizing level, many banks were still exposed to interest rate risk. This effect holds especially true for smaller banks in agriculturally dominant areas. Lack of loan and deposit diversity may be responsible for the asset-liability problems at these banks. Based on the findings of Belognia and Gilbert (1990), the greater the gap, the greater the likelihood of bankruptcy due to interest rate forecast.

Pederson, Pokharel, and Coon (1986) analyze how bank variability of interest income relates to bank management practices. Their results indicate that if banks' assets and liabilities are not equally sensitive to international rate fluctuations, changes in the interest rate will produce differential effects on interest income and interest expense. The level of systematic income risk increases with the degree of specialization in farm lending, creating a greater instability of net interest margins. The authors conclude that bank managers who allow high interest rate risk exposure either expect higher rates of return on assets or actively manage assets and liabilities so as to reduce net interest income sensitivity to market rate variability.

Wilson, Featherstone, and Preckel (1999) investigate interest rate volatility, funding costs, and balance sheet management in a Production Credit Association (PCA) using an expected utility-maximizing stochastic programming model. They examine balance sheet and funding decisions within a dynamic framework to consider loan volumes, loan maturities, and the funding options of notes payable and financial futures hedging. Their results confirm that Farm Credit Services can utilize financial futures to increase profits.

Recent evidence suggests an increasing gap between the sophistication levels of the interest rate management tools used by the Farm Credit System and smaller agricultural banks. Implications concerning the risk and profitability impacts of this widening gap warrant additional investigation.

Capital Adequacy

The changing regulatory environment and recent advancements in modeling and data collection procedures have resulted in new approaches to capital adequacy modeling. The recently proposed New Basel Capital Accord provides a platform on which to measure capital adequacy with considerably more flexibility and sophistication than the 1988 Basel Accord. Although many agricultural institutions may not be required to conform explicitly to the New Accord in its entirety, the concepts and proposed methods provide an analytical framework in which to measure and model risks. Risk-based capital models have previously been used in agricultural lending by institutions such as the Farm Credit System Insurance Corporation and Farmer Mac. Components of the New Accord will likely influence agricultural lenders' risk management and measurement for many years.

The financial crisis of the 1980s led to the creation of the Farm Credit System Insurance Corporation (FCSIC). This organization provides safety reserves for the FCS banks, who pay premiums to support the reserve fund. The secure base amount is defined as 2% of the aggregate of outstanding insured obligations of all insured banks, adjusted downward by a certain percentage of the System's government guaranteed loans. At year-end 1995, the insurance fund totaled $902 million, or 1.65% of adjusted insured obligations. As of September 2005, the unallocated portion of the reserve fund was $1.988 billion, or 1.87% of the secured base amount (FCSIC, 2006).

Barry et al. (1996) evaluate the initial adequacy of the insurance fund using a stochastic simulation model under alternative economic scenarios. The model accounts for credit, interest rate, and some liquidity risks through specified probability distributions and accounting specifications. Under strongly unfavorable conditions, the secure base amount of 2% was adequate 74.5% of the time. Under all other scenarios, the fund was adequate 99.3% of the time or more. Barry et al.'s Monte-Carlo simulation model provides an applied actuarial framework for determining institutional adequacy for risk protection under uncertainty. The framework could be adapted to early-warning risk systems for financial institutions as well as capital adequacy models.

A risk-based capital test for Farmer Mac was developed in 2001 [Farm Credit Administration (FCA), 2001]. The statutory specifications require worst-case credit scenarios, interest rate shocks, and an operational risk component. The test uses logit analysis to measure the credit risk component. The borrower's debt-to-asset ratio, loan-to-value ratio, loan size, debt service ratio, and worst-case land value declines account for the significant variables. This model provides a framework to build capital adequacy models for financial institutions lending to agriculture. Extensions of the model could be made to measure capital adequacy for commercial banks and Farm Credit System institutions.

Barry (2001) reviews the history of capital adequacy measures used by financial intermediaries and analyzes the new developments in capital management. He contends that while capital management implied by the New Basel Accord has many advantages, such as better integration of multiple risk sources (credit, market, and operational risk) as well as gains in efficiency due to increased pooling of loans and other financial services, it also introduces additional challenges for many FCS entities. For instance, the complexity of the models used, in combination with the lack of sufficient data histories for many institutions, presents significant obstacles. Barry argues that part of agricultural production will likely continue to be treated as commercial units and others may be classified as retail or consumer loans. Nevertheless, he states it is important to "retain the identity of agricultural finance in capital management and regulatory oversight, and to continue striving to keep agricultural credit risk measures and management in line with industry standards" (p. 120).

Research Opportunities

The previous sections of this paper provide a review of some of the primary issues and literature related to the structure, performance, and risk management of financial institutions lending to agriculture and rural America. Ongoing consolidation in financial services and agricultural production sectors, technological innovations, changing regulations, and new innovative research methods and models provide a rich set of research opportunities in these areas.

Implications of Regulatory Changes

Analyses of regulatory issues and their impacts will continue to be important to agricultural finance research. Consideration of the ongoing status of Government-Sponsored Enterprises (GSEs) will likely continue to receive attention as it remains a central policy issue. Federal Home Loan Banks (FHLBs) are also seeking additional securitization authorities. Moreover, FCS may seek expansion authorities, reopen the Farm Credit Act, or propose a partial or full privatization. Research to identify and assess inconsistencies, overlapping authorities, competitive implications, and potential capital arbitrage opportunities across the GSE institutions will aid in policy development of expanded authorities. For example, Farmer Mac has substantial exposure to stand-bys of loans held at Farm Credit System associations. What impact does this access have on the risk, capital levels, and strategies for each GSE? A high priority on this area of research is likely warranted.

Ongoing debate likewise continues regarding the overlap and the costs of regulatory burden. Commercial banks continue to debate the cost of complying with banking regulations, specifically the Patriot Act and the Community Reinvestment Act (CRA). The Farm Credit Administration oversees the Farm Credit System and Farmer Mac. Evaluating and comparing the regulatory burden costs across agricultural lenders would provide useful information on the competitiveness of these firms as well as other less regulated institutions lending to agriculture.

Expanded securitization authorities are being evaluated for FHLBs. Again, the Farm Credit System and Farmer Mac may seek additional authorities and expanded capital rules. These debates inevitably lead to some natural questions that can be informed by targeted research in agricultural finance. Are the regulators consistent in applying capital-based rules for entities holding equivalent amounts of risk? Should there be an incentive for one GSE to provide risk management tools for another GSE? Do these risk management tools ultimately benefit agricultural production and provide greater availability of capital to farmers and rural homeowners?

Ginder (2005) indicated there will be a need for clearer regulation regarding the authority individual Farm Credit System institutions will have to sell unilaterally. The procedures exiting the system associated with the property rights of the stakeholder will have to be determined by FCA and evaluated through research efforts. On December 8, 2005, the FCA Board approved amendments to termination regulations. It is likely that additional amendments may be forthcoming and warrant timely research.

Implications of Banking Structure

The changing competitive environment in rural and agricultural finance markets leaves many structure-related questions unanswered. Mergers and acquisitions of financial institutions are likely to continue, and understanding the longer-term impacts of these consolidations is important. Additional research examining the profiles of recent acquisitions, including characteristics such as their geographic proximity to metropolitan areas, their relative amount of fee income, and the resulting capital positions of the combined entities, is necessary. A challenge of this research is the reduction in available institution data as banks expand through branching. The majority of the performance data are based on the head office. Often, data for location and the extent of lending in agricultural and rural areas are aggregated. Researchers may have to consider alternative data to evaluate the impact of consolidation on lending to agriculture and rural America.

Rural communities have changed significantly over the past decade and will continue to change. A key feature regarding economic development is the importance of nonfarm income. Farming is becoming more dependent on rural communities and their economic development. Financing rural development growth will be a vital role for rural lenders. Case and feasibility studies evaluating entrepreneurial and employment opportunities will need to be supported. The use of government or GSE guarantees to enhance rural economic growth should also be evaluated.

Developments in relationships, farm size, farmer age, and technology can impact rural and agricultural banking and provide opportunities for future research. Relationship lending has been a strong foundation of agricultural lending. As agricultural firms consolidate, researchers must evaluate whether this consolidation affects the tradeoff between relationship lending and price, and determine how attractive the convenience of credit and one-stop credit shopping is for agricultural borrowers. Consolidation also raises the issue of credit gaps in rural areas, which should also be further examined by research. Moreover, a large number of the aging farm population will retire during the next decade and transfer the farm assets to the next generation. Future research should examine the succession plans of these farmers and the resulting impact on agricultural lenders.

Technology will continue to change the lending industry. It is anticipated this technological growth may further segment the delivery channels into commodity-based (loans and related services are commodities) and value-added channels. The commodity-based segment will be driven by low costs and enhanced efficiency.

Research into the impacts of and demand for internet technologies in credit and financial service delivery will provide insight on the potential impact of technology. Further, identifying value-added financial service components will be essential in order to assess the segments that warrant additional development.

The continual increase in size and complexity of farms raises several researchable questions: (*a*) Will venture/equity capital become more predominant? (*b*) What is the role of vendor financing? (*c*) What will be the role of community banks? and (*d*) Will larger farm sizes restrict smaller banks from providing a full range of service for borrowers?

Recent financial institution work has examined international issues and banking outside the United States. The role of international banks and companies in providing capital to domestic and foreign agricultural sector borrowers poses an important study issue.

Implications for Performance

Little evidence exists regarding the evaluation of inefficiency and the level of risk at financial institutions. In addition, the short- and longer-run institution-level performance impacts of financial innovations, derivative, and risk management tools could provide useful information for understanding the risk and performance profiles of agricultural lenders. Call and income reports now provide substantial information on securitization and the use of financial derivatives.

Changes in technology are also extremely important to establishing risk and performance profiles. Credit models are being implemented, online bank services established, and other operational efficiencies integrated into bank operating environments. Have these technological changes impacted scope, scale, or inefficiencies across lending institutions?

Ownership, market, and management characteristics and their relationship to performance provide other fruitful areas for future research. Case studies of successful entities have become popular. The management tools and demographic profiles of consistently high performing banks could be examined. The impacts of regional market performance on the performance of banks in those markets could also be explored. Potential ownership-related questions include:

- How does the ownership structure of commercial banks impact performance?
- What is the benefit of recently formed subchapter S banks?
- Do banks that remain under the same ownership over time perform differently?
- Is there a linkage to social capital for banks that have been under the same tightly held ownership over time?

Risk Management, Measurement, and Modeling

Advancements in modeling approaches, improvements in historical databases, and financial innovation provide a strong research platform for many issues related to risk measurement and management. Ginder (2005) identified a key issue facing the Farm Credit System as the determination of who owns the unallocated capital surplus. He posited potential claimants could be (*a*) the current stockholders; (*b*) the past stockholders who contributed to building the surplus; (*c*) the successor FCS Ag Credit Association chartered to replace FCSA; (*d*) the other Farm Credit System banks that provided assistance; and (*e*) the government who provided the initial risk capital, special tax treatment, and recapitalized it in the 1980s. Guidance in the distribution, role, and ownership of unallocated capital reserves is a high priority research area.

Basel II has accelerated the attention on capital and credit risk modeling for the largest, internationally active institutions. Agricultural institutions are likely to adapt their modeling approaches as well. As data systems become more developed, models like the Risk-Based Capital Model for Farmer Mac could be augmented to evaluate Farm Credit System and commercial banking institutions. Stochastic components similar to those outlined in FCSIC could be used to provide the necessary probabilistic estimates. A challenge will be to develop models that represent historic and stressful conditions in agriculture, but also represent the changing risk profiles of customers. These models will assist in developing stress-testing procedures for alternative investment and loan portfolios. Identifying key risk drivers in the stress-testing procedures will be a valuable contribution.

Community banks have traditionally held higher amounts of capital than their larger contemporaries. Additional analysis could shed light on the rationale for higher degrees of capital. Moreover, with Basel II on the verge of adoption, does this dichotomy create a competitive disadvantage for smaller institutions?

Concluding Remarks

This paper has reviewed a wide scope of research related to the structure, performance, and risk management of financial institutions lending to agriculture, and has provided a segue to many unanswered, yet researchable issues. Primary data collection methods, as well as expanding call and income report information for agricultural lenders, farm record data, ERS ARMS data, and lender credit databases, will be key components for researchers as the modeling and statistical approaches become more sophisticated. This research will be critical to maintain efficient rural financial markets that can provide consistent and competitively priced credit for rural America.

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Credit Risk Assessment

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Abstract

Lenders, regulatory agencies, and investors have increased their demand for credit risk exposure information to appropriately price risk and evaluate risk migration patterns that affect institution safety and soundness. This review provides a synthesis of the advances in credit risk assessment made through journal articles and other professional reports. Contributions in three primary areas are considered: (*a*) how the credit risk assessment problem has been defined and redefined over time in response to the changing information needs of lenders and regulators, (*b*) how methodological innovations have improved credit assessment procedures, and (*c*) how the efficiency of financial markets has changed due to the evolution of credit risk assessment. The paper concludes with a discussion of how transactional and relationship lending approaches are expected to evolve in the future and whether measures can be developed to more accurately assess factors such as management capacity and commitment to repay.

Key words: credit evaluation, credit risk assessment, credit scoring, loan default, loan repayment

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Analysts, policy makers, and practitioners have recently focused greater attention on credit risk assessment and capital adequacy following adoption of the new Basel II Accord which provides incentives for lenders to measure probability of default (PD) and loss given default (LGD) in their loan portfolios. Early credit scoring and other risk assessment tools primarily assisted lenders with delineating borrower characteristics associated with default. More recently, lenders, regulatory agencies, and investors have increased their demand for credit risk exposure information to appropriately price risk and evaluate risk migration patterns that affect institution safety and soundness.

This review provides a synthesis of the advances in credit risk assessment made through journal articles and other professional reports. Contributions in three primary areas are considered: (*a*) how the credit risk assessment problem has been defined and redefined over time in response to the changing information needs of lenders and regulators, (*b*) how methodological innovations have improved credit assessment procedures, and (*c*) how the efficiency of financial markets has changed due to the evolution of credit risk assessment.

A novel feature of this paper is that it compares transactional versus relational approaches to credit risk assessment. A constant struggle with respect to development of credit assessment models has been to appropriately balance quantitative and objective financial data with subjective measures of borrower behavior. Traditional credit risk assessment literature has focused on developing credit risk assessment tools (such as credit-scoring models) which are utilized in assessing loan transactions or

individual borrowers. While these approaches are also heavily utilized in relationship lending, the lender also evaluates a variety of factors such as management capacity and commitment to repay, which are frequently assessed by developing a relationship with the borrower. The paper discusses how the transactional and relationship lending approaches are expected to evolve in the future and whether measures can be developed to more accurately assess factors such as management capacity and commitment to repay.

Defining the Credit Risk Assessment Problem

The fundamental problem of the lender is how to accurately evaluate credit risk exposure at the transaction and portfolio levels because, as the level of credit risk increases, the realized rate of return on a loan portfolio is reduced and the required level of capital increases. This is a primary concern for lenders (and their shareholders), their regulators, and their borrowers.

The working hypothesis behind models developed to solve the credit risk assessment problem is that borrower creditworthiness can be determined by applying statistical models to measurable characteristics of borrowers at the individual transaction level. The results from these formal credit-scoring models (CSMs) can be used to predict the likelihood of repayment (default). There is no standard usage of the term "formal" in the literature (Ellinger et al., 1992). However, a formal credit evaluation procedure might refer to a pre-specified process used across all, or a class of, borrowers for the purpose of determining the risk of a farm borrower. The procedure incorporates specific measurable factors that predict the likelihood of repayment and that can be used to assign borrowers (or loans) to distinct risk groups to reflect their relative creditworthiness.

There appears to be relatively limited explicit recognition of the fact that there are costs to borrower misclassification in the credit risk assessment literature. LaDue (1989) reminds us that the cost of making a loan to a borrower who eventually defaults (i.e., a type I error occurs when a problem borrower is classified as an acceptable borrower) is different from the cost of not making a loan to a borrower who fully repays (i.e., a type II error occurs when an acceptable borrower is classified as a problem borrower). But credit-scoring models typically do not incorporate these misclassification costs, and the models have not differentiated between the various degrees of default that exist in a loan portfolio. These shortcomings appear to be related, and may be due to the lack of adequate data for estimating the costs.

The impetus for the development of agricultural CSMs during the late 1980s and early 1990s has been attributed to the large number of farm failures and loan defaults among farm borrowers in the United States in the early 1980s (Turvey, 1991). In addition to controlling and monitoring credit risk exposure, it has been suggested that CSMs are useful in assisting in loan approval decisions, pricing loans in which differential interest rates are used to price for risk, and meeting regulatory requirements and management objectives (Ellinger et al., 1992).

The use of CSMs generates the potential for endogeneity in the credit risk assessment problem. This may occur in two ways. As the model is applied to the population of borrowers to differentiate good from bad borrowers, a disproportionate share of good borrowers "survive" (i.e., they make good investments and increase their profitability over time, improving their qualifications for future loans), while the opposite is true of the proportion of bad borrowers. Thus, repeated sampling over time from the population of borrowers makes it progressively more difficult for the model to differentiate good borrowers from bad borrowers. Moreover, if there are

errors in the level of prediction accuracy of a model, those errors may be carried forward in successive applications of the model. Consequently, lenders need to periodically reestimate and update their CSMs.

How do credit-scoring models compare to portfolio models when looking at the credit risk assessment problem? Portfolio models of credit risk exposure do not focus directly on producing credit scores; rather, they take a more macro view of the problem. The portfolio view examines the level of default risk exposure in sub-portfolio segments and the correlation between those sub-portfolio segments in terms of their likelihood of default. Although different portfolio models exist, they generally focus on determining and monitoring capital requirements (economic capital) in order to cover expected credit risk exposures.

Early Credit Risk Assessment (pre-1990)

Determining the risk of both existing and potential agricultural loans has been described as the most important job responsibility of an agricultural loan officer. In addition to default risk, loan officers are also interested in minimizing time spent monitoring adverse loans and incurring the costs of delayed or partial repayment (Gustafson, Saxowsky, and Braaten, 1987). Both can be quite costly to a financial institution. Moreover, the credit status of a farm borrower could affect loan pricing as well as other nonprice factors (fees and collateral requirements). Regulators and investors also have keen interest in lenders' evaluations of borrower risks.

Prior to 1970, lenders relied primarily on subjective assessments to appraise the credit risk of farm borrowers. Krause and Williams (1971) were among the first to link subjective characteristics of a borrower's personality with loan performance. How well the lender knew the farmer and the size of the loan were two of the most important factors affecting interest rates paid by farmers according to Dahl (1962). However, as noted by Dahl, subjective assessments of borrower risk were quite informal and often led to discrimination. Today such lending practices would leave loan officers vulnerable to claims of lender liability. In their review of agricultural finance literature, Brake and Melichar (1977) reported that "few studies have examined the efficiency of lender operations or lending decisions. Lenders themselves could well undertake or sponsor more such work."

With the advent of computers, agricultural finance researchers actively developed more objective and quantitative decision criteria. One of the most popular efforts utilized discriminant analysis to distinguish between borrowers with good and poor credit risk based on their financial position and other loan application information provided. Brinegar and Fettig (1968) found capitalized expected future net returns to be highly correlated with loan performance. Bauer and Jordan (1971), Johnson and Hagen (1973), Evans (1971), and Reinsel and Brake (1966) estimated discriminant functions and attempted to link information on loan applications with loan success probabilities. The results of their efforts were mixed. The latter two studies in particular were not very robust, as results varied by length of patronage and lending institution, respectively.

Similar ambiguity in credit evaluation occurred in other financial markets prompting the Board of Governors of the Federal Reserve System to develop criteria for determining when a credit scoring system is statistically sound and empirically derived (Bieber, 1985). In essence, any model developed must be robustly estimated with both creditworthy and non-creditworthy borrowers, be validated, and updated over time.

Dunn and Frey (1976), Hardy and Weed (1980), and Hardy and Adrian (1985) improved the application of discriminant

analysis and variants of the technique with the addition of more explanatory variables and differing geographic regions. Results were still limited to Farm Credit System data, however. Leatham (1987) described the usefulness of these approaches for different lending functions. He also constructed a chart comparing the explanatory variables and approaches of the discriminant studies discussed above.

While these more quantitative approaches were being refined, several other researchers developed lender decision aids based on more subjective, experiential information—striving to find the balance between subjective and objective measures. Allcott (1985), Kohl and Forbes (1982), and Kohl (1987) proposed methods that included more comprehensive financial measures (liquidity, solvency, profitability, efficiency, repayment capacity, and management ability) and incorporated data from commercial banks. However, performance and validation measures were unavailable for evaluation.

Significant advances occurred in the 1980s, when even greater computer power and new statistical methods provided more opportunity for quantitative approaches. Fisher and Moore (1987) noted past discriminant approaches were limited because they assumed multivariate normality of explanatory variables, an unlikely assumption with financial ratio data. They proposed a logistic function which was not only more accurate, but relied on fewer explanatory variables. In favoring this objective approach, they conclude that subjective assessments "have undesirable implications for customer relations and possible adverse legal consequences."

Miller and LaDue (1989) and Turvey and Brown (1990) extended and refined the logistic method. Miller and LaDue dealt with several methodological issues. They specified the dependent variable more accurately with actual borrower repayment data, instead of relying on subjective lender or examiner assessments; delineated credit screening and loan review applications; grounded selection of independent variables based on ratio theory; considered costs of misclassification; and utilized a hold-out sample to test validity. Turvey and Brown incorporated covariance to account for regional and farm type differences.

In the later 1980s, credit-scoring models were integrated with other financial institution and farm decision models. The resulting insights clearly illustrated the jointness of credit and other firm managerial decisions. Lufburrow, Barry, and Dixon (1984) were among the first to link credit assessment with loan pricing using a probit model. Results enabled lenders to advise borrowers about factors that comprise credit scores and changes that could be undertaken to improve their classification.

Stover, Teas, and Gardner (1985) examined the interacting effects of farm loan decisions with credit considerations in the decision process of lenders. Mortensen, Watt, and Leistritz (1988) extended these results by linking credit scores, loan pricing, and lender revenue functions. Barry and Ellinger (1989) developed a multi-period model that endogenized credit, investment, and loan pricing decisions. Barry, Baker, and Sanint (1981) and Sanint and Barry (1983) considered credit risks jointly with other financial and business risks using mean-variance portfolio theory.

The need to develop credit assessment models that were more useful to lenders was paramount. The basic steps of developing a credit-scoring model were conveniently summarized in lay terms to facilitate expanded adoption by lenders (Barry et al., 2000):

- Identify key variables that best distinguish among borrowers' creditworthiness,
- Choose appropriate measures for these variables,

- Weight the variables according to their relative importance to the lender,
- Score each loan as a weighted average of the respective variables, and
- Assign the credit scores to the appropriate class.

Development of broad and robust models of credit assessment was still stymied by lack of consistent financial information across lending institutions, regions of the country, and farm types. Information-intensive quantitative models required more standardized data for estimation and validation. LaDue (1990), in cooperation with agricultural bankers, was instrumental in organizing such an effort leading to the creation of the Farm Financial Standards Task Force that provided this information. The resulting 16 financial ratios and methods of calculation are now widely adopted in the industry.

In addition to model development, the profession has actively critiqued itself by periodically reviewing progress and identifying voids requiring further development. The first type of review has been a self-critique conducted by peers. Studies by Leatham (1987) (mentioned earlier) and Gustafson (1987) were commissioned by Regional Research Committee NC-161. Both papers note that few financial institutions adopted early evaluation models, although their usefulness had been substantiated. Gustafson (1987) advocated use of portfolio analysis to examine contributions of individual borrowers to total portfolio risk.

A series of American Agricultural Economics Association invited papers in 1989 further document the role of credit evaluation in agricultural finance. Chhikara (1989) found that existing credit-scoring models have been limited by an exclusive focus on default rates. Like Gustafson (1987), he encourages development of portfolio and multi-period models that consider inclusion of expert models which incorporate more subjective variables.

Gustafson (1989a) suggests credit assessment techniques can be utilized to judge the sector's financial health. He also urges development of dynamic credit evaluation models, greater inclusion of behavioral indicators, and measures to evaluate the health of agribusinesses and international firms as concentration within the sector progresses. Gustafson (1989b) estimates the value of credit-scoring models in general, in addition to the value of a dynamic credit assessment. In reviewing the above papers, LaDue (1989) encouraged more focus on costs of misclassification and definition of credit. He also stressed the need for more accurate financial data, including forward-looking measures. In his review, Obrecht (1989) reminds us to remember the events of the 1980s farm financial crisis and incorporate them in our methods.

Finally, in LaDue's (1989) summary of NC-161 Regional Research Committee accomplishments, he reported that the credit scoring subcommittee "was the most active ... focusing on credit scoring and loan evaluation." LaDue noted out-of-sample properties for many of the models were acceptable, but variables contained in these models were quite diverse. Turvey (1991) compared and contrasted the performance of four alternative credit evaluation models—discriminant analysis, Probit, Logit, and linear probability. Despite differences in underlying assumptions, classification accuracies were similar for all approaches.

The second type of review was to actually gauge acceptance of the profession's research by the lending industry—the eventual purpose for which all these models were developed. Miller et al. (1993) surveyed 1,027 Midwest commercial banks and found growing use of risk-adjusted interest rates based on banks' ability to delineate credit risk among borrowers. Nonprice factors (fees and collateral requirements) also varied by risk class. Ellinger et al. (1992) report the findings of NC-161's regional research survey conducted to determine lenders' use of credit evaluation procedures, the extent to

which they are utilized, and whether these procedures are used for loan approval and pricing. Findings revealed that 62% of respondents used a formal credit evaluation method, with the proportion increasing with bank size. Lack of quality borrower information was a deterrent to use. Finally, Gustafson, Beyer, and Saxowsky (1991) conducted in-depth interviews with 10 loan officers to determine their information sources, credit evaluation procedures, and lending heuristics. Lenders surveyed employed conservative credit evaluation techniques and based credit decisions on borrowers' collateral positions, level of compensating balances, and character.

Until this point, it was assumed borrowers and lenders had equal information (or lack thereof). Underlying the credit risk assessment problem is an asymmetric information problem that is characteristic of all lending environments. Asymmetric information produces two related problems for a lender—*adverse selection* and *moral hazard*.

Adverse selection occurs when the lender is unable to distinguish between high- and low-risk borrowers. For example, a lender cannot simply charge an interest rate that equates to the risk of an average borrower, because only borrowers with risk at or above the average will agree to the loan terms (Stiglitz and Weiss, 1981). At higher interest rates, only high-risk borrowers can afford the rate and expected profit drops because credit risk drastically increases due to the loss of low-risk borrowers.

Moral hazard is the ability of a borrower to use loan funds to engage in activities that are riskier than the lender anticipated. Only the borrowers can know their true intentions for the loaned funds and their future ability and willingness to repay the loan.

A new line of research developed in the late 1980s assumed borrowers had more knowledge about their eventual credit risk than their lenders because they are more familiar with their business, financial position, and repayment intentions. Borrowers then have incentive to find lenders who allow them to undertake riskier actions, which increase likelihood of default (Robison, Barry, and Burghardt, 1987; Foster and Rausser, 1991). Gustafson (1987) foresaw this problem and urged researchers to place more emphasis on the mindset of borrowers to "identify a subject's state of knowledge and infer a model of cognitive process that is useful for prediction of observed behavior."

Lenders have responded to these problems of asymmetric information and adverse selection by focusing more closely on relationship information including borrower motivation, commitment, and intentions. These subjective characteristics are not directly observable in loan documents presented by borrowers. Lenders' attempts to obtain more personalized relationship information from existing and prospective borrowers is the topic of the next section.

Recent Credit Assessment Models (post-1990)

Multivariate, accounting-based credit-scoring models have been criticized due to their lack of a theory and their failure "to pick up more subtle and fast-moving changes in borrower conditions" (Caouette, Altman, and Narayanan, 1998, p. 134). Nonetheless, we observe that the agricultural finance literature on CSMs has developed through a series of experiments with alternative statistical models and data sets with varying degrees of success. The literature provides a useful description of several alternative statistical approaches which might be used for credit scoring (Chhikara, 1989). Yet, the research literature also reveals a paradox. There appears to be a reasonable level of consistency between these models when selected alternative model estimation techniques and a common borrower data set are used (Turvey, 1991; Ziari, Leatham, and Turvey, 1995). However, there is an apparent lack of consistency between the

actual models developed and used by different banks when applied to a common borrower data set (Ellinger, Splett, and Barry, 1991, 1992; Ellinger et al., 1992).

For example, Turvey (1991) reviews some commonly used parametric techniques for CSM estimation—linear probability models (LPMs), discriminant analysis (DA), and regression (Probit and Logit). Although Turvey's results are not conclusive, these alternative techniques are found to provide relatively similar predictive power, even though they employ somewhat different underlying assumptions. The LPM and DA techniques pose specific problems for model estimation (e.g., correction for heteroskedasticity in the case of LPM and the assumption of normally distributed random variables in the case of DA). The Probit and Logit model specifications have been more appealing, with the Logit estimation being less restrictive in terms of the underlying distributional assumption.

Ellinger, Splett, and Barry (1992) applied 87 different CSMs used by banks to a common set of 324 loan cases in order to evaluate the consistency between models—both consistency of credit scores across loan cases of different types and consistency of models in the loan rankings that are produced. They found there is no uniform model for lenders to use, but overall model consistency was better when predicting low-performance cases than when predicting high-performance cases. Loan rankings were shown to be positively correlated, but there were large variations. The observed diversity among the tested models was attributed to: (*a*) use of many different measures to estimate the variables, (*b*) differences in the incorporation of subjective measures (e.g., management), and (*c*) use of data from different points in time during the loan period to develop the models.

One general explanation for the apparent contradiction is that the models used by banks may differ due to: (*a*) different purposes of credit scoring (e.g., loan approval versus loan pricing), (*b*) differing risk attitudes of lenders, or (*c*) different types of borrowers and quality of information available to the lender (Ellinger, Splett, and Barry, 1992). A second general explanation might be that many such models are not adequately validated, given the short history of their development and use, and the potentially wide variation in data employed in their development. Thus, it is not surprising that a significant part of the recent agricultural finance literature has focused on the potential for improving the consistency (or robustness) of the models. We consider this literature in two ways—variations in model specification and variations in efforts to validate the models.

Model Specification

Miller and LaDue (1989) suggest that no specific factor has consistently been used to evaluate credit risk in the credit scoring framework, and the credit risk classifications from lenders and loan files tend to vary across research studies. Indeed, the literature reveals there are concerns over which factors to include as predictors of loan quality, how uniformly the factors are measured, how the models apply to different farm and loan types, and how well the models perform over time.

Lufburrow, Barry, and Dixon (1984) include measures of borrower liquidity, leverage, collateral, repayment ability, and repayment history. Miller and LaDue (1989) include profitability, leverage, and efficiency measures. Turvey and Brown (1990) incorporate liquidity, profitability, leverage, efficiency, repayment ability, farm type, and region as predictors of loan default.

A later survey of agricultural bankers indicates a similar wide range of financial and nonfinancial factors and factor weights are used in practice. In these models, high importance is given to borrower solvency, liquidity, repayment capacity, and collateral position (Ellinger et al., 1992). Splett et al. (1994) found different model specifications apply to term loans and operating loans.

Gallagher (2001) added nonfinancial characteristics of loans (combined manager and lender experience, and the use of a financial adviser) to predict the success of agribusiness loans. As reported by Zech and Pederson (2003), factors such as family living expenses and farm financial efficiency are excellent predictors of overall financial performance, even though they are frequently excluded from CSMs. Thus, model specification continues to be an issue for researchers and practitioners.

Model Data and Validation

In order to further improve the consistency and robustness of CSMs, several researchers have considered the importance of how factors are measured and how the resulting models are validated. Novak and LaDue (1994) raise two questions for CSMs generally: Does extending the time horizon of a credit score affect the ability to classify borrowers? And if so, what time horizon produces a reliable model result? They showed that multiple-year averages of variables can improve the stability of model parameters and the predictive accuracy of models when compared to models derived from individual year data. Novak and LaDue attribute the improvement in model performance to "smoothing effects" and the extension of the period of creditworthiness. This general finding has been confirmed in other studies (e.g., Turvey and Brown, 1990; Zech and Pederson, 2003).

A further effort to foster model consistency and robustness is found in the practice of model validation using out-of-sample testing. Model validation may be accomplished by testing the estimated model using hold-out sample data from the same period, or by testing the estimated model's ability to predict hold-out sample data outside the sample period. For example, Turvey and Brown (1990) use a series of tests to validate an estimated national model for Canadian farms. They use an estimated model to predict the incidence of loans being current in the subsequent two years and then compare the model results to actual results. Zech and Pederson (2003) estimate models for repayment ability and financial performance using three-year averages, and validate the models by predicting the creditworthiness variables for the next two years. In each of these studies the validation step is shown to differentiate the most significant predictors from those having relatively limited predictive ability.

Through this period of model development and testing, efforts have been made to identify a set of uniform financial standards for use in farm financial analysis. The Farm Financial Standards Task Force (FFSTF) has produced a set of common financial factors (profitability, solvency, etc.) and 16 financial variables agricultural lenders can adopt for use in credit-scoring models. The expectation is that widespread adoption of these measures will lead to greater uniformity of the variables which are derived from farm data, and potentially greater consistency in the CSMs developed by bankers.

Aggregate (Sectoral) Models

While CSMs have typically focused on analyzing data at the individual transaction level, Oltmans (1994) approached the loan assessment problem from an aggregate perspective. Ordinary least squares (OLS) regression is used to identify early warning models using farm sector data on collateral values, changes in farmland values, debt/asset ratios, government payments, and off-farm incomes to predict changes in loan quality in Farm Credit System institutions.

Additional tests of the estimated aggregate models indicate they outperform simple time-series models that use lagged loan quality indicators to predict future loan quality changes. Thus, changes in the fundamental financial indicators appear to be better predictors than trends in the time series. In addition, the aggregate approach to loan quality assessment may be combined with individual borrower analysis to increase the range of tools

available for portfolio analysis and risk management.

Nonparametric Approaches

While statistical credit-scoring models have expanded in use, they require the user to accept restrictive distributional assumptions which may undermine the reliability of the model results. For this reason, researchers have tried nonparametric approaches (such as recursive partitioning algorithms and mathematical programming techniques), and compared their results to those obtained with parametric (statistical) approaches. The results suggest that a recursive partitioning algorithm outperforms parametric models, such as discriminant analysis or Probit and Logit regression, in terms of classification accuracy (Chhikara, 1989). Further testing of this finding is needed.

Ziari, Leatham, and Turvey (1995) also found mathematical programming techniques perform as well as statistical models (and mixed integer programming models actually outperform the statistical models). The additional advantages of mathematical programming approaches are that they can accommodate various objective or criterion functions and sensitivity analysis can be readily performed. Both nonparametric approaches have the additional feature that misclassification costs can be incorporated into the model.

Best Practice in Credit Assessment

One of the objectives of applied research on credit risk assessment models is to identify good model characteristics, or what might be termed as "best practice." What does the agricultural finance literature indicate about these general characteristics?

Several studies suggest that model specification and validation are quite important to improving model consistency and accuracy. Greater attention to these factors will provide greater confidence in the model and less room for classification errors. Models need to be adequately validated by testing the predictive ability of the model when applied to out-of-sample data.

Various studies have also shown that using multiple-year averages of predictor variables in the models improves model parameter stability and model accuracy. Quantitative and qualitative variables need to be included where possible to improve model predictive ability. Descriptive variables for differences in farm type and geographic region may be desirable when the data allow them to be included in the model. Nonfinancial factors such as the experience of the loan officer should also be considered in the development and testing of CSMs. When the available data are characterized by small sample size and/or the data are heavily contaminated, mathematical programming may be a better tool for model estimation.

Credit Risk Migration

Recent attempts have been made to apply migration analysis to the credit risk of agricultural lending. A credit risk migration rate measures the probability that an asset will be in a certain credit risk class in a future time period given a current credit risk classification. Early credit risk migration research was performed by analysts looking for ways to predict future price movements of debt instruments such as bonds. For example, Altman and Kao (1992) analyzed S&P bond data from 1970–88. This and other research have evaluated the time homogeneity of ratings and the effect of the business cycle on those ratings. These two topics continue to be key issues in migration analysis today.

Due to the lack of sufficient agricultural loan risk-rating data, several previous applications of migration analysis to agricultural lending have used farm-level data. For example, Phillips and Katchova (2004) test for path dependence using the annual migration rates of credit scores

which are derived from the Illinois data in Barry, Escalante, and Ellinger (2002). The authors use annual credit score migrations so that they can condition on the business cycle. Two-sided *t*-tests and the singular value metric are used to show the presence of a trend reversal pattern in the migration matrix. Upgrades (downgrades) tend to be followed by downgrades (upgrades). They condition migration rates on three stages of the U.S. business cycle (as defined by the National Bureau of Economic Research). The singular value metric and cell-by-cell analyses show that upgrades are more likely to occur in an economic expansion phase. The opposite is true for an economic recession.

Similarly, Escalante et al. (2004) use credit scores based upon farm-level data from Illinois to represent credit risk. An ordered probit regression is used to determine path dependence while accounting for demographic, financial, and macroeconomic variables. The macroeconomic variables which are influential on loan risk migration include farmland value, aggregate money supply, the S&P 500 Index, and long-term agricultural interest rates.

Gloy, Gunderson, and LaDue (2005) perform a credit risk migration study on loan-level data provided by agricultural banks. This approach has the advantage of using credit risk ratings that are determined using the resources and methods agricultural lenders have available to them. A logistic regression model is used to detect factors influencing credit downgrades. Based on their findings, the probability of a downgrade differs across lending institutions. In addition, young borrowers and farm businesses in the declining stage of their life cycle are more likely to experience a downgrade. Their results show that livestock and horticulture operations are less likely to experience a downgrade than annual crop, permanent plantings, or other types of farms. At this early stage of research on risk migration, none of these previous analyses have simultaneously accounted for the influence of previous migrations, the economic cycle, and other important determinants.

The Future "R's": Regulations, Relationships, Robustness

The future of credit risk assessment can best be understood by viewing credit risk from the financial institution managerial perspective and the regulatory perspective. The primary focus of a managerial perspective is on accurate underwriting and pricing of credit risk. Accurate credit risk assessment helps management decide whether the credit risk posed by a borrower is acceptable given the institution's desired risk-bearing capacity.

From a managerial perspective, the accuracy of credit risk assessment serves two key purposes. First, it removes from consideration borrowers who present excessive credit risk. Second, for those borrowers who pass the first screen, it is used to determine how much credit should be extended and what price should be attached to an extension of credit. In this way, credit risk assessment serves the purpose of helping institutions align expectations of the risk and return with constraints on portfolio performance.

Both of these decisions play a critical role in determining the level and variability of the financial institution's earnings. Of course, the variability in earnings plays a key role in determining changes in the balance sheet of the financial institution. Large negative earnings reduce the capital of the institution and threaten its safety and soundness. This is where the regulatory perspective on credit risk assessment becomes important.

The primary focus of the regulatory perspective is to ensure that the institution's capital is not compromised to an extent whereby the soundness of the institution comes into question. The primary regulatory concern is whether adequate capital has been allocated to account for credit risk. Less concern is

focused on whether credit risk has been accurately priced. Instead, regulators are concerned whether credits carry too much risk, regardless of price.

The Basel II agreement is an important step in the regulatory approach to determining capital adequacy standards. The agreement is related to credit risk assessment because the advanced internal ratings approach outlined in the Basel II makes explicit use of internally generated estimates of the probability of default, loss given default, and exposure at default when calculating a financial institution's capital ratios.

While only the largest, multi-national financial institutions will be required to adopt the advanced internal ratings approach to determine capital adequacy, Barry (2001) points out that the agreement reflects the latest thinking in capital management. Barry offers a discussion of three pillars of the Basel II agreement and discusses how they might apply to agricultural lenders. The agreement provides additional information regarding modern capital management practices which may be used to improve and enhance credit risk assessment in banks and the Farm Credit System. However, the data and methodological requirements for the more advanced approaches to determining capital adequacy are substantial, and many agricultural lenders will not be able to comply with them.

As institutions begin to adopt ideas contained in the Basel II agreement, many will attempt to place a value on the credit risk contained in their portfolios. The literature on valuing the amount of credit risk held by an institution continues to evolve. An example of this research is an analysis by Sherrick, Barry, and Ellinger (2000), who estimated the cost of insuring pools of agricultural mortgages. Likewise, Katchova and Barry (2005) applied the CreditMetrics and Moody's KMV model to farm-level financial data to estimate capital requirements under Basel II principles.

Implications of the Managerial Perspective: Loan Costs and Pricing

The earlier review of research indicates a strong focus on the first component of the managerial perspective and the related regulatory perspective. Namely, what is a borrower's probability of default, or what is the likelihood that the borrower will fail to repay her obligations to the financial institution? While this is a critical question for the managerial perspective, several managerial areas are in need of additional research. The most obvious is the clear need to accurately tie credit risk assessment to loan pricing. In order to make this linkage explicit, it is critical that researchers work to identify the costs associated with default and the additional costs associated with monitoring borrowers with greater credit risk. In short, unless one understands the costs which accompany increased likelihood of default, one cannot fully understand credit risk.

The likelihood of movement to default or to another credit risk category is only one component of the puzzle. Pricing must accurately reflect the associated costs of servicing marginal credits, including those that have not defaulted but require considerable oversight and monitoring.

Arguably the most important unresolved research issue relates to developing a better understanding of the distribution of loss given default in loan portfolios. Featherstone and Boessen (1994) examined the loan losses suffered on agricultural mortgages and estimated the average magnitude of losses at 29 basis points. While aggregate and financial institution-level data are available on loan charge-offs, there have been few attempts in agriculture to link these charge-offs to prior risk ratings or borrower characteristics.

Furthermore, there have been few attempts to estimate the additional operating costs associated with loan losses. These costs can be numerous. First, the institution must commit personnel time and

resources to recovering the loans. Second, the institution does not accrue interest on many of these loans. Third, there are often significant recoveries associated with agricultural charge-offs. All of these issues deserve further attention in the literature. Information regarding all of these data is critical to fulfilling the second key aspect of the managerial perspective. Without these data it is impossible to accurately estimate the interest rate that must accompany a higher risk borrower.

Further work is needed to examine the methods used by lenders to collect loans in default and to assess whether some collection processes are more effective than others. In addition, there has been little work directed at understanding what is happening with the borrower's business that impacts the likelihood of default, e.g., are there factors which often result in defaults? Instead, the previous research has focused on financial variables that illustrate the outcome (reduced credit quality) but shed less light on the factors that have resulted in the borrower's poor financial condition.

While loan losses are a critical component of the actual cost of increased credit risk, making higher risk loans also requires additional loan monitoring. These higher monitoring costs also influence the price of credit, making it an important factor in the likelihood that a borrower's credit risk increases even if the borrower does not actually default on obligations. Recent work on estimating the costs of delivering credit to different types of borrowers indicates it is much more costly to lend to very high-risk borrowers, while servicing and monitoring costs of low- and medium-risk borrowers are similar (Gloy, Gunderson, and LaDue, 2005).

Implications of the Regulatory Perspective: Credit Availability in Agriculture

The regulatory perspective has driven a substantial amount of the research on credit risk assessment. Financial institutions and their regulators appear to be taking notice of the Basel II agreement. The Farm Credit System has recently undertaken efforts to standardize risk rating approaches and develop probability-of-default estimates (Anderson, 2004). As part of this process, an attempt is made to map default rates on different classes of agricultural loans to default rates on corporate bonds rated by Moody's and Standard & Poor's. Similar work has been undertaken by Featherstone, Roessler, and Barry (2004) who estimate the default rates on loans in the seventh Farm Credit District. Their findings suggest the default rate on an average quality loan in the district appears to correspond to the default rate on bonds in Standard & Poor's BB-rating category.

These recent attempts to relate agricultural credit risk ratings to corporate risk ratings come as regulators and investors express a desire for agricultural credit risk ratings to be reported in a manner that makes them comparable to the ratings developed by the ratings agencies such as Moody's and Standard & Poor's. As these efforts continue, work is needed to assist in determining how the ratings systems should be standardized and what data will be required to develop the ratings.

Designing Credit Risk Models for Relationship Lending and the Changing Structure of Agriculture

As agricultural lending continues to evolve, there are likely to be changes in the way credit risk is assessed and managed. Traditional agricultural credit risk assessment is based on a relationship whereby the lender gathers a considerable amount of financial data on the borrower and the borrower's business. The lender uses this relationship to obtain information and reduce problems of asymmetric information (discussed earlier). The loan officer spends considerable time gathering information about the farmer's business, assessing management capacity, and assessing the borrower's commitment to repay. This type of lending is costly because it involves

a substantial commitment of institution personnel.

Modern credit-scoring models (e.g., transactional lending) now allow lenders to make credit decisions without establishing a deep relationship between the borrower and lender. Instead, lenders place greater reliance on factors such as a credit bureau report and the output of the firm's own credit score when determining whether to grant credit, and less time is spent on traditional underwriting activities and relationship building.

The decision to apply the transactional model involves assessing the tradeoff between the cost of gathering additional information through a relationship and the benefit of reducing information asymmetry. It appears many lenders have decided that the risks associated with making errors on smaller loans are more than offset by the increased costs associated with the loan officer making this assessment, and that these measures may be at least as accurate as the loan officer's assessment. One important remaining question is to determine how the information gathered in the two approaches differs. And, if the additional information is obtained in the relationship model, can this information be standardized and incorporated quickly into credit-scoring models?

Implications for Different Types of Borrowers

The shift to increased reliance on credit scoring has many potential implications for the availability of credit to different types of borrowers. For many types of small farm borrowers, this means their creditworthiness will be assessed almost entirely by repayment history with the lender, their credit bureau score, and their current financial condition. To the extent these factors do not indicate all of the aspects of credit quality, some creditworthy borrowers will likely find it difficult to obtain credit. In other words, it will be too costly for the financial institution to overcome the adverse selection problem. These types of borrowers will often be forced to rely upon credit cards as a source of agricultural operating credit, and their real estate loans will be treated much like residential real estate loans. Smaller borrowers with sound credit histories, however, will likely have little trouble obtaining credit. Using the Economic Research Service's farm typology (USDA/ERS, 2000), the farms most likely to be impacted by this trend are small family farms (limited resource, residential/retirement, lower and higher sales farming occupation). Of these, the most affected will likely be the lower and higher sales farming occupation farmers who may utilize operating lines of credit.

As farms continue to grow larger and more complicated, it will be critical for researchers and lenders to carefully consider the adverse selection and moral hazard problems associated with credit risk assessment. When lending to larger farms, it is essential the loan officer has the expertise to unwind the complicated financial arrangements characteristic of larger farmers. Many large farmers will make use of complicated hedging and risk management activities that, when used improperly, can actually increase risk. In addition, lenders will need to make sure they have control mechanisms in place which can monitor borrower activities. This will become increasingly difficult as the geographic size and location of these borrowers increase. Finally, accurate evaluation of management capacity on larger farms will be critical to making wise credit risk choices. Additional research is needed to help identify key indicators of borrower managerial capacity.

Conclusion

Development and refinement of credit risk assessment models has been an ongoing priority of agricultural economists. Over the past four decades, enhanced computational power and new analytical methods have enabled both greater estimation precision and breadth.

Researchers have rigorously tested the empirical performance and usefulness of estimated models on a routine basis. Moreover, as regulators created new opportunities for credit risk assessment, researchers responded and reformulated their models in an effort to meet this critical need.

Although considerable effort has been devoted to the problem thus far, many questions remain unanswered. The changing structure of agriculture will likely result in unique and individually estimated credit risk assessment models for each segment. Future credit risk assessment models will also likely vary depending on whether the resulting information is being used for loan assessment, regulatory, or individual producer decision making. The constant tension between transactional and relationship methods of estimation still exists and will no doubt continue. As in the past, new analytical methods and greater collaboration with other disciplines can be expected to result in relationships and models that provide even greater insight into the delicate interrelated decisions of borrowers, lenders, and regulators.

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Developments in Portfolio Management and Risk Programming Techniques for Agriculture

Calum G. Turvey, Cesar L. Escalante, and William Nganje

Abstract

This paper reviews various optimization approaches used to address a variety of issues related to risk in agricultural finance and farm management. The central focus is in the Markowitz mean-variance model, which represents the classical approach to balancing risk and returns in an optimization framework. We also review other models that have been used historically to solve linearizations of the mean-variance problem including MOTAD and target MOTAD. Specialized optimization models such as Target semivariance and direct expected utility maximization are also discussed.

Key words: direct expected utility maximization, MOTAD, quadratic programming, risk programming, semivariance

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The purpose of this paper is to review and interpret various optimization approaches taken in the agricultural economics literature to address a variety of issues related to risk. The central focus is in the Markowitz (1959) mean-variance model, which represents the classical approach to balancing risk and returns in an optimization framework. We also review other models that have been used historically to solve linearizations of the mean-variance problem.

Further, we believe it is important in this review to develop the models not only mathematically and operationally, but with numerical solutions as well. There are two reasons why empirical applications should be presented. First it is often too easy to pick a model off the shelf for modeling purposes, but one must take care in understanding the true nature of risk being modeled, and how constraints and model structures affect solutions. Second, agricultural economists in general, and the sub-disciplines of agricultural finance and farm management, have a rich history of model use.

This paper reviews the Markowitz (1959) versus Freund (1956) approaches to quadratic risk programming from the 1950s; examines some of its linear alternatives such as the single-index model from the 1960s; broadens the definition of risk to consider downside-risk or semivariance models such as MOTAD, target MOTAD, and target semivariance from the 1970s and 1980s; and illustrates modern developments in direct expected utility maximization from the 1980s and 1990s.

Risk and Tradeoffs in Agricultural Production

Decision making under uncertainty involves the tradeoff between risk and returns. These tradeoffs are usually illustrated graphically with an E-V or expected value variance frontier that describes the complete set of efficient choices under uncertainty. A typical objective in agricultural economics is to determine an optimum operating plan, e.g., a portfolio of crops, which simultaneously provides either the lowest risk for a given level of expected income (or wealth) or the highest expected income for a given level of risk (portfolio standard deviation or variance). These arguments are consistent with at least second-order stochastic dominance and the expected utility hypothesis.

The inclusion of risk and the derivation of an optimum plan under uncertainty are important components of farm planning. They are also relevant since general axioms of expected utility theory are fully considered. However, farm modeling as such should not be considered a panacea for resolving problems in a positivist sense. Many researchers have come to accept approximate solutions as adequate (Hazell, 1971), others have focused widely on the data distributions (Chen, 1971; Adams, Menkhaus, and Woolery, 1980), while still others question whether small deviations from the efficient frontier are ever relevant (Schurle and Erven, 1979).

Quadratic Programming

The quadratic program is most commonly used to derive optimum farm plans under uncertainty. Several approaches have been used. The first is the Markowitz (1959) approach which minimizes the portfolio variance as defined by the interaction of variances and covariances with the activity levels subject to a set of linear constraints and nonnegativity, i.e.:

$$\begin{aligned} (1)\quad \text{Min } & \tfrac{1}{2}\mathbf{x}'\mathbf{Q}\mathbf{x}, \\ \text{s.t.: } & \mathbf{c}'\mathbf{x} \geq k \\ & \mathbf{A}\mathbf{x} \leq \mathbf{b} \\ & \mathbf{x} \geq 0, \end{aligned}$$

where $\mathbf{x}$ is a vector of crop alternatives; $\mathbf{Q}$ is a matrix of variances and covariances; $\mathbf{c}$ is a vector of activity gross margins or other economic measure, normally evaluated at their expected values; k is a scalar; $\mathbf{A}$ is a matrix of technical resource coefficients; and $\mathbf{b}$ is a vector of resource constraints. The E-V formulation yields a solution that maximizes expected utility if either (*a*) utility is quadratic, or (*b*) expected returns are normally distributed and utility is negative exponential.

The use of quadratic utility is discouraged since, over some range of relative risk aversion, inconsistent risk attitudes are exhibited. Thus the range of risk-aversion coefficients must be restricted.

A second formulation is attributed to a study by Freund (1956). Assuming a negative exponential utility and a joint density which is multivariate normal, the expected utility can be specified as:

$$\begin{aligned} (2)\quad \text{Max } & E[U] = \mathbf{c}'\mathbf{x} - \frac{\alpha}{2}\mathbf{x}'\mathbf{Q}\mathbf{x}, \\ \text{s.t.: } & \mathbf{A}\mathbf{x} \leq \mathbf{b} \\ & \mathbf{x} \geq 0, \end{aligned}$$

where α is the Pratt-Arrow coefficient of constant absolute risk aversion.

Robison and Barry (1987) provide an excellent example of how formulation (2) can be used in economic analysis. In particular, they show that the value of the objective function is in fact the certainty equivalent of the gamble where the economic gamble is the risky crop portfolio. An advantage of formulation (2) over (1) is that risk aversion is explicitly incorporated in the objective function through the Pratt measure of α. Explicit consideration of α is thought by some researchers to be advantageous because specific, formal tests and examinations of

hypotheses based on the expected utility model can be formulated.

The equivalence rule establishes that a primal and dual solution of the risk-minimizing problem can be transformed into the primal and dual solutions of the expected utility-maximizing model. The risk-aversion coefficient is the inverse of the shadow price of the income constraint, and the dual values are recovered by dividing the risk-minimizing Lagrangeans through by the scalar Z (Turvey and Driver, 1986).

From these results, it can be shown that $dE[U] = dk$. If $dE[U]$ is regarded as the certainty equivalent (Robison and Barry, 1987), then a one-to-one correspondence exists between the certainty equivalent and income. A direct corollary is that for any element in $\mathbf{B}$, $\partial E[U]/\partial B = \partial K/\partial B$ or, in terms of the shadow prices, $W = Y/Z$ (Turvey and Driver, 1986).

To see the equivalence rule, consider the Lagrangean forms of (1) and (2) as:

$$\text{(3a)}\quad \text{Min L} = \sigma^2 = \tfrac{1}{2}\mathbf{x}\mathbf{Q}\mathbf{x} + \mathbf{y}(-\mathbf{b} + \mathbf{A}\mathbf{x}) + \mathbf{z}(k - \mathbf{c}'\mathbf{x}),$$

$$\text{(3b)}\quad \text{Max L} = E[U] = \mathbf{C}'\mathbf{x} - \frac{\alpha}{2}\mathbf{x}'\mathbf{Q}\mathbf{x} + \mathbf{w}(\mathbf{b} - \mathbf{A}\mathbf{x}),$$

where $\mathbf{y}$, $\mathbf{z}$, and $\mathbf{w}$ are $m \times 1$, 1×1, and $m \times 1$ vectors of Lagrangean multipliers, respectively. Both model formulations will map out the exact E-V frontiers by varying k in (3a) and α in (3b). We use this aspect of the problem to establish the equivalence rule.

Primal optimization for the solution vector $\mathbf{x}^*$ results in the following Kuhn-Tucker constraint qualifications. For (3a),

$$\text{(4a)}\quad \nabla_{\mathbf{x}}\sigma^2 = \mathbf{Q}\mathbf{x} + \mathbf{A}'\mathbf{y} - \mathbf{z}\mathbf{x} \geq 0,$$

$$(\nabla_{\mathbf{x}}\sigma^2)'\mathbf{x}^* = \mathbf{x}^{*\prime}\mathbf{Q}\mathbf{x} + \mathbf{y}'\mathbf{A}\mathbf{x}^* - \mathbf{z}\mathbf{c}'\mathbf{x} = 0,$$

and for (3b),

$$\text{(4b)}\quad \nabla_{\mathbf{x}}E[U] = \mathbf{c} - \alpha\mathbf{Q}\mathbf{x}^* - \mathbf{A}'\mathbf{w} \leq 0,$$

$$\left[\nabla_{\mathbf{x}}E[U]\right]'\mathbf{x}^* = \mathbf{C}'\mathbf{x}^* = \alpha\mathbf{x}^{*\prime}\mathbf{Q}\mathbf{x}^* - \mathbf{w}'\mathbf{A}\mathbf{x}^* = 0.$$

Equating (4a) and (4b) results in the following identity:

$$\text{(5)}\quad \alpha\mathbf{x}^{*\prime}\mathbf{Q}\mathbf{x}^* + \mathbf{w}'\mathbf{A}\mathbf{x}^* = \left(\frac{1}{\mathbf{z}}\right)\mathbf{x}^{*\prime}\mathbf{Q}\mathbf{x}^* + \left(\frac{\mathbf{y}}{\mathbf{z}}\right)'\mathbf{A}\mathbf{x}^*.$$

The only conditions under which equation (5) holds are if $\alpha = 1/\mathbf{z}$, and the elements in the $\mathbf{w}$ vector correspond to the elements in the $\mathbf{y}$ vector divided by $\mathbf{z}$ [i.e., $\mathbf{w} = (1/\mathbf{z})\mathbf{y}$]. This is the equivalence condition. By definition, the Lagrangean $\mathbf{z}$ is defined as

$$\frac{\partial(\tfrac{1}{2}\sigma^2)}{\partial k},$$

i.e., the marginal change in variance arising from a \$1 change in income K. By equivalence, the implied risk-aversion coefficient is defined as

$$\frac{\partial k}{\partial(\tfrac{1}{2}\sigma^2)}, \quad \text{or} \quad \frac{\partial(\mathbf{c}'\mathbf{x}^*)}{\partial(\tfrac{1}{2}\mathbf{x}^{*\prime}\mathbf{Q}\mathbf{x}^*)}$$

if the income constraint is binding (which it should always be).

The condition $\mathbf{w} = \mathbf{y}/\mathbf{z}$ is an interesting result, not only in terms of the equivalence rule, but also in terms of the relationship between shadow prices. For example, any non-monetary objective function such as $\tfrac{1}{2}\mathbf{x}'\mathbf{Q}\mathbf{x}$ which has units of \$^{2} (or any other money metric) can be converted into monetary terms by dividing through by a shadow price which is denominated in \$. A generalization of this result is discussed in Preckel, Featherstone, and Baker (1987).

As to which of the two models should be selected for risk analysis is thus a matter of simple choice. In theoretical applications where explicit knowledge of the risk-aversion coefficient is unknown but required, it can be recovered from the

risk-minimizing solution. However, in many applications explicit knowledge of α is not required and it becomes only a parameterization coefficient. If explicit knowledge of risk aversion is not required, either model should do.

In situations where farmers are to select optimum plans it is far easier to parameterize the E-V frontier by changing income levels [model (3a)] than first estimating a single risk-aversion coefficient and using that in the analysis [as in model (3b)]. An example quadratic program for corn, soy, and wheat production is given by:

$$(6)\quad \text{Min}\begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix} \times \begin{bmatrix} 13{,}143.34 & 8{,}457.24 & 4{,}018.70 \\ 8{,}457.24 & 8{,}317.33 & 1{,}796.99 \\ 4{,}018.70 & 1{,}796.99 & 5{,}859.52 \end{bmatrix} \times \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix},$$

$$\text{s.t.: } 1x_1 + 1x_2 + 1x_3 \leq 400 \text{ (Land)}$$

$$235.42x_1 + 233.76x_2 + 194.09x_3 \geq 82{,}000 \text{ (Income)}.$$

The 3×3 variance-covariance matrix describes the joint probability distribution between corn, soybeans, and wheat net revenues in real 1990 dollars. This model has two constraints. The first constraint states that the amount of land allocated to the crops must be less than or equal to 400 acres, and the second states that expected income from these growing activities, given each activity's net return level, must be at least $82,000 (or any other level of expected income). The raw data for the empirical examples in this paper are presented in Table 1. Although variable costs are included, they are deterministic so that the stochastic relationships are defined by gross revenue interaction.

The model was run by varying the right-hand side of the income constraint from $82,000 to $94,168. Alternatively, the model can be specified in the Freund format and by parameterizing α from 0 to an appropriate level (in this case 0.000126). These results are presented in Table 2.

The results, also graphed in Figure 1, are indicative of risk-return tradeoffs commonly observed in farm planning models. The upward-sloping graph in Figure 1 is the E-V frontier. It is increasing at a decreasing rate which shows that the incremental increase in risk per dollar of income is greater than 1. The downward-sloping curve in Figure 1 maps out the implied risk-aversion coefficients for the various farm plans. These were obtained by inverting the shadow price on the income constraint to obtain

$$\alpha = \frac{1}{2}\,\frac{\partial \mathbf{x}'\mathbf{Q}\mathbf{x}}{\partial k}.$$

Substituting these α coefficients into the certainty equivalent model will generate an identical E-V frontier with farm plans identical to those in Table 2.

Note that as risk increases, the risk-aversion coefficient decreases, implying less risk-averse behavior. The point at which $\alpha = 0$ is the profit-maximizing risk-neutral solution, with expected income equaling $89,410. At low levels of income (high risk aversion), the farm portfolio is comprised primarily of soybeans and wheat. (Income levels below $82,000 are feasible, but solutions are obtained with land held in slack.) At $k = \$85{,}000$ (implied $\alpha = 0.000018$), corn starts to enter the solution as a substitute for soybeans and wheat. The risk-neutral solution ($89,410) is comprised of 238.58 acres of corn and 161.42 acres of soybeans. This solution is the maximum risk, maximum income combination obtainable with this math program.

Table 1. Activity Net Revenues (1990 = 100, excluding hired labor)

State	Corn Acres	Soybean Acres	Wheat Acres
1	264.84	240.63	180.16
2	228.99	213.48	172.16
3	226.45	202.13	156.14
4	506.22	370.27	269.13
5	196.51	146.80	429.40
6	409.59	220.98	257.30
7	263.26	202.97	147.98
8	269.09	351.36	160.77
9	278.23	350.56	138.40
10	291.84	332.33	292.18
11	434.53	432.46	262.91
12	248.01	268.32	244.89
13	159.45	178.11	116.15
14	285.12	302.84	161.27
15	221.07	186.58	212.73
16	76.15	150.32	176.79
17	78.37	123.18	110.08
18	158.18	190.70	191.93
19	157.10	213.90	144.12
20	105.81	104.74	118.71
21	85.12	126.36	132.76
Expected Value	235.42	233.76	194.09
Standard Deviation	114.64	91.20	76.55
Beta Coefficient [a]	1.3757	0.9973	0.6270
Crop	**Variance-Covariance Matrix**		
Corn	13,143.34	8,457.24	4,018.70
Soybeans	8,457.24	8,317.33	1,796.99
Wheat	4,018.70	1,796.99	5,859.52

[a] The beta coefficient is estimated by regressing corn, soybeans, and wheat against an equally weighted portfolio index. The expected value of the reference portfolio is $221.09, with a standard deviation of $78.79.

Applications of Quadratic Programming

From an historical point of view, three influential applications of quadratic programming models were contributed by Scott and Baker (1972); Lin, Dean, and Moore (1974); and Adams, Menkhaus, and Woolery (1980). The first two papers are significant as they were among the first to apply quadratic programming (QP) to problems in agricultural finance, and the third is important because of the manner in which it examined the structure of E-V frontiers under several specifications of the expected income and variance parameters.

Scott and Baker (1972) recognized the duality between Freund's (1956) expected utility-maximization approach to portfolio selection and Markowitz's (1959) variance-minimization approach to farm-level quadratic programming. Specifically, Scott and Baker recognized that the

Table 2. Quadratic Programming Results for Hypothetical Farm

Risk-Aversion Coefficient	Income ($)	Standard Deviation ($)	Certainty Equivalent	Acres		
				Corn	Soybeans	Wheat
0.000068	82,000	19,004	57,441	0.00	210.51	189.49
0.000048	83,000	19,469	64,806	0.00	234.95	165.05
0.000037	84,000	20,081	69,080	0.00	259.38	140.62
0.000018	85,000	20,987	77,071	39.45	237.55	123.00
0.000015	86,000	22,420	78,460	76.21	232.04	91.74
0.000013	87,000	24,011	79,505	112.98	226.54	60.48
0.000011	88,000	25,732	80,716	149.79	221.04	29.22
0.000009	89,000	27,559	82,164	191.57	208.43	0.00
0.000008	89,410	28,427	82,945	238.58	161.42	0.00

mean-variance frontiers resulting from both models were identical. In much the same way as Turvey and Driver (1986) acknowledged this problem, Scott and Baker proposed that in extension applications, farmers can choose the enterprise combinations and levels of production on the basis of their own preferences or introspective risk aversion. Scott and Baker's model used net revenues in the linear objective of a model similar to equation (2), but employed gross revenues to calculate the variance-covariance matrix (an implicit assumption of deterministic costs). Moreover, farm plans included opportunities for participation in government programs.

Scott and Baker's (1972) model, while similar to that in equation (2), substituted a parameter ($\phi = \alpha/2$) to correspond with Baumol's (1963) risk-aversion coefficient. By parameterizing ϕ, a mean-variance frontier was generated. The selection of a farm plan from this opportunity set implies a risk-aversion coefficient equal to ϕ. The method altogether avoids explicit and prior knowledge of the risk-aversion coefficient.

Interestingly, Scott and Baker (1972) state they used the above formulation instead of the risk-minimization approach because it has "direct correspondence with the QP-risk aversion model" (p. 658). Scott and Baker presented the results of their study in terms of Baumol's (1963) gain-confidence limits. That is, for every E-V pair

$$\{\mathbf{c}'\mathbf{x},\ \sqrt{\mathbf{x}'\mathbf{Q}\mathbf{x}}\},$$

they generate the confidence limits

$$\mathbf{c}'\mathbf{x} - Z\sqrt{\mathbf{x}'\mathbf{Q}\mathbf{x}},$$

where Z is a normal standard deviate. Under the assumption of normality, the probability of income being greater than one standard deviation from expected is 84%, and the probability of getting above 1.96 standard deviations is 97.5%. Thus, by establishing the confidence limits, greater use is made of the probability environment.

The effect of using confidence limits is illustrated in Figure 2 for confidence limits +0.5 and -0.5 standard deviations from the expected base solution of Table 2. Since the base solution lies on a 50% confidence limit, the probability of exceeding or falling below points on the E-V frontier is 50%. The probability of exceeding income level on the $k + 0.5\sigma$ frontier is 30.85%, and the probability of falling below the $k + 0.5\sigma$ frontier is 30.85%. The probability of outcomes falling between the upper and lower confidence limits is 38.3%. Scott and Baker argue that these confidence limits should be used in conjunction with the expected income-variance criteria to provide a complete risk profile of individual portfolios from which strategy choices can be selected.

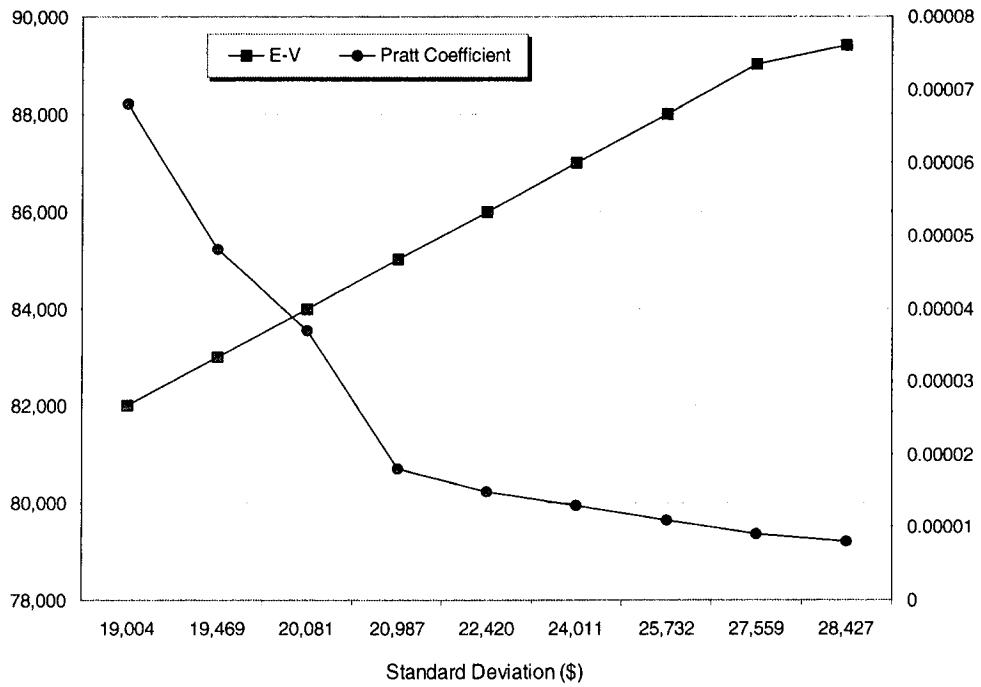

Figure 1. The E-V Frontier and Risk Aversion

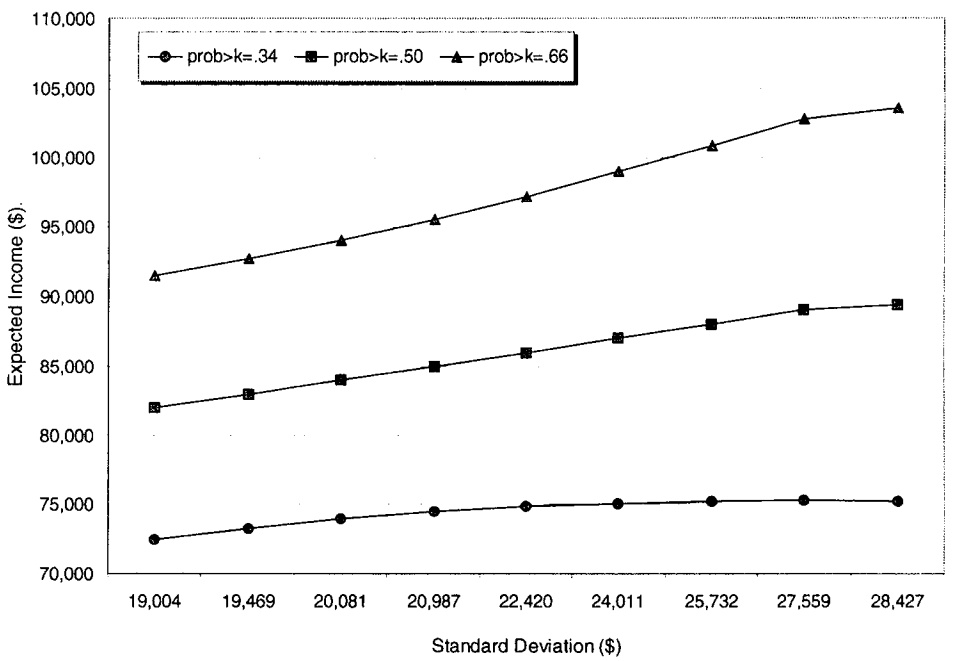

Figure 2. E-V Frontiers and Baumol's Gain-Confidence Limits

Lin, Dean, and Moore (LDM) (1974) tested the hypothesis that utility theory is a more accurate prediction of farm behavior. This objective was motivated by considerable research indicating that economic rationality implies profit maximization. To achieve the stated hypothesis, LDM generated a mean-variance frontier from a model similar to (2), except they fixed $\alpha = 1$. To maintain a Bayesian subjective probability framework, LDM elicited subjective estimation of expected returns and variances from six farms participating in their study. As the farmers were unable to provide covariance (i.e., correlation coefficients), these were taken from objective detrended time-series covariance relationships. Unique to this study, E-V frontiers were generated after-tax.

The next step involved deriving Bernoullian (subjective probability) and Lexicographic (goal-setting) utility functions. For each of the farms in the LDM study, these utility functions were compared to the E-V efficient plans and the risk-neutral profit-maximizing farm plan. In all cases, profit-maximization was rejected in favor of Bernoullian or Lexicographic utility—i.e., actual plans to predicted plans were closer in the latter than the former. Because there were substantial differences between the predicted and actual plans, the farmers were then asked to select the favored plan from the set defined to the E-V frontier. The selected plan was identical to that chosen by the Bernoullian utility function for three of the six plans, and was close for two others. Neither profit maximization nor Lexicographic utility performed as well. Indeed, recognizing that the profit-maximizing solution is the linear programming (LP) solution, LDM state, "this may explain why standard linear programming results are often disregarded by farmers as 'unrealistic' and why aggregation of individual farm LP studies to predict supply functions usually have overestimated actual response" (p. 507).

The approach to risk analyses has thus far not been overly concerned with data definitions and other model assumptions relevant to the position of the frontier in E-V space. Yet the problem reported in Adams, Menkhaus, and Woolery (1980) (AMW) is directly related to just these points. As a result, the problem they illustrate is that fragility with respect to data specification is a fundamental limitation of the E-V approach to farm-level decision making.

In the absence of subjective probabilities about risky outcomes, the most common approach to farm planning under uncertainty is to derive subjective probabilities from historical time series using objective measures. Yet researchers continually argue over what expected revenues should be used, whether or not historical data should be detrended and/or deflated, or prices represented in real or normal terms.

AMW generated E-V solutions for a U.S. Midwestern cash-crop farm using historical enterprise gross margins. Four specifications were used:

- Historical Mean: 20-year average (non-deflated) gross margin for the **C** vector;
- Total Variance: variance calculated from non-detrended data deferral;
- Contemporary Income: most recent four-year average, deflated and detrended; and
- Random Variance: detrended data used for variance (used in the error component method).

Based on these definitions, there were four possible combinations of **C** and $\mathbf{\Omega}$ vectors and matrices defined.

The results are generalized in the box below, and in Figure 3. The ovals in Figure 3 are illustrative of the efficient set results of AMW. In general, AMW found that the contemporary income value tends to increase overall expected income and the efficient set relative to historical means, while a detrended, or random variance, tends to cause a reduction in variance relative to total variance—a result

Data Representation in Risk Programming

Historical Mean total variance	Contemporary Mean total variance
Historical Mean random variance	Contemporary Mean random variance

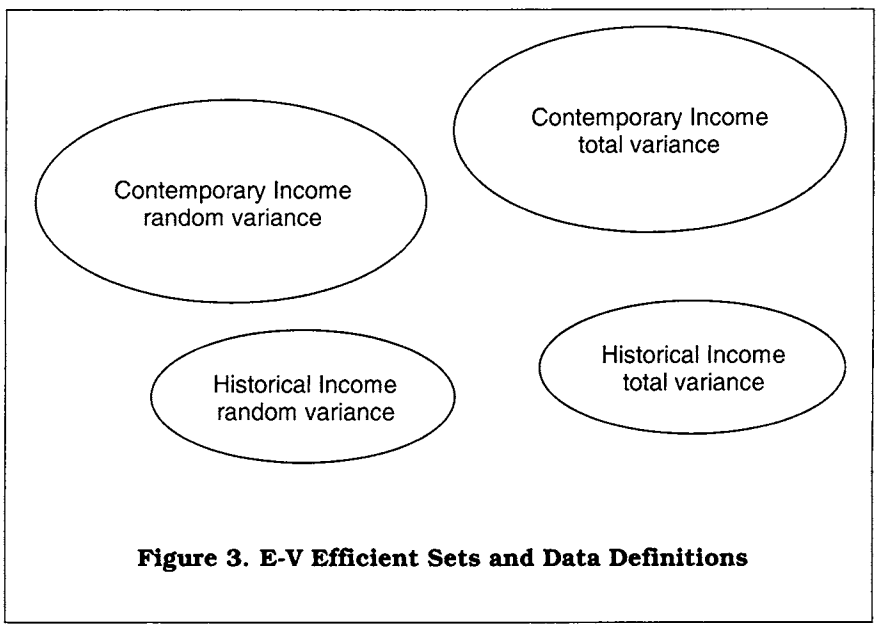

Figure 3. E-V Efficient Sets and Data Definitions

which is not surprising since the purpose of detrending is to eliminate variance which has been induced by technological innovation.

AMW note that decision makers may not necessarily be interested in the shape or location of the E-V frontier, but in the crop mixes along the frontier. With the sole exception of the risk-neutral solution, there were substantial differences in crop mixes. Specifically, for a given level of contemporary income but different definitions of risk, the farm plans were not similar (Figure 3). Unfortunately, the authors leave open the question as to which is best, or even correct.

Indeed, the problems raised by AMW are fundamentally important to quadratic programming in particular and risk programming in general. One of the more contentious issues (which they fail to raise) is the use of gross revenues or gross margins (net of variable costs) to obtain variance measures. It may be suggested that gross margins overstate risk because interyear changes in input prices and usages are assigned to variance, even though these costs are known, for example, at planting time when the decision is made as to what crop mix to grow. These costs are virtually deterministic, and hence the only relevant stochastic variables are price and yield which occur at the end of the crop year. Still, the vast amount of literature on this subject is at variance with this point of view. Consequently, the current status on risk assessment in terms of data definitions is still completely ambiguous.

The Single-Index Model

An alternative approach to modeling risk in a quadratic programming framework was introduced by Collins and Barry (1986), and Turvey, Driver, and Baker (1988). In these studies the quadratic programming solution is defined in terms of Sharpe's (1963) single-index model (SIM). This approach argues that there are in fact two components to enterprise risk: systematic or nondiversifiable risk, and nonsystematic or diversifiable risk.

Systematic risk is defined as that portion of enterprise risk which is correlated with the returns of the farm portfolio, while nonsystematic risk is uncorrelated with the farm sector portfolio. Since systematic risk is correlated with an already diversified portfolio, then further diversification cannot reduce this risk. Diversification can, however, potentially reduce nonsystematic risk. [For more on these technical details, see Turvey and Driver (1987) or Turvey (1991).] To obtain measures of systematic and nonsystematic risk, the following OLS regression is run for each of the enterprises considered in the portfolio:

$$(7) \quad \mathbf{R}_i = \alpha_i + \beta_i \mathbf{R}_p + e_i,$$

where $\mathbf{R}_i$ is the vector of enterprise gross revenues over time, $\mathbf{R}_p$ is the vector of portfolio revenues over time

$$\left(\mathbf{R}_p = \frac{1}{n} \sum_{i=1}^{n} \mathbf{R}_i \right),$$

e_i are the residual errors (with $E[e_i e_j] = 0$), and α_i and β_i are the model parameters. The expected value of (7) is:

$$(8) \quad \bar{\mathbf{R}}_i = \alpha_i + \beta_i \bar{\mathbf{R}}_p,$$

and the variance of i is defined by

$$(9) \quad \mathrm{Var}[\mathbf{R}_i] = e\left[\mathbf{R}_i - E[\mathbf{R}_i] \right]^2$$

or

$$(10) \quad \sigma_i^2 = \beta_i^2 \sigma_p^2 + \sigma_{ei}^2.$$

The first component on the right-hand side in equation (10) is the systematic risk measure, and the second component is the nonsystematic risk.

Using the definition of portfolio variance,

$$\sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j \rho_{ij} \sigma_j \sigma_i,$$

and the fact that enterprise covariance is defined by

$$E\left(R_i - E[R_j]\right)\left(R_j - E[R_j]\right) = \beta_i \beta_j \sigma_p^2,$$

the variance of the portfolio can be written as

$$(11) \quad \sigma^2 = \left[\sum_{i=1}^{n} x_i \beta_i \right]^2 \sigma_p^2 + \sum_{i=1}^{n} x_i^2 \sigma_{ei}^2.$$

The first term on the right-hand side in equation (11) is called the Portfolio Beta, which measures the systematic risk of the portfolio. It includes both variances and covariances, as its expansion would show.

The single-index model, as stated in (11) above, is in fact a diagonal model with $n+1$ nonlinear objective function values. The form of the equation is as follows:

$$(12) \quad \mathrm{Max}\left[x_1 x_2 x_3 \ldots x_n x_p \right]$$

$$\times \begin{bmatrix} \sigma_{e1}^2 & & & & & & \\ & \sigma_{e2}^2 & & & & & \\ & & \sigma_{e3}^2 & & & & \\ & & & \ddots & & & \\ & & & & \sigma_{en}^2 & & \\ & & & & & \sigma_{ep}^2 & \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \\ x_p \end{bmatrix},$$

$$\text{s.t.: } 1x_1 + 1x_2 + 1x_3 + \ldots + 1x_n \le \mathit{Land}$$

$$R_1 x_1 + R_2 x_2 + R_3 x_3 + \ldots + R_n x_n \ge k$$

$$\beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_n x_n - 1x_p = 0.$$

Nonnegativity, as well as other constraints, can be added to the model. The $\sigma_{\varepsilon i}^2$ terms are the residual variance from the OLS characteristic regressions (7) and (8), and σ_p^2 is the variance of the reference portfolio, $\mathbf{R}_p$. The beta constraint in (12) multiplies acreages by the respective beta coefficients and then sets them equal to the variable x_p, which is then transferred to the objective function and squared.

Applying this model to a beef feedlot operation in southern Ontario, Turvey, Driver, and Baker (1988) found that 4 of 13 farm plans were identical to conventional quadratic programming (QP) solutions, and none of the other plans deviated by more than 4%. These results were different than those reported by Collins and Barry (1986) (they used a different model formulation), where the variance of their model was found to differ by 16%.

The advantage of the SIM diagonal QP framework is that it requires substantially less information than the conventional QP. For example, the number of parameters required to solve the problem are n beta coefficients, n measures of nonsystematic risk, and the portfolio variance (i.e., $2n+1$), whereas the conventional QP requires $n(n+1)/2$ pieces of information (variances and covariances). Perhaps more important is the information content of the beta coefficient. In addition to their use in the diagonal model, they hold substantial promise as a standard definition of enterprise risk (Turvey and Driver, 1987; Turvey, 1991).

Turvey, Driver, and Baker (1988) also developed a linear programming formulation of the single-index model. In this formulation the objective function is simply to

$$\text{Min } X_p = \sum_{i=1}^{n} \beta_i X_i,$$

subject to the system constraint. The form of this model is written as:

$$\begin{aligned} (13)\quad \text{Min } & x_p, \\ \text{s.t.: } & \beta'\mathbf{x} - x_p = 0 \\ & \mathbf{Ax} \le \mathbf{b} \\ & \mathbf{c}'\mathbf{x} \ge 0 \\ & \mathbf{x} \ge 0, \end{aligned}$$

where β is the $n \times 1$ vector of beta coefficients and x_p is the portfolio beta. In their study, Turvey, Driver, and Baker found this problem formulation provided solutions identical to the QP framework for 11 of 13 farm plans.

The reason for this result becomes evident when looking at the exact marginal risk criterion used in quadratic programming. For example, variance is measured as:

$$(14)\quad \frac{1}{2}\sigma_p^2 = \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j \sigma_{ij},$$

where σ_{ij} are covariances and σ_{ii} are variances.

The derivative

$$(15)\quad \frac{1}{2}\frac{\partial \sigma_p^2}{\partial x_i} = \sum_{j=1}^{n} x_j \sigma_{ij} = \sigma_{ip},$$

which is the covariance between crop i and portfolio returns. But we know by definition that the beta coefficient, as a measure of systematic risk, is just an index of the covariance between crop i and the portfolio; that is

$$(16)\quad \beta_i = \frac{\sigma_{ip}}{\sigma_{pp}} = \frac{\delta_{ip}\sigma_p}{\sigma_{pp}^2}.$$

The marginal risk is therefore $\sigma_{ip} = \beta_i \sigma_p^2$. Hence, the use of beta coefficients provides a definitive measure of marginal risks and as such the optimizing criteria are virtually identical.

As an example of the SIM in practice, consider the following beta coefficient, nonsystematic risk pairs (β_i, $\sigma_{\varepsilon i}^2$) for corn, soybeans, and wheat, respectively: (1.3757, 1,395.60), (0.9973, 2,143.50), and (0.6270, 3,419.23). The variance of the reference portfolio (σ_p^2) is 6,207.34.

Both single-index models were run, with the σ_{ei}^2 and σ_p^2 making up the diagonal elements of the quadratic objective function in (12) (the off-diagonal elements are zero), and the β_i being the coefficients in the beta-risk constraint. With the exception of the added beta-risk constraint, and the x_p column variable in the objective, the model is identical to that for the QP problem and the off-diagonal elements in the QP file are set to zero. The results are presented in Table 3 for the quadratic SIM formulation and Table 4 for the linear SIM formulation.

The quadratic SIM model should theoretically provide results identical to the conventional QP formulation since it minimizes both systematic and nonsystematic risk. Five of the nine solutions in Table 3 are identical to those in Table 2 for the QP, and Table 4 for the linear SIM, although the profit-maximizing solution would necessarily be the same. Of those solutions that differ (K = \$85,000 to K = \$88,000), the total risk differences of the farm plans are negligible. Similarly, the linear programming formulation has five of nine plans identical to the QP formulation. However, the plans which differ (K = \$85,000 to K = \$88,000) show substantial differences in risk; i.e., the SIM linear program provides farm plans which are more risky than the QP. For example, at \$86,000, the standard deviation of the QP solution is \$31,707, whereas the linear SIM model's standard deviation is \$32,425.

The reason for this result is that the SIM linear program minimizes systematic risk while ignoring nonsystematic risk. In principle, this nonsystematic risk is essentially commodity specific (uncorrelated white noise), and on this premise it makes sense to concentrate only on minimizing systematic risk. By comparing the systematic risk results reported in Table 4 to those in Table 3, it is evident that systematic risk with the linear SIM model is no greater than that for the quadratic formulation, and for four of the nine plans it is less. For these four plans, minimizing systematic risk permits selecting farm plans which have greater total risk than either of the quadratic (total risk) formulations.

MOTAD and Target MOTAD

MOTAD, and target MOTAD, are often considered as models which challenged the conventional QP approach to risk programming. The earliest model used the excuse that the model formulations were appropriate since QP algorithms were rare and expensive (Hazell, 1971; Thomson and Hazell, 1972a,b). Given the advancements in computer technology, this is no longer the case; however, MOTAD formulations are still being widely used. MOTAD as introduced by Hazell considered using the mean absolute deviation in a linear program as a substitute for the full variance-covariance matrix.

$$(17)\quad MAD = \left| \frac{1}{k} \sum_{k=1}^{k} \sum_{i=1}^{n} (c_{ki} - \bar{c}_i) x_i \right|,$$

where k is the number of discrete states of nature, c_{ki} represents the revenue of enterprise i in state k, $\bar{c}_i$ denotes the mean of the enterprise i revenue distribution, and the x_i are the activity levels. The minimization of total absolute deviations is accomplished by defining a variable,

$$(18)\quad Y_{ki} = \sum_{i=1}^{n} (c_{ki} - \bar{c}_i) x_i$$
$$= (Y^+ - Y^-) x [Y^+, Y^-] \geq 0$$
$$(k = 1, \ldots, n).$$

Hence, the state-dependent deviation can be defined as

$$Y_k = \text{Min}\left[\sum (c_{ki} - \bar{c}_i) x_i < 0,\ 0 \right],$$

which takes on a value $Y_k < 0$ or $Y_k = 0$. For each k, we can then establish a constraint,

$$(19)\quad \sum_{i=1}^{n} (c_{ki} - \bar{c}_i) x_i - Y_k^+ + Y_k^- = 0$$
$$\forall\, k = 1, \ldots, k.$$

Table 3. Single-Index Model Results for Hypothetical Farm

Expected Income ($)	Risk $(x'\Omega x)^{1/2}$	Portfolio Beta $(\Sigma x_i\beta_i)$	Systematic Risk $(\Sigma x_i\beta_i)\sigma_p$	Acres		
				Corn	Soybeans	Wheat
82,000	26,876	328.75	25,901	0.00	210.51	189.49
83,000	27,534	337.80	26,614	0.00	234.95	165.05
84,000	28,400	346.85	27,327	0.00	259.38	140.62
85,000	29,686	367.20	28,930	33.96	245.25	120.79
86,000	31,735	390.35	30,754	61.27	252.99	85.74
87,000	34,027	413.67	32,592	88.58	260.73	50.69
88,000	36,391	436.98	34,428	115.88	268.48	15.64
89,000	38,975	471.41	37,141	191.57	208.43	0.00
89,410	39,235	489.19	38,542	238.60	161.40	0.00

Table 4. Linear Program SIM Results for Hypothetical Farm

Expected Income ($)	Risk $(x'\Omega x)^{1/2}$	Portfolio Beta $(\Sigma x_i\beta_i)$	Systematic Risk $(\Sigma x_i\beta_i)\sigma_p$	Acres		
				Corn	Soybeans	Wheat
82,000	26,876	328.75	25,901	0.00	210.51	189.49
83,000	27,534	337.00	26,551	0.00	234.95	165.05
84,000	28,400	346.85	27,327	0.00	259.38	140.62
85,000	29,888	359.24	28,303	0.00	292.83	107.17
86,000	32,425	376.28	29,646	0.00	338.85	61.15
87,000	35,415	393.32	30,988	0.00	384.86	15.14
88,000	36,968	428.03	33,723	76.93	323.07	0.00
89,000	38,975	471.41	37,140	191.57	208.43	0.00
89,410	39,235	489.19	38,542	238.60	161.40	0.00

Since only one of the Y_k^+ or Y_k^- will be chosen, then the absolute deviation can be defined as

(20) $\text{Max}(MAD) = |Y_k| = Y_k^+ + Y_k^-.$

Now, for a given farm plan,

$$Y_k = \left| \sum_{i=1}^{n} (c_{ki} - \bar{c}_i)x_i \right|,$$

when

$$\sum_{i=1}^{n} (c_{ki} - \bar{c}_i) > 0,$$

and zero otherwise; and

$$Y_k = \left| \sum_{i=1}^{n} (c_{ki} - \bar{c}_i)x_i \right|$$

when

$$\sum_{i=1}^{n} (c_{ki} - \bar{c}_i) < 0,$$

and zero otherwise. If the c_i are sample mean gross margins, then by definition,

$$\sum_{k=1}^{K} Y_k^- = \sum_{k=1}^{K} Y_k^+.$$

This results in an alternative formulation which is to minimize only the sum of the absolute values of the negative total gross margin deviations.

Hazell's (1971) model is outlined as follows:

$$\text{(21)}\quad \text{Min } \mathbf{e}'Y^-,$$

$$\text{s.t.: } \mathbf{Ax} \leq \mathbf{b}$$

$$\mathbf{Dx} + \mathbf{I}Y^- \geq 0$$

$$\mathbf{c}'\mathbf{x} \geq k$$

$$\mathbf{x}, Y^- \geq 0,$$

where $\mathbf{D}$ is the $k \times n$ matrix of state dependent deviations from the mean $(c_{kj} - \bar{c}_j)$, $\mathbf{I}$ is a $k \times k$ identity matrix, $\mathbf{e}$ is a $k \times 1$ unit vector, and all other variables are as previously defined. Hazell's results proved to be a reasonable approximation to QP results. However, Thomson and Hazell (1972b) have shown that in terms of relative efficiency in utility maximization, the MAD criteria performed well against the E-V rule, especially when revenue distributions were nonnormal. They also demonstrated that as the number of observations (i.e., k) increased and distributions approached normality in the limit, the E-V criterion was more efficient.

While Hazell's (1971) formulation (21) is widely used as a common approach to MOTAD modeling, an expected utility formulation of the absolute deviation model was introduced by Brink and McCarl (1978). The unique feature of their approach is the conversion of MAD into an approximate standard deviation. Hence, the objective function represents a mean standard deviation formulation of expected utility:

$$\text{(22)}\quad \text{Max } \mathbf{C}'\mathbf{x} - \lambda\varphi\mathbf{e}'Y^-,$$

$$\text{s.t.: } \mathbf{Ax} \leq \mathbf{b}$$

$$\mathbf{Dx} + \mathbf{I}Y^- \geq 0$$

$$\mathbf{x}, Y^- \geq 0,$$

where λ is level of risk aversion, and

$$\varphi = \frac{2}{K}\sqrt{\frac{K\pi}{2(K-1)}}.$$

The scalar φ converts the total negative deviation to an estimate of the standard deviation. K is equal to the number of states of nature in the sample, and π = *pi*. This conversion therefore approximates an objective function of the form:

$$\text{(23)}\quad \text{Max } \upsilon = \mathbf{c}'\mathbf{x} - \lambda\sigma.$$

An alternative model formulation developed independently by Tauer (1983), and Watts, Held, and Helmers (1984), is called target MOTAD. Target MOTAD considers only those deviations below a fixed target—i.e., across all states of nature, expected gross margins plus negative absolute deviations must be greater than some fixed target.

The appeal of target MOTAD rests in its approximation to the concept of Markowitz's (1959) semivariance, which has been found by Porter (1970), and Menezes, Geiss, and Tressler (1980) to be more stochastically efficient than traditional mean-variance analysis. For example, it is often found that optimal solutions using the target semivariance approach are more efficient in reducing risk than quadratic programming solutions. In general, the semivariance criteria can be stated as:

$$\text{(24)}\quad S(T, n) = \int_1^T (T - x)^n f(x)\, dx,$$

where x is the random variable, described by the probability density function $f(x)$. If $n = 0$, then

$$S(T, 0) = \int_1^T (T - x) f(x)\, dx$$

is the cumulative probability of outcomes falling below the fixed target T; if $n = 1$, then

$$S(T, 1) = \int_1^T (T - x) f(x)\, dx$$

is the mean absolute deviation $(T - x > 0)$ below the target; and if $n = 2$,

$$S(T, 2) = \int_1^T (T - x)^2 f(x)\, dx$$

is Markowitz's (1959) semivariance measure. When $T = E[x]$, then risk is

measured as the deviations below the mean and provides an identical interpretation to Hazell's (1971) criteria. However, Porter (1970) hypothesizes the stochastic dominance efficiency criteria do not hold at the mean, so that Tauer's (1983) target MOTAD efficiency criteria appear to be superior to Hazell's.

The model formulations are presented below. Tauer's (1983) formulation is given by:

$$\text{(25)} \quad \text{Max } \mathbf{c}'\mathbf{x},$$

$$\text{s.t.: } \mathbf{A}\mathbf{x} \leq \mathbf{b}$$

$$\mathbf{C}_k\mathbf{x} + \mathbf{I}Y^- \geq T$$

$$\mathbf{P}'Y^- = \Theta$$

$$X, Y^- \geq 0.$$

The model formulation developed by Watts, Held, and Helmers (1984) (and Anderson, Dillon, and Hardaker, 1980) is represented by:

$$\text{(26)} \quad \text{Max } \mathbf{c}'\mathbf{x},$$

$$\text{s.t.: } \mathbf{A}\mathbf{x} \leq \mathbf{b}$$

$$\mathbf{C}_k\mathbf{x} + \mathbf{I}Y^- \geq T$$

$$\mathbf{e}'Y^- \leq \hat{\Theta}$$

$$X, Y^- \geq 0,$$

where $\mathbf{c}$ is an $n \times 1$ vector of activity gross margins; $\mathbf{C}_k$ is a $k \times n$ matrix of gross revenue observations for each activity (x_i) in each period ($k = 1, k$); T is a target level of return which assumes that across all states of nature (the yearly gross margin observations), the level of income must be fixed; $\mathbf{P}$ is a $k \times 1$ vector of probabilities of each of k states of nature; Θ is a constant, parameterized from M to 0, where M is the maximum allowable expected deviations; and $\hat{\Theta}$ is the maximum allowable total absolute deviations.

The formulations of Tauer (25), and Watts, Held, and Helmers (26) are slightly different. Tauer fixes the target level and parameterizes with T, a measure of expected absolute deviations. The constraint multiplies the negative deviations by their probability of occurrence. Watts, Held, and Helmers set the sum of deviations from the target equal to the maximum allowable absolute deviations, but the deviations are not weighted by the probabilities. Therefore, Tauer's T is an expected absolute deviation, while Watts, Held, and Helmers' T represents total absolute deviations.

Unlike the MOTAD solutions in which solutions are generated by parameterizing income, or a risk-aversion coefficient, neither Tauer nor Watts, Held, and Helmers provide any clues as to how the target levels should be chosen or how to come up with an initial Θ or $\hat{\Theta}$. However, it must be recognized that these objectives were to challenge MOTAD, and therefore the MOTAD solutions were used as a point of comparison. In general the authors found that the target MOTAD solutions were second-order stochastic (SSD) efficient relative to MOTAD, and MOTAD is SSD efficient relative to QP. This is because only the negative deviations are penalized. Positive deviations, which are favorable outcomes, are not penalized.

In general, neither Tauer's nor Watts, Held, and Helmer's formulations appear satisfactory in a practical setting primarily because they require a priori estimates of Θ and $\hat{\Theta}$—a task which is formidable in its own right. A more fruitful approach, and one which will provide identical combinations of farm enterprises, is to:

$$\text{(27)} \quad \text{Max } \mathbf{e}'Y^-,$$

$$\text{s.t.: } \mathbf{A}\mathbf{x} \leq \mathbf{b}$$

$$\mathbf{C}_k\mathbf{x} + \mathbf{I}Y^- \geq T$$

$$\bar{\mathbf{c}}'\mathbf{x} \geq k$$

$$X, Y^- \geq 0.$$

Like the risk-minimizing QP and Hazell's (1971) MOTAD, this formulation requires only assessments of k and T, both of which are modestly easy to obtain. In addition, the more likely values of k and T will be such that $k > T$. The investment motive of the semivariance criteria (Porter, 1970) is that investors will tend to establish dual

Table 5. Target MOTAD Solutions for Hypothetical Farm

Minimum Income ($)	Target Income ($)	Actual Income ($)	E[MAD]	Acres		
				Corn	Soybeans	Wheat
		— 100% Target —				
82,000	82,000	82,000	10,972	0.00	210.51	189.49
84,000	84,000	84,000	11,444	0.00	259.38	140.62
86,000	86,000	86,000	12,532	84.99	219.75	95.26
88,000	88,000	88,000	14,270	203.89	145.15	50.96
89,000	89,000	89,000	15,372	228.52	156.64	14.83
89,410	89,410	89,410	15,846	236.57	161.42	0.00
		— 90% Target —				
82,000	73,800	82,000	6,706	0.00	210.51	189.49
84,000	75,600	84,000	7,038	0.00	259.38	140.62
86,000	77,400	86,000	7,925	36.51	287.69	75.81
88,000	79,200	88,000	9,793	202.57	147.01	50.43
89,000	80,100	89,000	10,961	228.52	156.64	14.83
89,410	80,469	89,410	11,440	238.57	161.42	0.00
		— 80% Target —				
82,000	65,600	82,000	3,819	0.00	210.51	189.49
84,000	67,200	84,000	4,119	0.00	259.38	140.62
86,000	68,800	86,000	4,786	20.80	309.70	69.50
88,000	70,400	88,000	6,361	150.04	220.62	29.34
89,000	71,200	89,000	7,446	191.57	208.43	0.00
89,410	71,528	89,410	7,934	238.57	161.42	0.00
		— 70% Target —				
82,000	57,400	82,000	2,045	0.00	210.51	189.49
84,000	58,800	84,000	2,173	0.00	259.38	140.62
86,000	60,200	86,000	2,724	0.00	338.85	61.15
88,000	61,600	88,000	3,894	103.35	286.04	10.61
89,000	62,300	89,000	4,635	191.57	208.43	0.00
89,410	62,587	89,410	4,998	238.57	161.42	0.00

objectives. The first objective is that $E[k] = \bar{\mathbf{c}}'\mathbf{x} \geq k$, which sets a minimum return level, and the second is that income in any state of nature cannot fall below the target. Hence, in the context of this problem, it is appropriate to set $T = \alpha k$, $0 \leq \alpha \leq 1$.

This formulation was used to obtain target MOTAD solutions for the case farm presented earlier. The $k \times n$ $\mathbf{C}_k$ matrix was defined over the 21 states of nature listed and summarized in Table 5. These are the same data used to derive the variance-covariance matrix and beta coefficients of the earlier section.

Table 5 presents optimum solutions for minimum income levels of $82,000, $84,000, $86,000, $88,000, and $89,410, respectively. Targets were set for 100%, 90%, 80%, and 70% minimum income. The MAD column in Table 5 is the value of the objective function. As with the previous models, low-risk plans are comprised of soybeans and wheat, while high-risk plans are comprised of corn and soybeans. In all cases, the solutions

which bind the income constraint are identical to the linear SIM in Table 4, while only the solutions at $82,000, $84,000, and $89,410 are the same as the QP results in Table 2. (There is no apparent theoretical reason why any target MOTAD solutions should be identical to linear SIM results except for the fact that these solutions exist only at corner points, whereas non-corner-point solutions are obtainable with QP.)

Mathematically, the higher the target is set, the greater is the cumulative probability semivariance below the target. In some instances, primarily those in which the income constraint is not binding, and target incomes are set high, the optimum strategy is to select a higher risk plan than that which occurs when the income constraint is binding. For example, with $K \geq \$84{,}000$ and $T = \$67{,}200$, the optimum strategy is to grow 334.75 acres of soybeans and 65.25 acres of wheat. The E[MAD] is 3,083 and the actual expected income of the plan is $85,910. This plan is more risky than a plan with lower target income = $84,000 which grows 259.38 acres of soybeans and 140.62 acres of wheat (see Table 5), yet it is still efficient in terms of the efficiency criteria under which it is defined—the selection of a plan which minimizes the chance of outcomes falling below a fixed target.

Target-Semivariance Modeling

An alternative to the general target MOTAD formulation is to minimize semivariance directly. Recall, in the above example the objective was to minimize the expected mean absolute deviation below the target, but true efficiency, however (in terms of Porter, 1970; Fishburn, 1977; and Menezes, Geiss, and Tressler, 1980), is related to semivariance. Skelton and Turvey (1994) employed semivariance modeling to examine the impact of hay insurance in Ontario. They were able to show that the semivariance objective was more efficient than target MOTAD solutions, and expected utility from a target semivariance model was higher than a MOTAD solution. But, as the authors also noted, to a large extent and for many solutions provided, the difference between target MOTAD and target semivariance was not too large. From an empirical point of view, MOTAD solutions are "as good" as semivariance solutions.

While obviously part of the family of downside risk models, the target semivariance approach of Skelton and Turvey (1994) uses a nonlinear rather than linear objective. Following Skelton and Turvey, the problem formulation is:

$$\text{(28)} \quad \text{Min } \frac{1}{k} Y^{-\prime} \mathbf{I} Y^{-},$$

$$\text{s.t.: } \mathbf{A}\mathbf{x} \leq \mathbf{b}$$

$$\mathbf{C}_k \mathbf{x} + \mathbf{I} Y^{-} \geq T$$

$$\mathbf{C}^{\prime}\mathbf{x} \geq k$$

$$\mathbf{x}, Y^{-} \geq 0.$$

The constraint set is identical to the target MOTAD model, but the objective is quadratic. Since $\mathbf{I}$ is a $k \times k$ identity matrix, the semivariance is actually

$$\frac{1}{k} \sum_{k=1}^{K} \left(Y_k^{-}\right)^2.$$

Substituting $Y_k^{-} = \text{Max}[T - \mathbf{C}_k^{\prime}\mathbf{x}, 0]$ into this objective yields

$$\frac{1}{k} \sum_{k=1}^{K} \left(\text{Max}\left[T - \mathbf{C}_k^{\prime}\mathbf{x}, 0\right]\right)^2,$$

which is the discrete form of the continuous semivariance measure, $S(T, 2)$, defined earlier. Using the same data as the target MOTAD model presented earlier, the results of the semivariance model provide similar results to target MOTAD. These are presented in Table 6. The semivariance model provides results which are similar to the MOTAD model. However, the E[MAD]s from the semivariance model are not less than, and in some instances are greater than, E[MAD]s from target MOTAD solutions. Furthermore, using the semivariance criteria tends to decrease substantially

Table 6. Semivariance Solutions for Hypothetical Farm

Minimum Income ($)	Target Income ($)	Expected Income ($)	E[MAD]	Semi-variance	Acres		
					Corn	Soybeans	Wheat
			— 100% Target —				
82,000	82,000	82,000	10,972	3.035E8	0.00	210.51	189.49
84,000	84,000	84,000	11,443	3.320E8	0.00	259.38	140.62
86,000	86,000	86,000	13,002	3.978E8	1.13	337.26	61.61
88,000	88,000	88,000	14,796	5.318E8	108.21	279.23	12.56
89,000	89,000	89,000	15,534	6.171E8	191.57	208.43	0.00
89,410	89,410	89,410	15,846	6.591E8	238.57	161.43	0.00
			— 90% Target —				
82,000	73,800	82,000	6,705	1.595E8	0.00	210.51	189.49
84,000	75,600	84,000	7,037	1.768E8	0.00	259.38	140.62
86,000	77,400	86,000	8,102	2.165E8	0.00	338.85	61.15
88,000	79,200	88,000	10,039	3.144E8	89.94	304.84	5.22
89,000	80,100	89,000	11,013	3.824E8	191.57	208.43	0.00
89,410	80,469	89,410	11,440	4.167E8	238.57	161.43	0.00
			— 80% Target —				
82,000	65,600	82,000	3,819	7.554E7	0.00	210.51	189.49
84,000	67,200	84,000	4,120	8.662E7	0.00	259.38	140.62
86,000	68,800	86,000	4,668	1.109E8	0.00	338.85	61.15
88,000	70,400	88,000	6,503	1.709E8	77.24	322.63	0.12
89,000	71,200	89,000	7,447	2.190E8	191.57	208.43	0.00
89,410	71,528	89,410	7,934	2.441E8	238.57	161.43	0.00

the number of different target MOTAD solutions, thereby making the choice selection of a farm plan simpler.

Direct Expected Utility Maximization

More recently, optimization has used various forms of the direct expected utility maximization (DEUM) model (Lambert and McCarl, 1985). The advantage of a DEUM approach is that any utility function can be used to define the objective function, and hence this approach does not require specific restrictions such as quadratic or negative exponential utility as required in the Markowitz (1959) and Freund (1956) models. While the model can be highly nonlinear, its properties are well defined and its output easily interpreted in terms of marginal utilities and certainty equivalence.

The DEUM has substantial appeal in agricultural economics for five reasons.

- First, there are no underlying assumptions about the type of utility function used, and therefore no prior restrictions with respect to risk-averse behavior (e.g., constant absolute or constant relative risk aversion).

- Second, there is no need to specify a priori a probability distribution about enterprise returns. These returns can be drawn from a normal, triangular, uniform, or any other probability distribution. The only requirement is that the probabilities be discrete, joint, and sum to one. This is a key advantage to researchers, especially when subjective probabilities have been elicited.

- Third, DEUM can be used to evaluate a wide range of problems. It has been used in the context of discrete sequential stochastic programming (see Cocks, 1968) to evaluate the effects on farm investments and financing decisions under alternative U.S. farm policies (Turvey, 1992; Turvey and Baker, 1990; Featherstone et al., 1988; Featherstone, Preckel, and Baker, 1990), and has been used to evaluate the liquidity aspects of farmers' use of futures and options (Turvey and Baker, 1990).[1] The problems to be solved need not be sequential or dynamic in nature. The DEUM approach can be applied to single-period enterprise choice models.

- Fourth, the existing debate over whether or not stochastic efficiency models, such as quadratic programming or MOTAD, include solutions which should not be in the stochastic dominance efficient set (type I error) or exclude solutions which should be in the efficient set (type II error) has not been fully resolved. For example, assuming multivariate normality, such as quadratic programming, is unsatisfactory for decision makers who have a preference for skewed distributions over symmetric distributions (Collender and Chalfant, 1986). Type II error arises since the third-order stochastic efficient set is excluded from the solution. This type II error has been shown theoretically by Hadar and Russell (1969) and empirically by Porter and Gaumnitz (1972). Thus one would suspect that direct maximization of expected utility with a well-behaved utility function, and a probability distribution freed from a priori definitions, would establish an efficient set which minimizes both type I and type II errors—a view held by both Lambert and McCarl (1985), and Patten, Hardaker, and Pannell (1988).

- Fifth, the DEUM is not a complicated problem. For enterprise selection, the constraint set is almost identical in structure to target MOTAD problems or semivariance models. Simple models, even with complex and highly nonlinear objective functions, can be solved using the optimizer in Excel or Quattro Pro.

Like the semivariance models, DEUM is constructed around the specific states of nature identified to represent the probability distribution. The mathematical formulation of the DEUM is similar to that used by Lambert and McCarl (1985), and Patten, Hardaker, and Pannell (1988).[2] Its structure is as follows:

$$
\begin{aligned}
(29)\quad & \text{Max } \mathbf{P}'U(w_k), \\
& \text{s.t.: } \mathbf{Ax} \le \mathbf{b} \\
& \quad -\mathbf{C}_k\mathbf{x} + \mathbf{I}w_k = w_0 \\
& \quad \bar{\mathbf{c}}'\mathbf{x} \ge k \\
& \quad \mathbf{x} \ge 0,
\end{aligned}
$$

[1] Discrete stochastic programming (DSP) provides a framework for a wide range of problem solving. Due to limitation in sizes, it is more useful in normative applications than positive ones. Nonetheless, the conditional decision-making sequence along each of the paths is very realistic. Applications of DSP are numerous but, in proportion to the number of research works using optimization methods, it is under-represented. Turvey and Baker (1990) use DSP to evaluate farm-level hedging decisions under alternative farm programs and capital structure. Featherstone, Preckel, and Baker (1990), and Kaiser and Apland (1987) use DSP to examine farm-level investment decisions under various macroeconomic and government policies. Leatham and Baker (1988) use it to study farmers' decisions under variable versus fixed-rate loans. Kaiser and Apland (1989) use DSP to examine the marketing and production decisions of Midwestern corn and soybean farmers. Rae (1971a,b) investigates production decisions of vegetable producers when weather is random. From this limited survey, it is clear that DSP can be used to solve a host of problems. And as Kaiser and Apland (1989) point out, the capability of DSP to capture the random nature of the constraint parameters and the realistic sequential nature of decision making are strong advantages of DSP over the more commonly used E-V and MOTAD approaches.

[2] Patten, Hardaker, and Pannell (1988) developed a modeling technique for what they call utility-efficient programming, using a "sumex" utility function. Utility-efficient programming in this sense requires use of a class of functions which are separable. Because of computational problems, the authors solve their problem using the parametric linear programming technique of Duloy and Norton (1975) which approximates the nonlinear objective function.

where **P** is a $1 \times k$ vector of discrete probabilities assigned to each of k states of nature, w_k represents the end-of-period wealth in each state of nature, and $U(w_k)$ is the utility of wealth in state k. The objective is to maximize the expected utility by taking the probability weighted average of the state dependent utility functions. In this format, terminal wealth is simply equal to beginning wealth, w_0, plus state dependent income from growing crops.

The utility function can take on any form so desired. Most often, however, the utility functions are based on either negative exponential functions $[U(w_k) = 1 - e^{\alpha w_k}]$ or power functions $[U(w_k) = (1/\gamma)w_k^{\gamma}]$, where α and γ are absolute and relative risk-aversion coefficients, respectively. Both utility functions are common in applied research. The negative exponential utility function is common because, when combined with an assumption that the enterprise returns distribution is joint multivariate normal, quadratic programming can be used to solve for enterprise proportions (Freund, 1956). The power utility is used because the assumption of constant relative and decreasing absolute risk aversion is seemingly more realistic than constant absolute and increasing relative risk aversion. Research in finance by Levy and Markowitz (1979); Pulley (1981); and Kroll, Levy, and Markowitz (1984) reveals that for different levels of risk aversion, DEUM provides a close approximation to the mean-variance efficient set. Tew and Reid (1987) found the same results for a portfolio of farm enterprises.[3]

[3]Although there is general agreement in the literature that farmers exhibit risk-averse behavior, there have been relatively few studies which actually estimate risk-aversion coefficients or even whether absolute or relative risk aversion is increasing, constant, or decreasing. Lins, Gabriel, and Sonka (1981) have tested for evidence of absolute or relative risk aversion for a large sample of U.S. farms. Their results were mixed and were dependent on farm size, type, and portfolio composition—a result consistent with findings reported by Turvey and Driver (1986). Raskin and Cochran (1986) surveyed 17 studies, finding that the absolute risk-aversion coefficients ranged from 0.000001 to 0.005.

The two utility functions described above are concave functions of wealth with positive first derivates ($U'(W) > 0$) implying that utility increases with wealth, and negative second derivatives ($U'(W) < 0$) implying the marginal utility decreases with increased wealth. Together, these derivates suggest risk-averse behavior. A risk averter will always prefer an action with a certain return over an enterprise selection with an uncertain return (Cass and Stiglitz, 1972; Robison and Barry, 1987). The return to the certain action is called the certainty equivalent. The certainty equivalent measures a level of certain wealth, W^*, with which the farmer would be indifferent to the expected stochastic outcome $E[W]$. For example, suppose a solution yields $EU(W)$. Then the respective certainty equivalents for the negative exponential and power functions are:

$$(30) \quad W^* = -\frac{\ln(1 - EU(W))}{\alpha},$$

$$W^* = \gamma EU(W)^{1/\gamma},$$

and the risk premiums can be calculated from

$$(31) \quad \Psi = \sum_{k=1}^{K} w_k - W^*.$$

The solution is, of course, sensitive to the type of utility function used and the degree of risk aversion desired. The risk premium is the dollar amount by which the farmer must be compensated for undertaking the risky action. It is determined by the concavity of the utility function, which is determined by the degree of risk aversion and the probability distribution of risky outcomes. For the risk-neutral individual, the risk premium is zero. As risk aversion increases, so does the premium. Consequently, one would expect significant differences in risk premiums and certainty equivalents between the two utility functions for a given level of risk.

Table 7 provides a comparison of quadratic programming and DEUM using the negative exponential and power utility

Table 7. Direct Expected Utility Maximization

Risk-Aversion Coefficient	Income ($)	Standard Deviation	Certainty Equivalent	Acres		
				Corn	Soybeans	Wheat
		— Quadratic Program —				
0.000068	82,000	19,004	57,441	0.00	210.51	189.49
0.000048	83,000	19,469	64,806	0.00	234.95	165.05
0.000037	84,000	20,081	69,080	0.00	259.38	140.62
0.000018	85,000	20,987	77,071	39.45	237.55	123.00
0.000015	86,000	22,420	78,460	76.21	232.04	91.74
0.000013	87,000	24,011	79,505	112.98	226.54	60.48
0.000011	88,000	25,732	80,716	149.79	221.04	29.22
0.000009	89,000	27,559	82,164	191.57	208.43	0.00
0.000008	89,410	28,427	82,945	238.58	161.42	0.00
		— DEUM: Negative Exponential Utility —				
0.000068	84,375	28,772	65,311	0.00	268.52	131.48
0.000048	84,375	28,772	69,577	0.00	268.52	131.48
0.000037	84,733	29,330	72,326	1.95	278.74	119.30
0.000018	86,363	32,313	78,266	68.61	254.76	76.64
0.000015	87,334	34,765	79,597	113.46	241.19	45.33
0.000013	88,392	37,388	80,702	157.95	227.53	14.53
0.000011	89,024	39,036	81,662	194.14	205.86	0.00
0.000009	89,334	39,954	82,644	229.69	170.31	0.00
0.000008	89,412	40,204	83,835	238.64	161.36	0.00
		— DEUM: Power Utility —				
6.800	84,538	29,030	71,496	0.00	274.47	125.53
4.750	84,846	29,544	75,083	0.00	285.76	114.29
3.655	85,597	30,954	77,223	33.91	272.71	93.38
1.775	89,250	39,693	82,503	220.06	179.94	0.00
1.470	89,412	40,204	83,656	238.64	161.36	0.00
1.255	89,412	40,204	84,481	238.64	161.36	0.00
1.094	89,412	40,204	85,105	238.64	161.36	0.00
0.940	89,412	40,204	85,701	238.64	161.36	0.00
0.765	89,412	40,204	86,387	238.64	161.36	0.00

functions. The results were derived from running the variance-minimizing QP model and extracting the absolute risk-aversion coefficients for each income level. These coefficients were used directly in the negative exponential utility function and converted to a relative risk-aversion coefficient for the power function by multiplying it by $100,000 of initial wealth. For example, if a target portfolio under the QP is $87,000, this can be achieved by growing 112.98, 226.54, and 60.48 acres, respectively, of corn, soybeans, and wheat. Selection of this strategy "implies" an absolute risk-aversion coefficient (RAC) of 0.000013.

Setting initial wealth to $100,000, the DEUM model used this RAC and the negative exponential utility function directly. Because the DEUM is driven by risk aversion and not a target income, one would expect a solution similar to that of the QP. For negative exponential utility

using RAC = 0.000013, the optimal solution is 157.95, 227.53, and 14.53 acres of corn, soybeans, and wheat, respectively, for expected income of $88,392 and risk of $37,388.

The equivalent relative risk-aversion coefficient is 1.255 for the power utility function. At this risk aversion, the optimal solution is 238.64, 161.36, and 0.0 acres of corn, soybeans, and wheat, respectively, for income of $89,412. This solution is identical to the maximum feasible income solution of the QP and the negative exponential utility models.

Table 7 also records the certainty equivalents. For absolute risk aversion of 0.000013, the certainty equivalents across the three models are $79,505, $80,702, and $84,481, suggesting respective risk premia of $7,495, $7,690, and $4,931.

The results in Table 7 illustrate some complexities in how such models are used in agricultural finance. First, comparing the standard deviation of the QP model to that of the two DEUM models shows a significant difference in portfolio standard deviation. This observation is due to some underlying assumptions about risk. The QP model, for example, uses the variance-covariance matrix under the assumption that the measure represents the population of risk under the joint normal assumption. No Assumption is required of the DEUM models, whose variance measure is based only on the 21 discrete states of nature defined in Table 1. Using Freund's (1956) assumptions, if the negative exponential utility model was defined over a large number of jointly distributed states of nature (from a random number generator), the solutions in the second panel should asymptotically approach the solutions in the first panel.

Second, one of the persistent economic problems is in identifying not only risk aversion but also the nature of utility. On the one hand, this may not be a major problem so long as the solutions are in the neighborhood of each other. But one cannot generalize, especially based on the illustrative results in Table 7. From examining the portfolio proportions for each degree of risk aversion, the QP model and the negative exponential model are quite close, but the power utility model converged to the profit-maximizing solution when absolute risk aversion was only 0.000013 and relative risk aversion at 1.47. That the power utility converges to profit maximization so soon is likely due to its shape (which is highly logarithmic), the limited number of states of nature, and scaling problems (recall all models were solved in Excel).

Third, the certainty equivalents for all three models are reported in Table 7. The difference in certainty equivalence and risk premiums is also problematic. Part of the difference is surely due to the objective functions on the optimization. But again, the results provide no guidance as to which if any of the approaches are adequate for small sample optimization. Despite numerous past efforts (such as Lin, Dean, and Moore, 1974), we are still not clear on whether human risk behavior and portfolio choices are based on normality and quadratic utility (Markowitz, 1959), normality and negative exponential utility (Freund, 1956), or direct negative exponential or power utility.

Summary

This paper has provided an overview of risk optimization techniques applied to problems of agricultural finance at the farm level, focusing largely on quadratic programming models, semivariance models, and direct expected utility. However, the profession has provided a rich history of innovative programming techniques to meet particular needs of the research program at hand. Techniques such as Driver and Stackhouse's (1976) linear programming-risk simulator, marginal risk constraint programming as prescribed by Chen and Baker (1974), or Cocks' (1968) passive stochastic programming model are representative of these innovations but were not discussed here. Other applications, such as the

game theoretic approaches of Maruyama (1972), Maruyama and Kawaguchi (1971), Kawaguchi and Maruyama (1972), Hazell (1970), and McInerney (1967, 1969), have also been employed in innovative ways to solve related problems of mini-max and maxi-min in the context of development research.

The tools discussed in the main text used a common set of risk characteristics and constraints to illustrate commonalities among the programs, and over the past 15 to 20 years many applications have employed these techniques. For example, quadratic programming is still in use for investigating a variety of issues such as diversification of hog producers between actively investing in capital to diversify on-farm, or through passive investment in shares of companies that are vertically linked to hog processing (Buhr, 2002). Popp and Rudstrom (2000) have used quadratic programming techniques to investigate diversification into specialty crops, and other aspects of farm planning risk can be found in Collender (1989).

There has also been interest and applications in the diversification between farm and nonfarm assets including farm land and equities (Buhr, 2002; Collins, 1988; Irwin, Forster, and Sherrick, 1988; Duval and Featherstone, 2002; Young and Barry, 1987), while other applications have used portfolio models to examine tradeoffs between risk and return on owned versus rented land (Blank, 1993; Turvey, Baker, and Weersink, 1992).

Other applications have added dynamics to the problem of farm financial structure such as the multiperiod quadratic programming models employed by Gwinn, Barry, and Ellinger (1992) to examine risk-efficient growth plans and financial structures of a cash grain farm; or the discrete stochastic programming models in a direct expected utility framework to examine leveraging decisions related to capital structure (Featherstone, Preckel, and Baker, 1990; Turvey and Baker, 1990).

The applications of financial models have also been applied to agronomy. For example, Dahl, Wilson, and Nganje (2004) use a risk-adjusted portfolio model that simultaneously incorporates correlations between grower and end-use characteristics of wheat to compare the portfolio value of different varieties. Curtis et al. (1987) and Frank et al. (1989) have used target MOTAD to look at marketing strategies including options.

The application of mathematical programming models to problems in agricultural finance, and to extension risk management, agribusiness finance, and government policies, has yet to run its course. The general availability of nonlinear programming algorithms, even in common spreadsheets that are rapid and efficient, makes the use of optimization techniques even more attractive. For example, few of the applications reviewed here applied models with nonlinear constraints, yet many problems in finance deal with such nonlinearities. Production functions or capital constraints can be very nonlinear.

While academics will no doubt create even more clever applications of optimization in the future, it may be wise to reconstitute some of the earlier models in a different frame. For example, the MOTAD and target MOTAD models discussed in the text embody certain economic characteristics related to downside risk that have not been overly exploited. Yet, when one considers the full regimen of problems facing agriculture, including the use of contingent claims on prices and yields, or the implicit option value of an investment, or the expected marginal value of farmland, clearly there are nonlinearities inherent in the MOTAD and direct expected utility maximization model structures (especially the dual) that have not been widely acknowledged in practice.

As a final comment, economists still struggle with the positivist aspects of expected utility, not only by application of the utility function but also direct measure of risk aversion. There have been but a

handful of studies to actually measure utility or attempt to map the solution from an optimization model to actual decision making by, for example, farmers. Models based on utility, the Markowitz (1959) model, semivariance and MOTAD models, or direct expected utility maximization still need to be grounded in reality. Models along the lines of Lin, Dean, and Moore (1974) or Pope (1982) attempted to do this, but there has been a dearth of interest in examining whether the normative application of optimization models in a virtual world holds up to positivist decision making in the real world.

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Current State of Agricultural Lending: Challenges and Relevant Research

Edward Coates

Challenges for the Future

Agricultural lending faces a number of challenges for the future. For many of these issues, research or summarizations of the information that is available could be useful to lenders.

Competition is a chronic concern for lenders. The problem is not the *existence* of competition—strong competition is healthy for the industry. Rather, it is the *changes* in competition that represent the real challenge. In recent years, Rabobank and Dairylea have become important lenders in our area. John Deere and other captive finance companies have stepped up the types of lending they offer.

It would be helpful to have some idea of who might be entering the agricultural lending arena in the future. Are there other firms who might find agricultural lending to be a profitable activity that we, as lenders focusing on conventional day-to-day lending, may not be thinking about? Is there reason to believe food retailers or Wal-Mart, or some other firm, would have incentives to move into agricultural lending? Are non-traditional lenders considering products or delivery methods that commercial banks and Farm Credit have not recognized?

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The *changing and shrinking customer base* is a constant issue. There continue to be fewer farms and farmers in any market area. Although the increased size of farms helps maintain the portfolio size, expanding the portfolio requires more effective competition or enlarging the market area.

Non-local business owners are becoming increasingly prevalent. People from outside the market area are buying farms and operating them from a distance, or are purchasing agricultural property, sometimes for the house on it, and conducting agricultural operations on which they at least expect to break even. It would be helpful to have a better understanding of what is motivating these individuals and to know their real expectations from the lender. It is often difficult to service these customers. They are accustomed to the house mortgage and automobile markets, which provide quick decisions, often with a quite low rate of interest. They do not understand that the higher risk of the agricultural operation may result in a 20- or 25-year loan instead of 30, and a rate which is 100 to 150 basis points above house mortgage rates. Are there products or services lenders should be offering to better serve the "part-time" farmers or rural acreage landowners?

The traditional high-touch agricultural customer likes to have the loan officer come out to the farm to review performance, discuss alternatives, and establish loans for the coming period. These customers expect to be able to contact the loan officer at any time for additional loans, services, or financial analysis. Other customers prefer the high-tech route and want on-line banking,

sweep deposit accounts, electronic advances, and all the other services technology can provide. And a growing number of customers want both! This makes the loan officer's job and the management of an agricultural portfolio increasingly difficult.

Operating costs must be controlled in order for the bank to maintain earnings. Providing both the high-touch and high-tech alternatives for customers raises bank costs. Because the skill sets required for each alternative offering are quite different, the same bank personnel cannot be used for both. Thus, the bank must bear the dual costs of hiring two separate groups of employees.

Some attention to the future funding of bank loans could be of value. Are banks going to continue to focus on traditional deposits? Or will they move to more borrowed funds? Is there an overriding rationale for the direction of bank funding?

A better understanding of the basic loan loss relationships for agricultural loans of various risk levels could assist financial institutions in establishing appropriate loss reserves. Small business commercial loans have the same problem. Establishing loan loss reserves represents a cost to the bank and, even if they are reversed at a later date, they reflect a "black mark" on the portfolio. While most banks experience few losses on agricultural loans, the variability in agricultural incomes makes significant amounts of the portfolio appear to be high risk during times of low commodity prices.

Any one bank does not have a sufficiently large loan loss experience to develop the exact relationships needed for appropriate loan loss provision. Also, a loss loan takes a long time to "play out." Consequently, there may be a number of years between the original loan loss provision and the reversal, with complete payment, or write-off. Information tracking net losses on agricultural loans over a long term relative to yields of the overall agricultural lending portfolio would be beneficial. Moreover, an assessment of how these numbers compare to bank portfolios for other types of loans and to bank target numbers would be useful.

Knowledge of agriculture has long been considered an important attribute of a good agricultural lender. As the number of farms declines, the cadre of college graduates with agricultural backgrounds diminishes. Fewer people can even claim to have uncles or grandparents or neighbors with farms. Thus, a smaller and smaller group of people meet the historical requirements for an agricultural loan officer.

This situation also means there are fewer and fewer people in bank management who know anything about agriculture. In fact, there is a tendency to view farms like other businesses. For example, if a farmer has a bad year, bank management is likely to ask why the farm manager did nothing about it. Management does not understand that there are often causes of a "bad year" which are beyond the farmer's control—and the fact that the situation was not corrected does not necessarily mean the farm enterprise has poor management, or represents excessive risk.

The same thing can be said for bank regulators as for bank management. This is particularly true in regions of the country where agriculture is less important. A regulator who sees very few agricultural loans finds it easy to be very critical of them if they have different characteristics than other commercial loans.

Lack of knowledge of agriculture also leads to less institutional patience. Managers tend to be focused on the last quarter, expecting any problem should be fixed by the next quarter. The notion that a business could have a short-term problem which will last a couple of years (such as the dairy industry in 2002 and 2003) is difficult for managers to understand. They find it impractical to take a four- or five-year view. A number of banks decided to get out of agriculture when the primary agriculture in their area was experiencing

a low point in income variability, even though that industry was quite profitable in the longer run. A lender must exercise patience to get through such periods.

Clearly, a lack of knowledge of agriculture can lead to impatience with agriculture. During the 2002–2003 low price period for the dairy industry, 5% of our bank's agricultural portfolio was in non-accrual. Since that time, non-accruals have been worked down to about 1% with a larger loan volume and few write-offs. Institutional patience was necessary to allow this process to occur.

To be patient, bank management must believe there is a light at the end of the tunnel. We do a number of things to be sure management sees the light. During good times, we repeatedly point out that we need to prepare for a bad year—because history indicates it is coming. We point out that farmers are also members of churches, school boards, municipal governments, and other local organizations. A farmer who is happy with the bank's treatment of his or her business is likely to encourage these organizations to use the bank for their own business needs. We also price for profit by being sure we charge for risk. By carefully relating risk to rate and not being afraid to charge what the risk deserves, we are able to maintain a 50-60 basis point higher yield than other portfolios in the bank.

One problem that troubles me is the possible "pied piper" effect when some large banks leave agriculture. When banks like Fleet, CoreStates, and HSBC, who had quite large agricultural portfolios at one time, decide to leave agriculture, other banks are led to wonder if those banks "know something we do not." A short-run downturn in local agricultural enterprises can lead to a long-run decision to leave agricultural lending.

Relevant Research Topics

Summarized below are several relevant research topics suggested for future consideration.

- *Electronic Delivery for Agricultural Lending.* Much of our bank's process for making loans to agriculture is carried out the old-fashioned way. We obtain information from borrowers in hard copy, often with a visit to the farm. We convert some of the information to our forms, make a decision, and relay this decision to the farmer by mail, phone, or personal visit. Mortgage and car loans are done more efficiently. We would like to become more efficient, and we have the feeling that many of our customers would prefer a more streamlined procedure. This prompts the important question: What type and level of an electronic system would farmers accept? Also, how important is it for the loan officer go to the farm? Some work on the design of an efficient system that farmers would accept would be useful.

- *Risk Rating Standards for Agricultural Loans.* Over the past several years, we have seen an increased focus on risk rating systems. Every institution has its own system, typically with five to 22 risk levels. Our bank has nine levels. One of the inherent problems with these systems is that they are interpreted differently depending upon who is doing the review. The lender, internal review staff, OCC, and FDIC all interpret information based upon their own experience and perspective. Commercial loan standards are often applied to agricultural loans even if they do not fit. Information on the various risk rating systems being used around the country and whether they could be consolidated or standardized would be valuable. Definitions specialized for agriculture would be helpful, and consistency among the various examining authorities (OCC, FDIC, FCA) would "level the playing field" for commercial banks and Farm Credit entities.

  For example, OCC rates any loan on interest-only for over three to six months as an impaired loan, a normal commercial loan standard. The Farm

Credit System uses a 12-month standard. For most of agriculture, three- or six-month time frames make little sense. With the annual crop cycle, most farmers who need interest-only need it for 12 months for it to do any good. An agricultural department that is trying to do a good job of servicing loans, and allows interest-only on some loans for 12 months during a low price period for otherwise good loans, can suddenly find itself with a number of non-performing loans when OCC comes to review. Such occurrences can lead to banks leaving agriculture. Research on appropriate standards for agriculture and how they should differ from normal commercial loan standards would be beneficial.

- *Risk Management Issues.* A research focus on what lenders could do to encourage farmers to consistently use risk management measures and the financial tools lenders could offer to mitigate risk would be helpful. Farmers are paying attention to risk management when the price of milk is $11, but when it is $16 they lose interest. Identification of the appropriate role for lenders in limiting customer risk would be of value.

  A related issue is the identification of tools agricultural banks can use to limit interest rate risk that may be different from those applied to commercial loans. Our bank has used Farmer Mac and it has been helpful. What other tools are available or could be developed?

Current State of Agricultural Lending: Considerations for Future Research– A Practitioner's View

Michael Gerber

Agriculture continues to evolve. Those changes can be observed in every facet of agricultural business. New agronomy practices and new techniques in livestock production are evident. Changes are just as apparent in new ownership structures and new capitalization strategies.

These changes have and will continue to have an impact on agricultural finance. New production techniques will bring a need for more capital investment, often in higher risk investments like technology. New ownership and organizational structures will provide challenges that come from off-farm investment, non-farm ownership, multiple owners, and greater sophistication of borrowers in general. For current providers of credit and financial services, some of these changes will be incremental and some will be significant. To assist with those transitions, academics and researchers can play an important role. Highlighted below are just a few areas where I think future agricultural finance research will be valuable.

- *Understanding the Competition.* Many research opportunities exist in the areas of benchmarking and comparison analytics. These analytics would be helpful as we continually work to become more efficient with both human and capital resources. Research would also be valuable in the area of development of new delivery systems that would better serve customer needs or improve efficiency.

- *Product Innovation.* Bankers historically have not been the most innovative creatures on the planet. Today, however, our customers are thinking about new ways to bring capital into their business. Factors such as new forms of equity, subordinate debt, commercial paper, and grant monies will likely change our roles in financing agriculture. While this has long been the norm in the commercial world, it is a newer phenomenon for agriculture. New product offerings that meet the needs and acknowledge the unique business issues surrounding agriculture could strengthen the industry.

- *Risk Mitigation.* Today, there are a number of ways to mitigate risk for financial institutions. However, most of those exist primarily for the largest of the banks. For smaller institutions (both Farm Credit institutions and commercial banks) it is difficult, as loans get larger and more complex, to manage the risk associated with these kinds of credit.

  Research into areas such as pooling of loans, secondary market utilization, credit, and financial derivatives would greatly improve our ability to compete with the larger financial institutions. I believe smaller institutions play a valuable role, especially in rural communities. To continue to be

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successful, research into identifying new tools for risk mitigation at the bank level would be helpful.

While nothing listed above is specific or new and brilliant, I think some creative energy will improve flow of capital into rural America and stimulate growth in the agricultural and rural sectors. Indeed, that should be held out as the ultimate goal of any finance research—to provide tools for the efficient and sufficient flow of capital from investors to the capital projects where it is needed.

Agricultural Finance Research Retrospective and Challenges for the Future

Eddy L. LaDue

Agricultural finance research has been conducted on a coordinated national basis for over 35 years. This coordination has allowed agricultural finance economists to contribute to improved financing of U.S. agriculture and rural areas in an efficient and effective manner. Although a large amount of significant research has been conducted over that period, the changing nature of agriculture, rural areas, and financial institutions leaves a plethora of issues and questions for economists to investigate over the next several years.

In this paper, I provide a short review of the coordinated agricultural finance research efforts over the past 35 years and discuss some of the issues and challenges in need of research efforts in the coming years.

Retrospective

Over the past 35 years, national coordination and cooperation in agricultural finance research, under the regional research project umbrella, has changed regional affiliation (Western to North Central) and operated under several different research project numbers. However, participation in the group has always been national in scope. Most people in the United States and some from Canada, who did research in agricultural finance, were members of this group. The composition, of course, changed as individuals retired and new people were hired.

Throughout this period, agricultural finance economists from the Federal Reserve Banks, Farm Credit, FCA, and USDA have been an integral part of the group. This membership kept the academic's eye on the important issues and broadened the scope of the work of the group.

We have always met at least once per year, usually at the offices of a financial institution (Federal Reserve Bank, Regional Farm Credit Office, FCA, or major bank). Convening at these locations gave us excellent meeting facilities and access to an array of industry speakers. Industry speakers were an important part of each annual meeting.

The first regional project of this era was Western Regional Project W-104, "Economic Growth of the Agricultural Firm," and its successor Western Regional Coordinating Committee WRCC-16, also titled "Economic Growth of the Agricultural Firm," which ran from 1968 to 1973, and 1973 to 1976, respectively.

I remember attending as a new assistant professor. There were two factions at those meetings. One group felt that agriculture could be represented by a series of mathematical equations. By assuming away 95% of the real characteristics of agriculture, they could solve for results they found interesting. The other group used a variety of quantitative techniques and had a more practical bent. This second group

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provided leadership for and wrote most of a very useful bulletin titled (strangely enough) *Economic Growth of the Agricultural Firm.* Peter Barry was a major contributor to that publication.

W-104 was followed by North Central Regional Research Project NC-161, which had a number of titles, including "Evaluating Financial Markets for Agriculture" and "Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues." As their titles suggest, these projects were much broader in scope than W-104. With this broader mandate, research was conducted on a wide variety of agricultural finance topics. A considerable amount of research done under this project number related to the agricultural recession of the 1980s and the resulting environment for financing agriculture.

In 1991, the group developed a new research agenda under Project No. NC-207 titled "Regulatory, Efficiency, and Management Issues Affecting Rural Financial Markets." In 1996, a research agenda was designed under the title "Financing Agriculture and Rural America: Issues of Policy, Structure, and Technical Change," which was given the administrative numbers of NCT-173 and NC-221.

At the end of NC-221's life, the group developed a replacement project proposal under the title "Agricultural Financial Markets in Transition." Administratively, this project was titled NCT-194 and finally the current project, NC-1014.

A major result of these regional projects has been a high level of interaction among agricultural finance professionals nationwide and the coordination of research efforts on a multi-state and national level. The group has produced a large number of journal articles, research publications, and extension articles. From 1983 through 2003, proceedings were published from the annual meetings, to keep the papers presented from ending up in the "fugitive literature." The ball was dropped in 2004, but hopefully will be picked up for future years. Over time, the group has organized many sessions at the AAEA meetings, and has held a number of symposiums and conferences.

Challenges for the Future

The papers prepared for this issue of *AFR* are designed to consolidate the findings, define the current status of research, and provide direction for future research in several of the areas on which the group has spent considerable time over the past 30 years. These papers provide a number of ideas for future research. In the discussion that follows, I review some of these topics which appear to me to be most likely to contribute to the appropriate future financing of agriculture and rural America.

Structural change in agriculture and financial institutions is a continuing process that gradually changes the economic environment within which farmers and lenders operate. It results in fewer and larger farms and financial institutions. Correct solutions to a myriad of problems and issues gradually become less and less appropriate, resulting in the need for a new set of solutions. Thus, it will be necessary for agricultural finance researchers to revisit a variety of issues on a periodic basis. The administrators and fund providers who say "that was done many years ago" will need to be convinced it is once again an issue of importance to people and the institutions financing agriculture.

Agriculture is increasingly a business of contracts and asset control by means other than ownership. The success of a business, and thus the likely repayment of loans, is becoming more closely tied to the structure of management. Assessment of the hard assets available for collateral is a more complex task, and those assets are becoming a less important part of the total. Lenders need assistance in developing procedures to work through the complexities and in identifying the value of other types of assets as security for loans.

Globalization of agriculture and finance results in a very competitive and internationally intertwined environment for both farmers and lenders. International principles and rules will undoubtedly become increasingly important for both accounting and lender underwriting standards. Lenders and farmers will each need assistance in understanding exactly what the standards are and what they mean for U.S. agriculture. Lenders may need assistance in developing appropriate lending protocols for providing credit in these markets.

Farmland valuation research likely should shift from trying to assess why farmland may have a lower return than other assets and instead focus on the value of the multiple uses of land. As the purchase of development rights and conservation easements become increasingly prevalent, determining the value of the various uses or the joint products of land becomes an important issue for farmers and lenders, as well as the agencies attempting to purchase these rights.

Risk management has received significant research effort in the past few years, and there is considerable work yet to be done. Much effort has been expended in trying to encourage equity investment in farm businesses in the same manner as is invested in non-farm Fortune 500 firms. There has been little success in this regard. However, a huge non-farm investment in agriculture has taken place as land has been purchased by non-farm investors and leased to farmers, and the leasing of other assets by farmers has dramatically increased. In addition, many inputs are now provided under contract with the contractor providing the investment. The risk/return ratios in agriculture make these very logical occurrences. Most farm businesses do not have high enough operating returns to attract venture capital investment. With leasing and contracting, investors receive modest but adequate returns with a very low level of risk, because they own the assets. The price is predetermined and usually not dependent upon the profitability of individual farm businesses.

However, the increasing prevalence of leased assets and other contractual methods of controlling assets have dramatically changed the risk position of farmers and lenders. Research is needed to correctly characterize this risk and identify means to control and modify it.

Contracting to ensure a market for agricultural production and/or a source of inputs is becoming widely used as a method of controlling some market risks. Often an established price is also part of these contracts. However, these contracts are frequently designed by processors or suppliers, to limit their own risk. In the process, they create an array of risks for farmers. Research is needed to determine the risks for both parties of various contract terms and to identify contract provisions that mitigate or clearly identify the risks involved.

A high proportion of the risk management research conducted to date has focused on program crops (those associated with government support programs). Dairy, livestock, and vegetable producers have received little attention, and in many cases have more risk than program crop producers. Research on these enterprises will be more difficult for a variety of reasons, including product quality differences, multiple joint products, and less available data. However, the contribution of such research could be much greater than another article on crop insurance for corn.

New technologies create new risk. In many cases technology is developed to reduce risk, such as insect, disease, or weed risk, but creates another risk, such as food contamination. Technology to increase production or reduce costs may have unintended side effects. Operators who have dealt with the old risk for years are often taken off guard by, and often find it difficult to manage, the new risk. Studies to help understand each of these new risks or a general management

protocol to help operators identify potential risks with new technology would be helpful to the industry.

Macro and tax policy clearly influences the agricultural industry. As long as we have politicians, we will have changes in tax policy. Many of these changes need to be investigated to identify their real or potential effects compared to the political rhetoric. Also, the effect on the agricultural community is sometimes different than the effect on society as a whole. The constant change in tax law provides a basis for continued research in this area. In some cases it will be the indirect effect on agriculture that should be studied. For example, an important objective is to understand how the tax system influences the structure of land ownership.

Estate tax policy is currently receiving considerable attention. Farmers have a tendency to grossly overestimate the real effect of estate taxes on the agricultural community. Investigation of the real effects of estate taxes on farmers and a conversion of that research to outreach efforts which accurately communicate those results to the farmers could greatly assist the agricultural community. Involving other disciplines in assessing the equity of the estate tax could also be considered. For example, is it inequitable to tax gains received by a farmer who happens to own land near a city that expanded and made the farm assets very valuable?

Social Security reform has received a great deal of press. Most of the "evaluations" presented to date have been by people with an "axe to grind." Some objective research on the various alternatives and their likely effect on the farm and rural communities could add light where heat has been the rule. Many members of society seem to think they should be able to live forever but retire at 62. As life spans increase, the trade-offs between work life and retired life, as well as savings during the work life and spending during the retired life, need to be carefully assessed and explained to the population.

Commodity policy in general receives a considerable amount of academic effort. Thus, agricultural finance economists should focus on the financial effects. Although not a politically popular view, it is generally agreed by agricultural economists "talking off the record" that government payments are a large contributor to increasing land values. The "snowball" effect of increasing land values on the need for ever-increasing payments exacerbates the problem. The relationship between payments and land values needs to be clearly documented to assist policy makers in designing policies to short-circuit this relationship.

Revenue and net income stabilization programs have resulted in optimum farm organization with higher levels of leverage and narrow margins on large volume. Businesses are no longer organized to be able to handle significant variability in income or costs. Government programs absorb these historically normal variations. This new farm organization maximizes profit in the short run, but makes the business much more susceptible to small shocks. Small shocks, which may come from a wide variety of sources, can threaten the survival of many firms. This potentially negative effect of farm programs needs academic attention.

The political process adds to *federal credit programs*, but rarely makes major modifications to, or eliminates, programs. Current Farm Service Agency (FSA) programs were designed in the 1930s and expanded during farm economy downturns of the 1960s and 1980s. Major structural changes have taken place in agriculture in the intervening period. Direct lending programs are being choked off by limited funding, and guaranteed lending, which largely reduces private lender risk, is being encouraged. The real need for these programs must be assessed.

FSA programs were originally designed to improve credit market performance (meet credit needs the market was not fulfilling) or to improve social welfare.

Are these rationales still valid? Socially disadvantaged, minority, and beginning farmer programs should be given an unbiased assessment. Do all people in these categories deserve special assistance, or should assistance be limited to some carefully defined subgroup? If programs are needed, the optimum organizational structure required for FSA to provide these services needs to be designed.

Some careful thought on a real measure of competition in credit markets would be useful. The measures historically used by agricultural economists (taken largely from the structure, conduct, and performance literature) are of little value in assessing competition in agricultural credit markets. In some markets, 10 banks may provide little competition for agricultural lending, when none of them are committed to agricultural lending. In other markets, one bank and a Farm Credit office may provide strong competition. A good measure must take into consideration more than the existence of firms. With electronic banking, is a local presence essential for effective competition?

A closely related issue arises from the changing structure of the commercial banking industry. Merger activity in the banking industry is rapidly moving that industry toward a few very large firms. As the banks get larger, their portfolios begin to resemble a cross-section of the U.S. GNP. Since production agriculture represents only a small portion of GNP, it is therefore only a small portion of the bank's portfolio. Such banks often decide not to give agriculture any special attention and do away with agriculture departments and agricultural loan representatives. Some parts of the United States are now, and others soon will be, served only by branches of such larger banks. In these cases, banks provide little or no competition in agricultural lending. Farm Credit becomes the only non-government lender with an interest in agriculture.

Many *financial structure, performance, and risk measurement* issues deserve attention in the next five to ten years. One issue that will be continually before Congress is the appropriate authorities for the Farm Credit System. Progressive managers of the System will continue to press for greater and broader authorities. Authorities cannot remain constant forever and need to be adapted to the needs of modern agriculture. However, allowing System institutions to lend outside of agriculture runs the risk of the System becoming just another group of large banks with only peripheral interest in agriculture. Studies of the appropriate authorities relative to agribusiness, rural infrastructure, and lending for out-of-country activities of U.S. farmers are examples of authority issues deserving study. The justification for Government Sponsored Enterprise (GSE) status and the expectations of society, if it is continued, could also be investigated.

The economies-of-size and -scope studies of financial institutions which were conducted in the 1980s are likely out of date. The world has changed considerably since the data for those studies were collected. Given the mergers that are taking place among large financial institutions, it may be important to consider factors other than costs in these analyses. Factors such as market or political power and risk bearing with large borrowers, where one large bankruptcy could sink a small institution, need to be included in the analysis.

Relationship lending has been the lynchpin in successful lending for many years. As the range in farm business size expands, electronic credit delivery increases the sources of credit, and competition forces greater efficiency, appropriate relationship lending may change. Different types of relationships may need to be developed for different borrower groups. The definition of profitable relationship lending may need to be adjusted.

The mantra that fee-based services provide the best route to lender success needs to be investigated. The high correlation

between fee service income and loan volume brings into question the many basic analyses that show fee services to be strongly related to lender profitability. The impact of these services on lender performance needs detailed study.

The impact of the Basel II Accord on agricultural lending could be significant. While only the larger banks will likely be required to meet Basel II standards, the fact that larger influential banks must meet these standards could result in many of the principles being effectively applied to all banks. It will be important that lenders and policy makers understand these effects to ensure agriculture continues to be appropriately funded.

During the 1980s agricultural recession, the Farm Credit System used up a large proportion of its equity capital. This caused the System and its regulator, the Farm Credit Administration, to place a great deal of focus on increasing System institution capital. Over time, System entities amassed large amounts of equity capital. Some institutions developed patronage dividend policies and optimal equity guidelines. Others continued to accumulate capital. Research on optimal equity capital levels and alternate patronage dividend policies would help System institutions develop policies more in keeping with current economic conditions and make them more efficient in providing capital to agriculture.

Advances in computer technology have allowed development of more advanced *credit risk assessment* (credit-scoring) models. Academicians have developed some quite sophisticated models that appear to do a good job of assessing risk. Many lenders are using credit-scoring models in lending and loan review. However, the models used by lenders are different than those developed by academics. The models being used require less sophisticated data and less data. Research on the accuracy and justification for the lender models versus the academic models might provide information of value to both.

Increased leasing, contracting, and development of intellectual property, as well as more complex business ownership structures, are changing the character of collateral and the analytical approach to lending. Such changes could modify the appropriate model needed for successful loan analysis. To be ahead of the curve, academics need to investigate the effect these changes will have on appropriate models and data needs.

Successful lenders have few losses in most years. Thus, any one institution has insufficient loss observations to really understand the basic characteristics of the loss loan relationship. They are also reluctant to share their loss data with other lenders. This is a perfect opportunity for the academic community to work with a group of lenders to collect data on loss loans and analyze the loss relationship. Data collection would take several years, since it often takes a long time for a loss relationship to work itself to a final conclusion. However, the results could help lenders more definitively incorporate potential losses into policies instead of basing expected losses on the most recent, or most horrific, loss situation they have experienced. Given the low losses occurring in agriculture, clear specification of expected loss levels could go a long way toward keeping some commercial banks in agricultural lending.

Agricultural Finance Review

Guidelines for Submitting Manuscripts

We invite submission of manuscripts in agricultural finance, including methodological, empirical, historical, policy, or review-oriented works. Manuscripts may be submitted for the research, teaching, or extension sections. Papers must be original in content. Submissions will be reviewed by agricultural finance professionals. The final decision of publication will be made by the editor.

State in a cover letter to the editor why the manuscript would interest readers of *AFR* and indicate whether the material has been published elsewhere. Also, indicate whether the manuscript is being submitted as a research, teaching, or extension article. Please prepare manuscripts to conform to the following outline.

Title. Short and to the point, preferably not more than seven or eight words.

Abstract. No more than 100 words.

Key Words. Indicate main topics of the article (up to eight key words or short phrases, in alphabetical order).

Author's Affiliation. Author's title and institutional affiliation appears as a footnote at the bottom of the first page of the article.

Specifications. Manuscript should not exceed 25 pages of typewritten, double-spaced material, including tables, footnotes, and references. Place each table and figure on a separate page. Provide camera-ready art for figures. Number footnotes consecutively throughout the manuscript and type them on a separate sheet. Margins should be a minimum of one inch on all sides. Please number pages.

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