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BIOGRAPHY

INVITED PAPERS

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EXTENSION

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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.

VOLUME 66, NUMBER 1 REVIEWERS

Manuscripts will be accepted at any time.

Calum G. Turvey
Editor

Bruce J. Sherrick
Associate Editor

Announcement of The W.I. Myers Prize in Agricultural Finance

To encourage the publication of peer-reviewed research, Myers Endowment funds will be used to support two awards starting with the Spring 2006 issue of ***Agricultural Finance Review***. The prizes will include a monetary award as well as a certificate. Selected by the editors and on nomination by subscribers to *AFR*, the two awards will be for:

- *Overall Best Journal Article*, and
- *Best Journal Article Authored by a Student*.

All articles are eligible for an award, including invited papers and papers submitted for special issues. There are no specific criteria for determining what constitutes a "best" journal article except that it will be known to be best once read. The student award must have the student as senior author, must have been written principally by the student, and must contain thesis, dissertation, or any other research originated by the student either independently or under the advisement of a faculty. The two awards are mutually exclusive, meaning that if the student award is also the best journal article, only the best journal article award will be given. The winners of the award will be announced annually in the Spring issue of ***Agricultural Finance Review.***

The W.I. Myers Professorship of Agricultural Finance

Gifts made to Cornell in W.I. Myers' name help underwrite ***Agricultural Finance Review*** for the continued dissemination of research in agricultural finance and to grow the discipline into other fields of study such as micro finance, development economics, agricultural business, and risk management. Following his death at the age of 84 in 1976, Cornell University and friends established an endowment in Myers' name for the sole purpose of promoting his legacy and dedication to the practice and scholarship of agricultural finance. As the mandate for the endowment states, "the need for research is growing rapidly in the area of capital management of farm firms and agribusiness firms and must continue in the decades ahead to ensure a sound American agricultural system."

The Myers Chair was held first by Robert S. Smith on a part-time basis. In 1981, Dr. John R. Brake was recruited from Michigan State University to take the chair, which he held until his retirement in 1996. His successor, Dr. Eddy LaDue, then held the chair for 10 years until his retirement in 2006.

Calum G. Turvey
W.I. Myers Professor of Agricultural Finance
Editor, *Agricultural Finance Review*

William Irving Myers: A Biography

Calum G. Turvey and Douglas P. Slaybaugh

William Irving Myers (1891–1976)

The death of William Irving Myers on January 30, 1976, marked the passing of a man who not only shaped the study of agriculture at Cornell University but also helped create the Farm Credit System that has insured reliable credit for countless farmers across the United States. As a Cornell undergraduate, Myers became a protégé of the legendary agricultural economist George F. Warren, first as an undergraduate (1910–1914) and then as a graduate student (1914–1918). Warren supervised Myers' doctoral dissertation and subsequently hired him as an assistant professor in 1918, with promotion to full professor in 1920.

In 1938, upon Warren's death, Myers became head of the Department of Agricultural Economics (now the Department of Applied Economics and Management), and in 1943 the dean of Cornell's College of Agriculture (now the College of Agriculture and Life Sciences) until his retirement in 1959. One of his greatest achievements as dean was the establishment of a program in international agriculture. Among other personal milestones, Myers served as secretary of the American Farm Economics Association from 1927–1931, and its president in 1934. He was made a Fellow of the AFEA in 1958. Myers sat on the board of the Rockefeller Foundation (where he had a hand in supporting "the Green Revolution"), the Agricultural Development Council, and the Federal Reserve Bank of New York. He also advised Presidents Truman and Eisenhower.

Despite such accomplishments, Myers is best known for his work under Franklin D. Roosevelt's New Deal, where he was instrumental in creating and running the

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Calum Turvey is the current holder of the W. I. Myers Chair in Agricultural Finance in the Department of Applied Economics and Management, Cornell University; Douglas Slaybaugh is Professor of History at St. Michaels's College in Vermont. This paper is largely based on the book *William I. Myers and the Modernization of American Agriculture* (Iowa State University Press, Ames, IA, 1996) by Professor Slaybaugh, with some of the facts and dates confirmed with reference to Bernard F. Stanton's *Agricultural Economics at Cornell: A History, 1900–1990* (Cornell University Press, Ithaca, NY, 2001). Any errors or omissions are the sole responsibility of the authors.

Farm Credit Administration. Myers' rise to the governorship of the FCA was the pinnacle of a lifelong dedication to modernizing agriculture.

The future FCA Governor was born December 18, 1891, on his grandparents' mixed dairy, beef, and tobacco farm in Chemung County, New York. There he spent his youth. After working for a year as a timber cruiser in northern Quebec, Myers entered Cornell as a freshman in 1910. Encouraged by Warren, Myers commenced graduate study in 1914 and received his Ph.D. in 1918 after submitting his dissertation, "An Economic Study of Farm Layout."

The dissertation is an early expression of a lifelong commitment to making farming more business-like and scientific. In this work, Myers evaluated the land use and property layout of 53 farms to determine the economic relationships between the placement of fields and the proper use of labor and equipment. He argued in favor of best management practices like rectangular fields as more efficient than square ones because of less turnaround time. While such a practice reflects the current wisdom, in 1918 no scientific study had definitively tied farm layout to economic efficiencies. In fact, Myers, who majored in farm management and minored in economics, was the first doctoral student to combine the two fields of study—pointing the way to the future discipline of production economics.

In the early 20th century, as Myers was becoming an agricultural economist, much of the academic debate in farm management and agricultural economics focused on the traditionalist versus modernist views of agriculture. The traditionalist view, as embodied by Liberty Hyde Bailey, the first dean of the state agricultural college at Cornell and Warren's mentor, tried to use scientific means to serve the Jeffersonian goal of maintaining a vibrant rural society with large numbers of people in farming.

The modernist view to which Warren and Myers were committed, however, held that agriculture and farm management must be geared toward economic efficiency. Indeed, Myers could seem Darwinian, arguing that the many inefficient farmers must give way to fewer, more efficient ones capable of achieving scale and size economies. This view reflected not just the teachings of Warren, but also Myers' upbringing in a family that prized self-reliance. Although he made some tactical accommodations to the statist agricultural policy of the New Deal, Myers never wavered in his belief in a self-sufficient, stand-alone agricultural economy with only the most necessary involvement from government and an avoidance of subsidies. In the 1950s, he had greater success advocating a more market-driven policy as an advisor to Eisenhower's Secretary of Agriculture, Ezra Taft Benson. As late as 1968, Myers argued for a similar approach as a member of Richard Nixon's campaign advisory committee on agriculture and food.

Unlike Bailey, Myers believed it necessary to subordinate agriculture to the needs of an industrial society. Even when the expansion of agriculture in the West, together with the application of new technology, increased supply, Myers was more likely to praise the resulting gains for consumers than to worry about the problems this created for many farmers. In 1973, just a few years before his death, Myers told an audience that "as long as consumers continue to demand and enjoy three meals a day, they can expect an abundant supply of a wide variety of foods produced by the most efficient agriculture in the world at prices consistent with the general price level of the economy" (Slaybaugh, 1996, p. 227).

The Birth of Agricultural Finance

The problem with a cheap-food, non-interventionist agricultural economy is that from time to time growth is unsustainable and prices collapse. The frequency of recessions in the agricultural economy in the late 19th and early 20th centuries motivated Warren to survey farmers' records for explanatory clues. When his research showed larger farms had lower unit costs of production, Warren demonstrated that the long-standing belief in the greater efficiency of small farms was a myth. In 1919, Warren's surveys also inspired him to examine such farm finance issues as how young farmers obtained credit and how lenders provided capital to agriculture. To ensure further study of agricultural finance, Warren secured the funds to add Myers to the Cornell faculty as a specialist in the subject.

Although admired as a teacher and sought after by graduate students, Myers was not a prolific scholar. Rather, his forte was extension, outreach, and advocacy, including lobbying for farm credit reform. Prior to the 1920s, farmers did not need a lot of credit, but with technical advances and expanding farm size, credit became indispensable for sustainable growth strategies. Unfortunately, at this time commercial lenders largely ignored the business opportunity in agricultural lending, leaving those farmers who did borrow from commercial banks faced with high interest rates, poor credit terms, and often the need for a co-signatory. Myers led the quest for lower cost commercial credit. He encouraged greater understanding between farmers and bankers and wrote extensively in the farm press about the need for loan structures that matched the sequencing and timing of cash flows in agriculture. As he repeatedly argued, the unique cash flow patterns in agriculture caused significant cash flow problems for suppliers.

In 1924, Myers convened the first farmer-banker conference at Cornell. His message to bankers was that they needed to hire specialists who understood the needs of farmers. Despite much early resistance, bankers gradually followed this advice until it became the norm in agricultural areas. Myers' message to farmers was that in order to acquire credit at good rates it was necessary to convince lenders of their serious intent by following such good management practices as keeping sound financial records including (for the purposes of collateral) inventory valuations, as well as making debt payments on time, and immediately discussing any problems in doing so with the bank.

Building on such ideas, in the late 1920s Cornell established "inventory week" for the first week in January to encourage farmers to take stock, and have the stock certified, as a means of showing creditworthiness. Collectively, these activities provided the impetus for the formation of the Agricultural Bankers School (by professor Van Breed Hart) in the early 1930s. This institution survives to this day at Cornell and has been copied throughout the United States, and indeed the world.

There is a certain irony to Myers' early work with bankers and farmers. Prior to joining the New Deal, he successfully brought agricultural lending to commercial banks and onto the radar of the American Bankers Association. However, during the New Deal, Myers designed and oversaw a government agency, the FCA, which purchased mortgages from insolvent commercial lenders and thereafter became a competitor of commercial banks for agricultural loans, creating a tension that exists to this day. Myers' justification for greater government intervention in agricultural credit was that the Depression showed the unsustainability of the existing system. As he saw it, farmers who were losing their land due to bad luck rather than bad practices deserved a more reliable agricultural credit system. At the same time, an industrial nation required the consistent supply of food and fiber which could more predictably be assured.

W. I. Myers and the Farm Credit Administration

While a professor, Myers taught a course on cooperative markets and worked with farm groups to set up buying enterprises.

The first of these cooperatives was the Grange League Federation (GLF) which eventually became AgWay. A major advantage of such cooperatives was their ability to provide the equity which could be leveraged to acquire credit on terms better than farmers could obtain on their own. Myers' experience with agricultural finance and cooperatives suggested to him how to structure the FCA. He had come to believe that successful farm cooperatives had to be self-sustaining with efficiencies derived from large-lot purchases, and reasoned that farm credit institutions should be set up in a similar way.

Warren had considered the problem of agricultural credit as early as 1913. He argued that an adequate supply of credit could be provided through decentralized cooperative credit associations operating outside of a subsidy regime, but within the sphere of government oversight, as limited liability corporations. Warren believed such a system would not only prove adequate in the short run, but would also provide the long-term stability that would ultimately attract commercial lenders to agriculture. It was such thinking, coupled with the growing demand for agricultural credit, which finally led to the passage of the Federal Farm Loan Act of 1916. This Act instituted a federal land bank system to handle farm mortgages and, after an amendment in 1917, emergency crop loans. The 1916 Act established 12 regional land banks, set up as cooperatives, to operate in conjunction with local farm loan associations, and 12 regional joint stock land banks to act as private businesses to provide good credit risk. Farmers would use 5% of the loan proceeds to purchase stock in the local farm loan association. Collectively, the associations would in turn control a supervisory land bank board.

The 1916 Act was followed by the Agricultural Credit Act of 1923, which provided for 12 federal intermediate credit banks corresponding with, and overseen by, the 12 federal land banks, and also allowed for cooperative marketing associations to set up credit corporations to grant production credit (today's production credit associations).

The Depression severely stressed the land bank system, as low prices coupled with poor production reduced the ability of farmers to pay mortgages. In turn, the land banks, which had issued bonds to private investors, could not obtain funds required to service the bonds. By 1932, Myers had become disenchanted with the inadequate response of the Hoover administration to this problem and began looking to New York State Governor Franklin D. Roosevelt as a leader more open to new ideas. Following Roosevelt's presidential victory in November, Myers took a leave of absence from Cornell to join the New Deal. He was instrumental in helping pass and implement the Emergency Farm Mortgage Act of 1933 and the Farm Credit Act of 1933.

The Farm Credit Act of 1933 established the Farm Credit Administration as an independent agency, intended to give farmers pushed to their financial limit some breathing room. The Act declared a moratorium on foreclosures until its provisions could be fully implemented, reduced interest from 5.5% to 4.5% on all new and existing federal land bank loans, and carried out new appraisals in order to adjust the face value of existing mortgages based on inflated land values to reflect, instead, realistic market conditions.

At the same time, Myers had no intention of using the FCA to dispense charity. Farmer eligibility for assistance would depend on evidence of farming skills and productive land. This he made clear on several occasions (Myers, 1934, 1937), and his objection to any governmental interference in the operations of the FCA was underscored in an address presented in 1940 (Myers, 1940).

Perhaps the best statement of the core values behind the FCA can be found in a 1937 article Myers wrote for the *Journal of Farm Economics*:

> *[The purpose of the Farm Credit Administration] is to establish, on cooperative principles, a complete coordinated credit system for agriculture, operated on a business basis, farmer owned and controlled, and designed to meet at all times and at the lowest possible cost the sound credit requirements of the farming industry on repayment terms suited to its needs. Stated another way, the credit system we are seeking to establish may be thought of as a farmer-owned cooperative service organization whose function it is to borrow funds, through the sale of bonds and debentures, for such periods of time as may be required for the farming industry; and to make loans to individual farmers and farmers' cooperative associations with a basis for credit on terms best suited to their needs at interest rates representing the cost of borrowed funds plus a margin to cover the cost of operation and necessary reserves* (Myers, 1937, p. 83).

This view and structure was vital because Myers intended for the FCA to function as a bottom-up, not a top-down program, with farmers themselves ultimately working through their credit cooperatives to make decisions and relying on the credit market rather than the U.S. Treasury for support. Government guarantees were intended as limited—to carry farmers through the current emergency and to act as a last line of defense. The FCA was empowered to issue bonds secured by the value of farm real estate. The private credit market could be induced to buy such bonds only because the FCA had ordered a marked write down of some agricultural assets in order to reduce the risk of the bonds and thus the bond yields with which to pay for them. In addition, the FCA would also purchase loans at discounts from closed or troubled commercial banks, thereby transferring much needed funds to reconstitute deposits and provide capital for new loans.

Myers became Deputy Governor of the FCA in June 1933, and took over as Governor in November. He was an extremely busy man. In addition to being the principal architect and top administrator during the revitalization, reorganization, and expansion of the national cooperative farm credit system, he also had to hire senior officials, develop appraisal rules, train staffers to implement the new credit policies, maintain accounts and communications with bond markets, and brief the President and Congress. Although there were some complaints about delays in loan reviews, as well as about appraisal standards which mandated greater efficiency, it is astonishing that between June and December 1933 the FCA received over 500,000 applications and processed 82,600 loans totaling $222 million. In 1934, the agency processed 500,000 loans worth $1.25 billion. The numbers fell in 1935, and by 1936 the FCA had successfully ended the farm credit crisis.

Myers resigned as FCA Governor in 1938 to return to Cornell. Shortly after his departure, the FCA, to Myers' consternation, was assimilated into the USDA and, from his perspective, politicized (see Myers, 1940). He would work for the next 15 years to return the agency to its independent status, ultimately succeeding with the onset of the more conservative Eisenhower Administration. Meanwhile, Myers resumed his teaching duties and took over from Warren as head of the Department of Agricultural Economics. In 1943, he was appointed Dean of Agriculture. He died at the age of 84 in 1976.

While the success of Myers' work at the FCA was his greatest accomplishment, this achievement was inexorably linked with his teaching, his deanship, and his work on the Rockefeller Foundation and New York Federal Reserve boards, among other institutions, to further his lifelong goal of using the tools of science, the discipline of the market, and, when needed, government engagement to help farmers help themselves to adapt to the requirements of the modern world. In doing so, Myers rejected any sentimental attachment to the agrarian culture of the past in favor of a vision of agriculture in service to a dominant industrial culture.

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Bankruptcy Reform and the Effects on Chapter 12 Bankruptcy for Farmers (and Fishermen)

Neil E. Harl

Abstract

The United States Constitution assures debtors a right to relief from creditors seeking to satisfy claims against debtors unable to pay their debts. For well over a century, farmers as debtors have enjoyed a favored status by being exempt from involuntary bankruptcy. The landmark 2005 bankruptcy legislation continues that favored status even though the thrust of most of the rest of the 2005 law tightens the rules for non-farm debtors in several significant respects. The 2005 bankruptcy amendments made Chapter 12 bankruptcy for family farmers a permanent part of the Bankruptcy Code, relaxed the rules on family farmers eligible to file for Chapter 12 bankruptcy relief, and created an innovative way to treat tax liability from liquidation of business assets. The contrast in Congressional treatment of farm debtors and non-farm debtors in the 2005 statute is striking and appears to be attributable to strong and effective political support from farm state Members of Congress, the widespread belief that farmers in financial difficulty are deserving of assistance, and that abuse of the bankruptcy system has been less of a problem with the agricultural sector.

Key words: 2005 legislation, bankruptcy, Chapter 12 bankruptcy, farmers, financial stress, indebted farmers, political support

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As is widely known, bankruptcy in the United States is a constitutionally assured[1] procedure available to persons (including corporations and some other entities) who are unable to pay their debts as the debts become due.[2] Moreover, the importance of bankruptcy is substantially greater than the effect on debtors who file a petition in bankruptcy (an "order for relief") and their creditors. As the procedure of last resort for heavily indebted debtors, the availability of bankruptcy influences the use of other options open to debtors for resolving their problems of excessive debt, including foreclosure, forfeiture of contract rights, and debt restructuring (which was used heavily in the agricultural sector in the 1980s during the farm debt crisis of that era).[3]

Indeed, Chapter 12 bankruptcy, as enacted in 1986, represents an institutionalized form of debt restructuring which is based on a key assumption—it is generally not rational to liquidate a loan if the loss expected to be taken is greater than what would be required to keep the debtor in business by restructuring the loan.[4] A comparison of outcomes (restructuring, asset foreclosure or forfeiture, reorganization bankruptcy,

[1] See United States Constitution, Article I, Section 8: "The Congress shall have Power ... to establish ... uniform Laws on the subject of bankruptcies throughout the United States...."

[2] See generally *1 Collier on Bankruptcy* ¶¶ 0.02, 0.03 (15th ed., 1986); 13 Harl, *Agricultural Law*, Ch. 120 (2006).

[3] See Harl, *The Farm Debt Crisis of the 1980s*, Ch. 3, Iowa State University Press, 1990.

[4] See 13 Harl, *Agricultural Law* § 120.01[4] (2006).

bankruptcy liquidation, or informal liquidation outside of bankruptcy) on a net present value basis provides guidance as to the most rational approach for a lender.[5] Such an analytical approach also provides useful information to a debtor unable to pay debts as the debts become due.

A Brief History of Bankruptcy

Although uniform bankruptcy laws were assured by the United States Constitution, as noted,[6] the enactment of the federal Bankruptcy Code preempted the enforcement of state bankruptcy laws inconsistent with the federal law.[7] The Bankruptcy Act of 1898 was replaced by the Bankruptcy Reform Act of 1978.[8] In 1982, the U.S. Supreme Court held the provisions of the Bankruptcy Reform Act of 1978, establishing the bankruptcy courts as an independent part of the judiciary, to be unconstitutional.[9] To meet the objections raised by the U.S. Supreme Court, the Congress amended the 1978 law to vest all jurisdiction over cases under the Bankruptcy Code in the federal district courts, with the bankruptcy courts functioning as units of the district courts.[10]

Under the 1986 amendments to the Bankruptcy Act of 1978, Congress created Chapter 12 bankruptcy for "family farmers."[11] Chapter 12 was initially enacted to expire in 1993, but was extended 11 times, the latest to July 1, 2005.[12]

The Bankruptcy Abuse Prevention and Consumer Protection Act of 2005[13] represented the most far-reaching revision of bankruptcy law since 1978.[14] Although widely credited with tightening the rules applicable to debtors and debtors' rights, the enactment of the 2005 legislation represented significant gains for debtors and debtors' rights under Chapter 12 bankruptcy for "family farmers" and "family fishermen."

Major Changes in Bankruptcy Law for Debtors Generally

Under the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005,[15] in general the legal pendulum has swung dramatically away from favoring debtors under the "fresh start" philosophy articulated by the U.S. Supreme Court in 1979[16] (which has been described as the most extensive "since the seven-year release described in the Old Testament"[17]) and toward favoring creditors. Some of the more significant provisions contributing to that pendulum swing are discussed in the subsections following.

The "Means Test"

One of the more heavily criticized parts of the 2005 Act was the imposition of a "means test."[18] As has been noted, the test is probably more accurately described as a "median test"[19] followed by a means test[20] for those who fail the median test.[21]

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[5] *Id.*

[6] See note 1 *supra.*

[7] See 1 *Collier on Bankruptcy* ¶¶ 0.02, 0.03 (15th ed., 1986).

[8] Pub. L. No. 95-598, 92 Stat. 2459 (1978), effective October 1, 1979.

[9] *Northern Pipeline Co. v. Marathon Pipeline Co.*, 458 U.S. 50 (1982).

[10] Bankruptcy Amendments and Federal Judgeship Act of 1984, Pub. L. No. 98-353, 98 Stat. 333 (1984).

[11] Pub. L. No. 99-554, 100 Stat. 3105 (1986), adding 11 U.S.C. § 1202 *et seq.*

[12] See 13 Harl, *Agricultural Law* § 120.08[1], footnote 4 (2006).

[13] Pub. L. No. 109-8, 119 Stat. 23 (2005).

[14] See Harl, Neil E., Joseph A. Peiffer, and Roger A. McEowen, "Major Developments in Chapter 12 Bankruptcy," 16 *Agric. L. Dig.* 57 (2005).

[15] See note 13 *supra.*

[16] *Brown v. Felsen*, 442 U.S. 127, 128 (1979).

[17] *In re Bailey*, 53 B.R. 732, 736 (*Bankr.* W.D. Ky. 1985).

[18] 11 U.S.C. § 707(b).

[19] 11 U.S.C. § 707(b)(7).

[20] 11 U.S.C. § 707(b)(2).

[21] See 13 Harl, *Agricultural Law* § 120.02[1][a][i] (2006).

The means test (and the median test) is framed to prevent debtors whose debts are primarily consumer debts from filing a Chapter 7 (liquidation) bankruptcy to discharge the consumer debts if the debtor does not pass the means test. If the debtor fails the test, conversion of the case to Chapter 11 or Chapter 13 (both reorganization bankruptcies) or dismissal of the case is the remedy.

In simplified form, the median test compares the debtor's current monthly income (CMI) with the median income for the debtor's state for households of a comparable size.[22] If the debtor's CMI over the six months preceding the filing of the case is less than the state's median income for a comparably-sized family,[23] the debtor is deemed not to be an abuser, and the court cannot dismiss the case for abuse.[24] For purposes of these calculations, in determining whether the debtor's case should be dismissed, the court may not take into account whether a debtor has made or continues to make charitable contributions to a qualified religious or charitable organization.[25] Moreover, income received in the form of social security benefits is excluded from the calculations[26] and, if the debtor is a disabled veteran and the indebtedness occurred primarily during a period over which the veteran was either on active duty or performing homeland defense, the court cannot dismiss the case for abuse.[27]

If a debtor fails the median test, several deductions are subtracted to determine the disposable monthly income (DMI) which is used to determine whether the debtor passes the *means* test. The deductions include living expenses,[28] housing and utilities, and transportation expenses,[29] as well as several actual expense deductions.[30] Those include the following:

1. secured debt payments for the debtor's house and vehicle or vehicles, provided they are necessary for the support of the debtor and the debtor's dependents;[31]
2. amounts necessary to allow the debtor to cure defaults and maintain the debtor's house and motor vehicle;[32]
3. care and support of elderly, chronically ill, or disabled household members who are unable to pay for such reasonable and necessary expenses;[33]
4. mandatory payroll deductions for retirement plans;[34]
5. actual administrative expenses of administering a Chapter 13 plan, not to exceed 10% of projected plan payments;[35]
6. education expenses for each dependent child less than 18 years of age, not to exceed $1,500 per child to attend a private or public elementary or secondary school given debtor-provided documentation and why such expenses are reasonable and necessary;[36]
7. an allowance for housing and utilities in excess of local standards for home energy costs if reasonable and necessary;[37]
8. taxes including federal income tax, FICA, Medicare, state and local taxes, and personal property taxes;[38]
9. insurance including term life, dental, vision, long-term care, and health savings accounts;[39]

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[22] 11 U.S.C. § 101(10A).

[23] The figures for a state's median income may be found on the U.S. Census Bureau website which is at http://www.census.gov/hhes/www/income/statemedfominc.html. The median income is the latest Census data adjusted by the Consumer Price Index.

[24] 11 U.S.C. § 707(b)(7).

[25] 11 U.S.C. § 707(b)(1).

[26] 11 U.S.C. § 101(10A)(A), (B).

[27] 11 U.S.C. § 707(b)(2)(D).

[28] See 11 U.S.C. § 707(b)(2)(A)(ii).

[29] *Id.*

[30] 11 U.S.C. § 707(b)(2)(A)(iii).

[31] 11 U.S.C. § 707(b)(2)(A)(iii)(I).

[32] 11 U.S.C. § 707(b)(2)(A)(iii)(II).

[33] *Id.*

[34] See Official Form 22.

[35] 11 U.S.C. § 707(b)(2)(A)(iii)(III).

[36] 11 U.S.C. § 707(b)(2)(A)(iii)(IV).

[37] 11 U.S.C. § 707(b)(2)(A)(iii)(V).

[38] 11 U.S.C. § 707(b)(2)(A)(iii)(II).

[39] 11 U.S.C. § 707(b)(2)(A)(ii)(I).

10. court-ordered payments for current domestic support (excluding past-due support);[40]
11. child-care expenses including babysitting, day care, nursery, and pre-school;[41]
12. healthcare expenses including health insurance, medical services, medical supplies, and prescription drugs;[42] and
13. business expenses necessary for the production of income.[43]

After the allowable expenses are deducted, the result is the debtor's disposable monthly income (DMI). If the debtor's DMI when multiplied by 60 is greater than the lesser of 25% of the debtor's nonpriority unsecured claims in the case, or $6,000, whichever is greater, or $10,000, abuse is presumed and the debtor fails the means test.[44] In that event, the debtor has the choice of having the case dismissed or converting the case to Chapter 11 or Chapter 13.[45] Also, the outcome of the means test is used to determine, in a Chapter 13 case, whether the plan will be a three-year or a mandatory five-year plan.[46]

In studies published by the American Bankruptcy Institute in 1999 and 2000, the authors concluded that fewer than 1% of all debtors would fail the means test.[47] The actual impact of means testing will not be known for some time.

Dismissal for "Abuse"

Before enactment of the 2005 Act, a bankruptcy case could be dismissed for "substantial abuse."[48] Under the 2005 Act, bankruptcy cases can be dismissed for mere "abuse"[49] and such action can be brought by a wider group including the bankruptcy court, the United States Trustee, the case trustee, or any party in interest.[50] Moreover, the prior presumption in favor of granting the bankruptcy relief was removed by the 2005 Act.[51]

Small Business Chapter 11 Cases

The Bankruptcy Abuse, Prevention, and Consumer Protection Act of 2005[52] established a "small business Chapter 11 case"[53] with significantly different requirements and with more regimentation than a regular Chapter 11 plan. A "small business debtor" is a person engaged in a commercial or business activity with aggregate, noncontingent, liquidated, secured, and unsecured debts as of the date for the order for relief (bankruptcy filing) in an amount of not more than $2 million (excluding debts owed to one or more affiliates or insiders) for a case in which the United States trustee has not filed a committee of unsecured creditors or where the court has determined that the committee is not sufficiently active and representative to provide effective oversight of the debtor.[54] The term does not include any member of a group of affiliated debtors with aggregate, noncontingent, liquidated, secured, and unsecured debts in an amount greater than $2 million (excluding debts owed to one or more affiliates or insiders).[55]

Debtors in small business Chapter 11 cases face several additional requirements:

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[40] 11 U.S.C. § 707(b)(2)(A)(iii)(II).

[41] *Id.*

[42] *Id.*

[43] *Id.*

[44] 11 U.S.C. § 707(b)(2)(A).

[45] 11 U.S.C. § 707(b)(1).

[46] 11 U.S.C. § 1325(b)(2), (3).

[47] Culhane and White, "Taking the New Consumer Bankruptcy Model for a Test Drive: Means Testing Real Chapter 7 Debtors," *ABI Law Rev.*, Spring 1999; Flynn and Bermant, "Pre-Bankruptcy Planning Limits Means Testing Impact," *ABI*, Feb. 1, 2000.

[48] See 11 U.S.C. § 707(b).

[49] 11 U.S.C. § 707(b)(1).

[50] *Id.*

[51] Pub. L. No. 109-8, Sec. 102(a), 119 Stat. 27 (2005).

[52] See note 13 *supra*.

[53] 11 U.S.C. §§ 101(51D), 1116, added by Pub. L. No. 109-8, Sec. 432, 119 Stat. 110 (2005).

[54] 11 U.S.C. § 101(51D).

[55] *Id.*

1. filing the most recent balance sheet, statement of operations or cash-flow statement, and federal income tax return;[56]
2. attending meetings scheduled by the court or the United States trustee;[57]
3. timely filing of all schedules and statements of financial affairs;[58]
4. filing all post-petition financial and other reports;[59]
5. maintaining insurance customary and appropriate to the industry;[60]
6. timely filing tax returns and other government filings and timely paying all taxes entitled to administrative priority;[61] and
7. allowing the United States trustee to inspect the debtor's business premises, books, and records.[62]

Small business debtors are required to file periodic financial and other reports focusing on the debtor's profitability, projected cash receipts and disbursements, comparisons of actual with projected cash receipts and disbursements, and whether the debtor is in compliance with the applicable requirements.[63]

Only the small business debtor may file a plan until 180 days after the date of the order for relief unless the period is extended or the court orders otherwise.[64] The plan and a disclosure statement are to be filed not later than 300 days after the date of the order for relief.[65] The court is generally to confirm the plan within 45 days after the plan is filed unless the period is extended.[66]

Limits on Automatic Stay for Frequent Bankruptcy Filers

In general, the filing of a bankruptcy petition bars a broad range of legal actions by creditors against the debtor and the debtor's property.[67] The automatic stay continues as to acts against the debtor's property until the property is no longer estate property[68] and against other actions until the bankruptcy is dismissed or closed or a discharge is granted or denied.[69]

Those provisions were amended in 2005 for frequent or repeat bankruptcy filers.[70] Thus, the automatic stay terminates 30 days after filing if a Chapter 7, 11, or 13 case was pending within the one-year period before the filing of the current case and the prior case was dismissed other than for a refiling after a dismissal for bad faith.[71] A rebutable presumption arises that a second filing within one year is in bad faith.[72] The 2005 law also prevents the automatic stay from having an effect in cases where an individual debtor had two or more cases pending within the prior year which were dismissed and refiled other than for dismissals in bad faith.[73]

Homestead Exemptions

The homestead exemption [allowing the debtor to exempt all or a specified part of the value of the debtor's (or the debtor's dependent's) residence] was significantly narrowed and made more uniform by the 2005 Act.[74] Under the 2005 legislation, a debtor cannot exempt an interest in a homestead acquired during the 1,215-day period prior to filing the petition if the homestead exceeds $125,000 in value.[75]

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56 11 U.S.C. § 1116(1).

57 11 U.S.C. § 1116(2).

58 11 U.S.C. § 1116(3).

59 11 U.S.C. § 1116(4).

60 11 U.S.C. § 1116(5).

61 11 U.S.C. § 1116(6).

62 11 U.S.C. § 1116(7).

63 11 U.S.C. § 308(a), (b).

64 11 U.S.C. § 1121(e)(1).

65 11 U.S.C. § 1121(e)(2).

66 11 U.S.C. § 1121(e)(3).

67 11 U.S.C. § 362(a).

68 11 U.S.C. § 362(c)(1).

69 11 U.S.C. § 362(c)(2).

70 See 11 U.S.C. § 362(c).

71 11 U.S.C. § 362(c)(3).

72 *Id.*

73 11 U.S.C. § 362(c)(4).

74 11 U.S.C. § 522(o), (p), (q).

75 11 U.S.C. § 522(p)(1).

This limitation does not apply to an exemption claimed by a family farmer for the principal residence of the farmer[76] or to any interest transferred from the debtor's previous principal residence acquired prior to the 1,215-day period before filing which was transferred to the debtor's residence, provided the residences are located within the same state.[77] Also, if the debtor has been convicted of various crimes, the debtor may not exempt more than $125,000 in the homestead.[78] Finally, the $125,000 limit does not apply if it is reasonably necessary for support of the debtor or dependents of the debtor.[79]

Lien Avoidance

Bankruptcy law has long provided for avoidance of liens which impair an exemption to facilitate the debtor's fresh start.[80] Lien avoidance is significantly narrowed in the 2005 Act:

- Under the 2005 legislation, judicial liens for domestic support cannot be avoided.[81]
- The 2005 law redefines "household goods" for purposes of lien avoidance and excludes the following:

  "Works of art (unless by or of the debtor, or any relative of the debtor); electronic entertainment equipment with a fair market value of more than $500 in the aggregate (except for one television, one radio, and one VCR); items acquired as antiques with a fair market value of more than $500 in the aggregate; jewelry with a fair market value of more than $500 in the aggregate (except wedding rings); and a second household computer, motor vehicle (including a tractor or lawn tractor), boat, or motorized recreational device, conveyance vehicle, watercraft or aircraft."[82]

Payments Required Under Chapter 13

The 2005 Act established a national standard for the amount required to be paid under a Chapter 13 reorganization plan.[83] The minimum required payment is based on the current monthly income of the debtor and debtor's spouse, size of the household, and the median income of the state for a family of the same composition.[84]

"Disposable Income" for Plan Confirmation

The 2005 Act redefines the term "disposable income" for purposes of confirmation of a Chapter 13 plan.[85] The term means current monthly income received by the debtor (other than child support payments, foster care payments, or disability payments for a dependent child) less amounts reasonably necessary to be expended for the maintenance and support of the debtor or a dependent of the debtor or for a domestic support obligation first payable after the date the petition is filed, for charitable contributions in an amount not to exceed 15% of gross income and, if the debtor is engaged in business, the payment of amounts necessary for the continuation, preservation, and operation of the business.[86]

Denial of Discharge

Under the 2005 Act, failure to complete an instructional course concerning personal financial management can result in a

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[76] 11 U.S.C. § 522(p)(2)(A).

[77] 11 U.S.C. § 522(p)(2)(B).

[78] 11 U.S.C. § 522(q)(1). The value of the homestead is reduced for exemption purposes to the extent the value is attributable to any portion of the residence disposed of in the 10-year period ending on the day of filing with an intent to hinder, delay, or defraud a creditor. 11 U.S.C. § 522(o).

[79] 11 U.S.C. § 522(q)(2).

[80] See 13 Harl, *Agricultural Law* § 120.04[1][a][iii] (2006).

[81] 11 U.S.C. § 522(f)(1)(A).

[82] 11 U.S.C. § 522(f)(4)(B).

[83] 11 U.S.C. § 1322(d).

[84] 11 U.S.C. § 1322(d)(1).

[85] 11 U.S.C. § 1325(b)(2), (3).

[86] *Id.*

denial of discharge unless the debtor lives in a district where the United States trustee or the Bankruptcy Administrator determines that the approved instructional courses are not adequate to service the individuals who need the course.[87]

Major Changes in Chapter 12 Bankruptcy

In striking contrast to the numerous provisions in the 2005 Act applicable to Chapter 7, 11, and 13 filers, as noted above, the Chapter 12 provisions in the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005[88] *are almost universally and without exception friendly to debtors.* The concluding section of this article addresses that phenomenon.

Chapter 12 Made Permanent

Perhaps the most surprising provision in the legislation, in light of the non-Chapter 12 provisions in the 2005 law, makes Chapter 12 a permanent part of the Bankruptcy Code[89] and extends the scope to include a "family fisherman"[90] as well as a "family farmer."[91] Chapter 12 was enacted as temporary legislation, with a seven-year life,[92] but was extended 11 times.[93]

Eligibility to Be a "Family Farmer"

The definition of the term "family farmer" was changed to allow an individual or an individual and spouse engaged in a farming operation to have aggregate debts not to exceed $3,237,000 (up from $1,500,000 under prior law)[94] with not less than 50% of the aggregate, noncontingent, liquidated debts (excluding the debt from a principal residence) arising out of a farming operation (down from 80% under prior law).[95] Moreover, the requirement that more than 50% of gross income must be received from a farming operation in the taxable year preceding filing has been relaxed to allow the 50% test to be met, in the alternative, during the second *and* third tax years preceding filing.[96] Thus, a Chapter 12 filer must have more than 50% of its gross income from farming in either the tax year prior to filing *or both* the second and third tax years prior to filing the Chapter 12 petition.[97] The dollar requirements are to be adjusted for inflation at three-year intervals.[98] The increase in allowable debt levels represents an increase of nearly 116% compared to the $1,500,000 level of prior law.

Interestingly, the eligibility requirements for family fishermen remain at $1,500,000 and at least 80% of the debts must arise out of a commercial fishing operation operated by the individual or individual and spouse,[99] and the 50% gross income test must be met during the taxable year preceding filing.[100]

Modification After Confirmation

The 2005 Act provides that, after confirmation, the Chapter 12 plan may not be modified in the last year of the plan by anyone *except the debtor* to require payments that would leave the debtor with insufficient funds to carry on the farming operations after the plan is completed.[101]

The 2005 law also changed the manner of modifying plans with respect to increasing

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[87] 11 U.S.C. § 722(a)(11).

[88] Pub. L. No. 109-8, 119 Stat. 185 (2005).

[89] Pub. L. No. 109-8, Secs. 1001, 1007, 119 Stat. 185 (2005).

[90] 11 U.S.C. §§ 109(f), 101(19A).

[91] *Id.*

[92] Pub. L. No. 99-554, 100 Stat. 3105 (1986), adding 11 U.S.C. § 1201 *et seq.*

[93] See 13 Harl, *Agricultural Law* § 120.08[1] (2006), footnote 4.

[94] 11 U.S.C. § 101(18)(A), (B).

[95] *Id.*

[96] 11 U.S.C. § 101(18)(A).

[97] *Id.*

[98] 11 U.S.C. § 104(b)(1).

[99] 11 U.S.C. § 101(19A)(A)(i).

[100] 11 U.S.C. § 101(19A).

[101] 11 U.S.C. § 1229(d)(3).

the disposable income to be paid to the trustee.[102] Under the 2005 rules, a plan may not be modified to increase the amount of any payment due before the plan as modified becomes the plan[103] or by anyone (except the debtor) based on an increase in the debtor's disposable income, to increase the payments to unsecured creditors required for a particular month so that the aggregate of such payments exceeds the debtor's disposable income for such month.[104]

Post-Petition Taxes

When Chapter 12 bankruptcy was enacted, Congress failed to amend the Internal Revenue Code to enable Chapter 12 debtors to be eligible for a new tax entity as is possible with Chapter 7 or 11 filings by individuals.[105] Separate entity status is important for debtors to be able to avoid income tax liability for assets liquidated by the bankruptcy estate.[106] Efforts to provide separate entity status to Chapter 12 filers were resisted by creditor groups.

The 2005 Act accomplished a result similar to separate entity status by amending, not the Internal Revenue Code, but the Bankruptcy Code.[107] This provision is of immense potential importance to Chapter 12 filers.

The 2005 tax provision was effective on enactment,[108] one of the few provisions not to be effective 180 days after enactment, which was the date of the President's signature (April 20, 2005).[109]

The tax provision allows a Chapter 12 debtor to treat amounts arising out of "claims owed to a governmental unit" as a result of "sale, transfer, exchange, or other disposition of any farm asset used in the debtor's farming operation" to be treated as an unsecured claim that is not entitled to priority under Section 507(a) of the Bankruptcy Code, *provided the debtor receives a discharge* in bankruptcy.[110] Thus, income taxes within the scope of the provision are eligible for discharge as unsecured claims. An important point is that the provision is limited to gains from "any farm asset used in the debtor's farming operation" which should embrace farmland, machinery, equipment, and breeding and dairy animals, but will likely be interpreted as not extending to crops or livestock produced and held for sale. Note that nothing in the legislation specifies when the property can be disposed of in order to be eligible for unsecured claim status. Another important point is that the taxing agencies must receive at least as large an amount as would have been received had the claim been a pre-petition unsecured claim.

The key point is that, under prior law, taxes were a priority claim and had to be paid in full.[111] Even though the priority tax claims could be paid in full in deferred payments under prior law,[112] in many instances the debtor did not have sufficient funds to allow payment of the priority tax claims in full even in deferred payments.

This amendment addresses a major problem faced by many family farmers in filing under Chapter 12 where the sale of assets to make the operation economically viable triggered gain which, as a priority claim, had to be paid. For 25 years,

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[102] 11 U.S.C. § 1229(d).

[103] 11 U.S.C. § 1229(d)(1).

[104] 11 U.S.C. § 1229(d)(2).

[105] I.R.C. § 1398(a).

[106] See generally 13 Harl, *Agricultural Law* § 390.04[2] (2006).

[107] 11 U.S.C. § 1222(a).

[108] 11 U.S.C. § 1222(a)(2)(A).

[109] Bankruptcy Abuse Prevention and Consumer Protection Act of 2005, Pub. L. No. 109-8, Sec. 1501(b)(1), 119 Stat. 185 (2005).

[110] Bankruptcy Abuse Prevention and Consumer Protection Act of 2005, amending 11 U.S.C. § 1222(a)(2)(A).

[111] 11 U.S.C. §§ 507(a), 1222(a)(2).

[112] 11 U.S.C. § 1222(a)(2).

debtors filing as individuals under Chapter 7 or 11 bankruptcy have been eligible for separate entity status after bankruptcy filing.[113] That was the mechanism by which income tax on gains on property liquidated after filing could be avoided.[114]

If the debtor's year was closed as of the beginning of the year, income tax liability for the period in that short year before bankruptcy filing became a priority claim against the bankruptcy estate.[115] The tax liability involved can be collected from the bankruptcy estate if there are sufficient assets to pay the estate's debts.[116]

Separate entity status, however, was not extended to Chapter 12 filers. Therefore, the 2005 amendment, in a different manner, affords Chapter 12 filers a measure of relief similar, but not identical, to the relief long available to individual filers under Chapter 7 or Chapter 11 bankruptcy.

Under the provision, if a Chapter 12 bankruptcy filer liquidates assets used in the farming operation within the tax year of filing or liquidates assets used in the farming operation after Chapter 12 filing as part of the Chapter 12 plan, and income tax on gain or depreciation recapture income or both are triggered, the plan should provide that there will be no payments to unsecured creditors until the amount of tax owed to governmental bodies for the sale of assets used in the farming operation is ascertained. The tax claims[117] are then added to the pre-petition unsecured claims to determine the percentage distribution to be made to the holders of pre-petition unsecured claims as well as the claims of the governmental units that are being treated as unsecured creditors not entitled to priority.[118] With that approach, all claims deemed to be unsecured claims are treated equitably. Litigation will likely be necessary to establish the proper way to handle unsecured tax claims under the provision.

Arguably, if a debtor determined, post-confirmation, that, to insure financial and economic viability, assets used in the farming operation must be liquidated, the Chapter 12 plan could be modified to allow the sale of assets so long as the modified plan made provision to make payments to the taxing bodies in an amount that would equal or exceed what would have been received had it been a pre-petition unsecured claim. Upon entry of the Chapter 12 discharge, the claim of the governmental body for taxes on the sale of assets used in the farming business would also be discharged. If the debtor does not receive a Chapter 12 discharge, the taxing bodies would be free to pursue the debtor as if no bankruptcy had been filed, assessing and collecting the tax and all penalties and interest.

The 2005 Act also specifies that a Chapter 12 plan may provide for less than full payment of all amounts owed for a claim entitled to priority under 11 U.S.C. § 507(a)(1)(B) (a higher priority classification for domestic support obligations assigned to governmental units) only if the plan provides that all of the debtor's projected disposable income for a five-year period beginning on the date that the first payment is due under the plan will be applied to make payments under the plan.[119]

The 2005 Act also adds a new provision requiring an individual Chapter 12 debtor to be current on post-petition domestic support obligations as a condition of confirmation of a plan.[120]

[113] I.R.C. § 1398(a). See 5 Harl, *Agricultural Law* § 39.04 (2006).

[114] See I.R.C. § 1398(a).

[115] See 5 Harl, *supra* note 113, § 39.04.

[116] *Id.*

[117] 11 U.S.C. § 1222(a)(2).

[118] See Harl, Neil E., Joseph A. Peiffer, and Roger A. McEowen, "Major Developments in Chapter 12 Bankruptcy," 16 *Agric. L. Dig.* 57, 58 (2005).

[119] 11 U.S.C. § 1222(a)(4).

[120] 11 U.S.C. § 1225(a).

Conclusion

Perhaps the most puzzling feature of the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005[121] is why did Chapter 12 filers (family farmers and family fishermen) fare so dramatically better than other debtors under the other bankruptcy chapters? That question will likely consume the attention of commentators for years. The explanation likely rests with several circumstances:

- The support of key Congressional leaders from farm states surely played a role.
- However, the more compelling reason is that debtors generally were repeatedly characterized as being responsible for their plight, which was represented as attributable to mismanagement and greed or opportunists who abused the system for financial gain. The public tends to have little concern for individuals who fall into those categories. That characterization, which was an unfair portrayal of debtors generally, apparently was never extended to family farmers and family fishermen.

Regardless of the reasons for the result, the outcome certainly ranks as one of the more fascinating contrasts in legislative annals in several years.

[121] Pub. L. No. 109-8, 119 Stat. 185 (2005).

Permanent and Expanded: Chapter 12 Bankruptcy Regulations Following BAPCPA

Barbara O'Neill

Abstract

The purpose of this article is to describe Chapter 12 of the Federal Bankruptcy Code and recent changes in federal bankruptcy legislation that affect family farmers and fishermen. Chapter 12 provides debt relief to financially stressed family farmers and, since 2005, fishermen with regular income. It was first enacted in 1986, in response to the farm financial crisis of the early- to mid-1980s, and was subsequently renewed by Congress until being made a permanent part of the Bankruptcy Code on July 1, 2005. This article provides an overview of the history and procedural aspects of Chapter 12 bankruptcy for family farmers and fishermen who are experiencing financial distress. It also discusses changes to the Bankruptcy Code enacted in 2005 under the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) that affect the agricultural community.

Key words: bankruptcy, BAPCPA law, Chapter 12 bankruptcy, farm financial distress

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The purpose of this article is to describe Chapter 12 of the Bankruptcy Code and recent changes in federal bankruptcy legislation that affect family farmers and fishermen. When loss of income and/or increased expenses make debt repayment impossible, many individuals and businesses file for bankruptcy as a last resort. The United States has the highest consumer bankruptcy rate in the world (Lown, 2005), with more than 1.5 million people seeking personal bankruptcy protection in 2004 (U.S. Courts, 2005c).

Bankruptcy is a federal court process designed to help consumers and businesses eliminate their debts or repay them under the protection of the bankruptcy court (U.S. Courts, 2005a; Martin and Paley, 2006). Federal law defines four methods of declaring bankruptcy: Chapter 7 (a.k.a., straight bankruptcy), Chapter 13 (personal debt reorganization), Chapter 11 (business debt reorganization), and Chapter 12 (farm debt reorganization). So-called "Chapter 20" filings (i.e., Chapter 13 filings that degenerate into Chapter 7s) are also frequently seen.

Chapter 12 of the Federal Bankruptcy Code provides debt relief to financially stressed family farmers and, since 2005, fishermen with regular income. It was first enacted in 1986, in response to the farm financial crisis of the early- to mid-1980s, and was subsequently renewed by Congress in 1993, 1998, and 2003 ("Chapter 12 Background," n.d.; USDA/Economic Research Service, 1997). The primary purpose of Chapter 12 bankruptcy is to give small farm owners a chance to reorganize their debts and keep their farms ("An Overview of Chapter 12 Bankruptcy," 2005).

Key to the success of a Chapter 12 bankruptcy is the ability of a farmer to "cash flow" the structured loan terms (Legal Aid of Nebraska, 2002). Modeled after Chapter 13 (a.k.a., "wage earner plan") bankruptcy for consumers who repay past debts with future income, a debtor farmer files a plan with the courts to repay outstanding debts over time ("Types of Bankruptcy," n.d.; "What Is Bankruptcy?" 2005). Two categories of farmers can file under Chapter 12: an individual or individual and spouse, and a corporation or partnership farm operation (U.S. Courts, 2005a).

Chapter 12 has higher debt ceilings than Chapter 13 consumer bankruptcies to accommodate the large debts often associated with operating a farm, yet it is also more streamlined and less expensive than the Chapter 11 bankruptcies used by large corporations. While regular debt repayments are being made, the farming operation continues. The Bankruptcy Code requires that only a family farmer with "regular annual income" may file a Chapter 12 petition to ensure a debtor's annual income is sufficiently stable to make plan payments ("Chapter 12 Background," n.d.). Allowances are made in a Chapter 12 plan, however, for situations in which family farmers have income that is seasonal in nature ("An Overview of Chapter 12 Bankruptcy," 2005).

Only a few hundred people file for Chapter 12 bankruptcy annually compared to hundreds of thousands who file for Chapter 13 ("What Is Bankruptcy?" 2005). While most farmers declaring bankruptcy elect to file Chapter 12, some choose Chapter 11 (large farm corporations) or file personal bankruptcy via Chapter 13, if their debts fall within the maximum allowable limit, or Chapter 7 (liquidation), if they have no current source of income with which to repay debts (USDA/ Economic Research Service, 1997).

The Chapter 12 Bankruptcy Process

The process of filing a Chapter 12 bankruptcy is as follows. A case begins when an eligible family farmer files a petition with the bankruptcy court serving the area where the individual lives or where the primary business or business assets are located (U.S. Courts, 2005a). As of October 17, 2005, the courts charge a $239 filing fee for Chapter 12 bankruptcies (U.S. Courts, 2005b), a $200 case filing fee, and a $39 miscellaneous administrative fee (U.S. Courts, 2005a). This is significantly less than the $1,039 for Chapter 11 filings, but more than the $189 fee required for Chapter 13 (U.S. Courts, 2005b).

Before filing, a number of statements and schedules related to a debtor's income and assets are prepared for the court by a debtor's attorney. Filing a bankruptcy petition "automatically stays" (stops) most collection efforts against a debtor or the debtor's property (U.S. Courts, 2005a). The bankruptcy clerk then gives notice of the case to all creditors whose names and addresses are provided by the debtor.

Between 20 to 35 days after a Chapter 12 bankruptcy petition is filed, the Chapter 12 trustee holds a "meeting of the creditors" (U.S. Courts, 2005a). This meeting is also called a "Section 341 meeting" or simply a "341 meeting," named after the section of the bankruptcy law that requires it (Martin and Paley, 2006). If the meeting is scheduled at a place that does not have regular U.S. trustee or bankruptcy administrator staffing, the meeting may be held no more than 60 days after the debtor files (U.S. Courts, 2005a). During the creditors' meeting, a debtor's paperwork is reviewed to make sure it is complete and accurate (Martin and Paley, 2006) and the debtor is placed under oath to answer questions asked by the trustee and/or creditors. Claims by unsecured creditors must generally be filed within 90 days of the first date set for the creditors' meeting (U.S. Courts, 2005a).

After the meeting of the creditors, the debtor, the Chapter 12 trustee, and interested creditors must attend a confirmation hearing for the debtor's Chapter 12 repayment plan. Unless an extension is granted, a repayment plan must be submitted to the court for approval within 90 days after filing a petition. The repayment plan provides for payment of fixed amounts at regular intervals by the debtor farmer to the Chapter 12 trustee, who subsequently distributes funds to creditors according to the terms of the plan (U.S. Courts, 2005a). A Chapter 12 repayment plan usually lasts for three to five years, but exceptions can be made for debts (e.g., equipment loan or mortgage) scheduled to be paid over more than five years as long as arrearages are made up during the plan (U.S. Courts, 2005a).

Within 45 days after filing a Chapter 12 repayment plan, the presiding bankruptcy judge will decide at the confirmation hearing whether the proposed repayment plan is feasible and meets the standards for confirmation under the Bankruptcy Code. If the court confirms the plan, the Chapter 12 trustee will distribute funds received from the debtor in accordance with the plan (U.S. Courts, 2005a). Like a Chapter 13 plan for consumer debtors, a family farmer filing bankruptcy must live on a fixed budget for a prolonged period. Failure to make payments may result in dismissal of the case for failing to comply with a court order (U.S. Courts, 2005a).

A dismissed bankruptcy case is a failed bankruptcy. This means that a case ends and the debtor gets no benefit from it, such as the automatic stay of collection activity (e.g., threatening letters and phone calls) by creditors, which is the reason many people originally file (Martin and Paley, 2006). It is as if no bankruptcy had ever been filed and creditors are, once again, free to pursue the debtor.

The court may also grant a "hardship discharge" to a Chapter 12 debtor if payments are unable to be made due to circumstances beyond the debtor's control and through no fault of the debtor. An example would be an injury or illness that precludes employment sufficient to fund even modified plan payments (U.S. Courts, 2005a).

If all payments under the Chapter 12 repayment plan are made, the debtor will ultimately receive a discharge, which releases him or her from all debts provided for by the plan. Since a Chapter 12 plan requires payment over three to five years, a discharge typically occurs about four years after the date of filing (U.S. Courts, 2005a). The creditors who were paid in full or in part may no longer initiate or continue any legal action against the debtor.

Like all bankruptcy chapters, certain debts are not discharged in a Chapter 12 case. These include money owed for alimony and child support, debts not listed on schedules (forms) required to be submitted to the bankruptcy court, and debts related to fraudulent activity or injury to others due to willful and malicious intent or intoxication (U.S. Courts, 2005a; Martin and Paley, 2006). As with all methods of filing bankruptcy, non-dischargeable debts are expected to be paid in full under a Chapter 12 plan.

The BAPCPA Law

Called "the most far-reaching revision of bankruptcy law since 1978" (Harl, Peiffer, and McEowen, 2005), the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (PL 109-8, or BAPCPA) was signed by President Bush on April 20, 2005, and includes several significant changes of interest to the agricultural community. Changes made to Chapter 12 were tailored to meet current financial realities of family farming and to eliminate barriers that farmers often encountered when trying to reorganize under Chapters 11 or 13. Chapter 11 filings are expensive and complicated and are designed for large corporations, while Chapter 13 filings are designed for wage earners and have lower debt ceilings than those experienced by many family farmers.

As under previous Chapter 12 law, the key to obtaining a successful discharge is sufficient cash flow to make restructured loan payments. Only a family farmer with regular annual income is eligible to file a Chapter 12 petition.

The BAPCA law made Chapter 12 bankruptcy permanently available to farmers, effective July 1, 2005, as opposed to its previous "on-again/off-again" status, with several gaps and reauthorizations since 1986. Chapter 12 is now a permanent part of the Bankruptcy Code and its provisions have been extended to "family fishermen" (i.e., family-operated commercial fishing operations and aquaculture), although with different eligibility requirements (Harl, Peiffer, and McEowen, 2005). BAPCPA law changes in filing Chapter 12 bankruptcy fall principally in two areas: (1) eligibility requirements for Chapter 12 filing, and (2) modification of income tax treatment on property liquidated in connection with a Chapter 12 bankruptcy reorganization (Harl, Peiffer, and McEowen, 2005).

In addition, the BAPCPA law substantially increased protection of retirement plan assets from the claims of creditors for all filers. This includes simplified employee pensions (SEPs) and individual retirement accounts (IRAs) that are often used by small family farmers lacking an employer-provided retirement plan. These assets now receive creditor protection in bankruptcy. SEP accounts receive unlimited creditor protection, while traditional and Roth IRAs are subject to a $1 million limit, excluding amounts attributable to rollovers from qualified retirement plans. Since IRA contribution rates have been low for decades, however, and few people have accumulated anything near $1 million, the IRA cap is virtually a non-issue (Kitces, 2005). The BAPCPA law also contains a new provision requiring an individual to be current on post-petition domestic support obligations as a condition of plan confirmation (Harl, Peiffer, and McEowen, 2005).

Specific BAPCPA Changes for Farmers

The BAPCPA law provides expanded eligibility for filing Chapter 12 bankruptcy. The definition of the term "family farmer" was changed to allow a maximum debt level for an individual or individual and spouse of $3.237 million, up from $1.5 million under prior law (Harl, Peiffer, and McEowen, 2005; Martin and Paley, 2006). This figure will subsequently be tied to the consumer price index (CPI) and adjusted for inflation at three-year intervals ("BAPCPA," 2005; Harl, Peiffer, and McEowen, 2005). Eligible Chapter 12 filers must receive more than 50% of gross income from their farming operation in either the tax year prior to filing or in both the second and third years prior to filing (Harl, Peiffer, and McEowen, 2005). The latter alternative, based on farm income from the second and third years prior to filing, is new. The purpose of these requirements is to prevent Chapter 12 from being used by individuals who are not actually farmers (Marquitz and Weber, 2005).

Another BAPCPA law change relates to the required percentage of debt attributable to farming operations. At least 50% of the total liquidated debts (excluding debt from a principal residence) must be related to the farming operation owned by the debtor. This is down from an 80% of debt requirement under prior law (U.S. Courts, 2005a; Harl, Peiffer, and McEowen, 2005; Marquitz and Weber, 2005). Like the gross income test (described above), the 50% of debt test is a requirement in order to qualify for debt relief under Chapter 12 and designed to disqualify filings by non-farmers.

In summary, there are four criteria for an individual or individual/spouse to file for Chapter 12 bankruptcy as a family farmer under the BAPCPA law. First, they must be engaged in a commercial farming operation, and second, total debt owed must fall under the maximum debt ceiling of $3,237,000. In addition, at least half of the total debt must be related to the farming operation, and finally, more than half of the debtor's or debtor/spouse's gross income must come from farming operations during the preceding tax year or during each of the 2nd and 3rd prior tax years (U.S. Courts, 2005a).

For partnerships or corporations filing bankruptcy under Chapter 12, the requirement to be actively engaged in farming, the $3.237 million maximum debt limit, and the 50% percentage of debt requirement also apply. Moreover, there are three additional requirements. First, more than half of the outstanding stock in the corporation or partnership must be owned by one family or by one family and its relatives. Second, more than 80% of the value of corporate or partnership assets must be related to the farming operation, and third, no publicly traded stock can be issued (U.S. Courts, 2005a).

Under the BAPCPA law, a family fisherman can file for Chapter 12 bankruptcy but the filing eligibility requirements for family fishermen are different than those for family farmers. In fact, they are essentially the same as those imposed on family farmers before the passage of the BAPCPA law. Specifically, the maximum debt level for family fishermen is $1.5 million, not less than 80% of liquidated debts must come from a commercial fishing operation, and the 50% gross income test must be met during the taxable year preceding filing (Harl, Peiffer, and McEowen, 2005).

Chapter 12 repayment plans are predicated upon a debtor having sufficient disposable income with which to make plan payments. Thus, filers must pass a disposable income test in order for the court to approve their repayment plan. Debtors are required to contribute all of their projected disposable income to the plan. Disposable income is defined as "the portion of a debtor's income not reasonably necessary for the maintenance and support of the debtor or the debtor's dependents and not necessary for the operation of any business in which the debtor is engaged" (Martin and Paley, 2006, p. 213).

For Chapter 12 filers, the BAPCPA law changed the way a debtor's disposable income, for repayment purposes, is calculated. The old law required payment of secured debts on the basis of a farmer's "projected disposable income" for the bankruptcy plan period. Secured debts could be discharged if the disposable income was insufficient to pay debts. However, creditors often successfully argued that a farmer's *actual* disposable income was more than the projected amount, thereby requiring the farmer to pay based upon a retroactive assessment of disposable income rather than the projected amount of disposable income approved in the bankruptcy plan. The BAPCPA law prohibits retroactive income assessments and requires that debts be paid or discharged only on the basis of projected disposable income (Bruynis, 2005).

Tax Obligations on Liquidated Property

Under prior bankruptcy law, taxes were a priority claim for debtor farmers and expected to be paid in full. However, in many instances, debtors did not have sufficient funds with which to pay taxes, even with deferred payment arrangements (Harl, Peiffer, and McEowen, 2005). The BAPCPA law addressed a major problem experienced by family farmers when they sold assets to stabilize their business operation. Previously, any funds received by liquidating farm assets were required to pay priority claims such as taxes. The BAPCPA law made a significant change in the treatment of tax debts. Under the new law, taxes owed to a governmental unit as a result of the "sale, transfer, exchange, or other disposition of any farm asset" will be treated as an unsecured debt that does not have priority over other claims, provided the debtor receives a discharge from the bankruptcy plan. If a debtor does not receive a discharge, however, taxing bodies are free to pursue the debtor and assess all the penalties and interest allowed by law (Harl, Peiffer, and McEowen, 2005).

The process of repaying tax arrearages is as follows. If a Chapter 12 filer liquidates farm assets within the tax year of filing, or liquidates them after filing as part of the court-approved repayment plan, the plan should provide that no payments are made to unsecured creditors until tax claims for the sale of farm assets are determined. Tax claims are then added to pre-petition unsecured claims to determine the percentage distribution to be made to creditors. Claims by governmental units are deemed to be unsecured claims. They are treated equitably with all other unsecured claims and are not entitled to priority payment (Harl, Peiffer, and McEowen, 2005).

Other BAPCPA Changes

Many of the most publicized changes resulting from the BAPCPA law apply to Chapter 7 and Chapter 13 consumer bankruptcy filings. Because Chapter 12 cases are classified as business bankruptcies, these requirements do not apply. Farmers who elect to file under Chapters 7 or 13 will be affected by the new consumer bankruptcy regulations, however. One widely reported change is the means test in order to file a Chapter 7 (liquidation) bankruptcy. Pre-BAPCPA, about 70% of consumers filing bankruptcy used Chapter 7 (Lankford, 2005). Many of these filings were perceived as abuses (Martin and Paley, 2006). Now, more people will be required to use Chapter 13, which, like Chapter 12, is a court-ordered repayment plan. Chapter 13 filers must have regular income, and unsecured debt less than $307,675 and secured debt less than $922,975 (Marquitz and Weber, 2005).

The means test is based on a bankruptcy filer's current monthly income, family size, and the median income for the filer's state of residence. Under the means test, those who earn less than the median income for a family of their size in their state will still be able to file under Chapter 7. Those who earn more and can afford to pay back at least $100 a month, after subtracting allowable expenses as determined by the IRS, will generally have to file under Chapter 13 and submit to a restrictive five-year repayment plan (Martin and Paley, 2006). Every consumer bankruptcy case filed must first have a means test analysis performed, which is predicted to significantly increase attorney's fees (Sahadi, 2005). Like a tax return, the means test requires a lawyer to work through the calculation step by step. The American Bankruptcy Institute expects attorney's fees to possibly double because of additional workload (Jean, 2005). Despite all the required paperwork, the means test will actually affect less than 15% of filers, and perhaps only 1% to 2% by some estimates (Blackman, 2005).

A second major requirement of the BAPCPA law is that, as a condition to file either Chapter 7 or Chapter 13 bankruptcy, a debtor must have consumer credit counseling to explore alternative options, within 180 days prior to filing a petition. The counseling session must be with a qualified, nonprofit agency approved by the U.S. Trustees office. (A list of approved providers can be found at the office's website: www.usdoj.gov/ust/bapcpa/ccde/index.htm.)

Additionally, after filing for bankruptcy, debtors must complete an approved two-hour personal financial management course in order to obtain a discharge from Chapter 7 or 13. The course must cover basic financial topics such as budget development, money management, and the wise use of credit. (Course providers are also listed at the above website.) Both the credit counseling and financial education services require filers to pay a fee set by the provider. These new regulations, along with increased legal fees, create additional hurdles for debtors (*Consumer Reports* staff, 2005). Critics have charged that this is exactly what Congress and credit card lobbyists wanted: to increase the bureaucracy and cost associated with bankruptcy whereby fewer people are inclined to file.

Summary

This article has provided an overview of the history and procedural aspects of Chapter 12 bankruptcy for family farmers and fishermen who are experiencing financial distress. It has also discussed changes to the Bankruptcy Code enacted in 2005 under the BAPCPA law. A fundamental goal of the bankruptcy process is to provide debtors with a "fresh start" by providing relief from burdensome outstanding financial obligations. Filing for bankruptcy offers some "breathing room" for those facing hostile creditors, repossession, utility disconnection, foreclosure, or eviction, and need time to work out a reasonable repayment schedule (Detweiler, 2003).

Like Chapter 13 bankruptcies for consumers, Chapter 12 debt repayment plans disburse payments to creditors over time, but they are especially suited to the needs of agricultural producers due to their higher debt ceiling. Farmers may also elect to file bankruptcy under other chapters of the Bankruptcy Code, but are subject to all of the regulations pursuant to them (e.g., credit counseling and financial education for Chapters 7 and 13).

Filing bankruptcy does not happen without serious consequences, so it should always be viewed as a "last resort." First, legal fees are expensive and are predicted to become even more so since the enactment of the BAPCPA law (Sahadi, 2005). In addition, those who file will often find credit difficult or expensive to obtain in the future when they are classified as subprime borrowers and charged high rates. Moreover, bankruptcy filings can remain on someone's credit report for up to 10 years (Detweiler, 2003), affecting decisions made, not just about an individual's creditworthiness, but about employment, housing, and auto insurance as well (Blackman, 2005). In short, bankruptcy is not an easy way out of debt. Farmers, like any other bankruptcy filer, may first want to consider alternatives such as negotiating with creditors, credit counseling, debt consolidation, or selling personal or business assets.

Listed below are some additional considerations for farmers filing bankruptcy and professionals, such as Cooperative Extension agents and specialists, who assist them:

- Preserve and protect your retirement assets. Recall that SEP accounts and IRA accounts, up to $1 million, are beyond creditors' reach. The BAPCPA law substantially increased creditor protection available to retirement accounts for those who declare bankruptcy (Kitces, 2005). Good records are necessary, however, to document assets eligible for protection, especially if IRA accounts contain rollovers from retirement plans from previous employers. It is absolutely essential to have a clear paper trail.

- Carefully time the filing of a bankruptcy petition. It is best to wait until the worst of a financial crisis is over—for example, after an individual has returned to work following an injury or illness, or a new market has been found for the farmer's crops, thereby generating additional income. The worst time to file is when a financial crisis is raging. First, it will be difficult to afford an attorney at that time, and second, additional debts are likely to be incurred until the situation stabilizes (Blackman, 2005). The individual would then be unable to discharge those new debts for another eight years from the date of the previous bankruptcy filing. This period was extended from six years under the BAPCPA law (Martin and Paley, 2006).

- Filing bankruptcy, especially Chapter 12, which is used relatively infrequently, requires the assistance of an experienced bankruptcy attorney. Lawyers are the only professionals who can provide legal advice and prepare the numerous documents required with a bankruptcy filing. Information about attorneys' areas of practice/expertise can be obtained from a state or county

Bar Association or from the Martindale-Hubbell Directory, found in the reference section of most large public libraries (and online at www.martindale hubbell.com).

- Realize that everyone involved with the process of filing bankruptcy—first and foremost bankruptcy attorneys—is on a steep learning curve. At over 500 pages in length, the BAPCPA law has been described as being "very poorly written and filled with ambiguities" (Geier, 2005). Bankruptcy attorneys are liable for any inaccuracies found in a client's case and, as a result, will need to spend more time verifying client information and making various calculations. Like many new laws, there will likely be court challenges and "technical corrections" following its implementation. The agricultural community should pay attention to emerging information on various provisions of the BAPCPA law.
- Finally, while filing bankruptcy offers family farmers and fishermen immediate relief from debt collection efforts and an opportunity to repay outstanding balances over time, it cannot assure that an agricultural enterprise will become and/or remain profitable. Professionals who advise agricultural producers must play a key role in helping their clients analyze the events that led to the bankruptcy, in order to prevent a future reoccurrence. In addition, information about farm business management and complementary income sources is critical, which may include career counseling programs for a farmer and/or spouse.

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Managing Economic Risk Caused by Insects: Bug Options

Timothy J. Richards, James Eaves, Valerie Fournier, S. E. Naranjo, C.-C. Chu, and T. J. Henneberry

Abstract

The market for insuring insect damage is far from complete. This study introduces a new type of derivative instrument—insect derivatives—that provide growers a market-based means of transferring insect risk to speculators or others who may profit from higher insect populations. A risk-neutral valuation model is developed and applied to *Bemisia tabaci* population data. Economic simulation models show how insect derivatives can improve risk-return results for a representative cotton farm in the Imperial Valley of California. The results suggest that insect derivatives may become important risk management tools for a wide range of growers.

Key words: Bemisia tabaci, cotton, derivatives, forecasting models, insects, insurance, risk management

Estimates of the economic damage caused by invasive species of all types in the United States are alarmingly high. Pimentel et al. (2000) estimate the total economic loss to invasive species at $137 billion per year. Although insects form only part of the larger invasive species problem, they hold perhaps the most potential for significant economic damage. Indeed, consider the example of the glassy-winged sharpshooter (a vector or carrier for Pierce's disease). If left unchecked, many believe this one species would likely destroy the entire $3.3 billion California grape industry [University of California Agricultural and Natural Resources (UCANR), 2004].[1]

Beyond the direct impacts on yield and quality due to feeding and reproduction, the indirect costs of insect infestation include widespread ecological damage due to chemical control activities, the budgetary cost of government eradication efforts, and the loss of important export markets, to name a few. While current chemical and biological control methods are becoming increasingly effective in managing pest outbreaks, they are costly. In fact, the total amount spent in the United States on agricultural insecticides in 2001 was approximately $1.326 billion (Kiely, Donaldson, and Grube, 2004). Clearly, growers need a method of controlling not only the agronomic risk from insect

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[1] The glassy-winged sharpshooter also carries strains of *Xylella fastidiosa* that threaten California citrus, alfalfa, almonds, stone fruits, and ornamentals–a total of some $27 billion in market value (UCANR, 2004).

infestations, but the economic risk as well.[2]

In the past, economists created dynamic optimization models intended to produce recommendations for insecticide application rates and thresholds. Typically, these models maximize the present value of profit from a given orchard or crop by choosing an insecticide application rate based on thresholds estimated from insect population growth and yield damage functions (e.g., Regev, Guiterrez, and Feder, 1976; Babcock, Lichtenberg, and Zilberman, 1992; Hof, 1998; Marsh, Huffaker, and Long, 2000; Eisworth and Johnson, 2002).

An optimal solution equates the marginal present value of reducing pest damage with the marginal cost of using either biological or chemical control techniques. This line of research has played an important role in the pest management literature because optimization models allow growers to control specific sources of economic loss in a profit-maximizing way. However, economic optimization does not imply the elimination of risk, or the *variability* of profit. Even if a grower were to follow an optimal control program, the cost of insect management will vary from season to season depending on the realization of actual insect densities and a variety of other environmental factors.

Growers have limited access to insurance products that would otherwise allow them to manage economic risk. Indeed, the market for pest risk management is far from complete. It is well known that private insurance markets in agriculture fail for reasons of moral hazard, adverse selection, and the high correlation of risks borne by growers. Moreover, government-subsidized insurance, particularly for speciality crops, has a history of low participation and excessively high budget costs (Knight and Coble, 1997; Richards and Manfredo, 2003). Many economists emphasize the role of public policy in mitigating the economic damage caused by insects (Carter, Chalfant, and Goodhue, 2004). Costly government intervention, however, is not the only solution and may, in fact, be less efficient than a market-based one. This study presents a new approach growers can use to mitigate the financial risk from invasive pests by transferring it to others through market-traded instruments known as *insect derivatives*.

Insect derivatives, or "bug options," represent a market-based means for growers to transfer risk to others who may profit from higher insect populations. Derivatives are, in general terms, contracts between two parties specifying a future exchange of money where the amount depends on, or is derived from, the value of an underlying asset or index value.

A swap is perhaps the simplest example of a derivative. To create an insect swap, a grower would enter into a contract (the insect derivative) with a counterparty that specifies how much it will pay to the grower should a specific pest population exceed a certain agreed level.[3] If the population is below the agreed level, then the contract would require payment by the grower to the counterparty. Both parties have an incentive to sign this contract because the counterparty would presumably suffer lower revenues when pest populations are low and the grower would have relatively high pesticide costs

[2] The importance of invasive species in general is indicated by the amount of research activity on this topic. In fact, as this paper was going to press, a special issue of the *Agricultural and Resource Economics Review* 35(April 2006) was dedicated to the economics of invasive species.

[3] Clearly, the "agreed level" would be one that is not actively managed by the grower. Counterparties would agree to an objective measurement standard such as traps at the nearest experiment station, or another, orchard-specific sanctuary. If the grower is paid for higher insect counts, then there is no incentive for fraud. Note that this example assumes growers spray only when insect populations are realized, and not as a matter of course at the start of a growing season. This assumption is consistent with current integrated pest management practice.

when populations rise.[4] In this example, both growers and counterparties are effectively managing their net income risk.

Although such derivatives seem a natural and logical outgrowth of the normal course of agribusiness, there are several reasons why they have not emerged to this point—reasons which careful academic research, such as that developed in this study, can help overcome. Specifically, the primary reason bug options have not yet gained acceptance is the lack of an agreed pricing mechanism. Therefore, the objective of this analysis is to develop a simple and intuitive valuation method for any species evolving within any well-defined agricultural region.

By creating a relatively straightforward, economically justifiable way of pricing bug options, this research seeks to ensure that insect derivatives become actively traded between growers and their natural counterparties (chemical companies, insurance companies, insectaries, and many others). Growers, chemical suppliers, and consumers in general each have an interest in the outcome of this research. First, growers will be able to plan more effectively, have greater access to lower cost sources of capital, allocate existing capital more effectively, pay lower taxes, on average, due to the fundamental convexity of tax schedules, or avoid the direct and indirect costs of bankruptcy (Smithson, 1998). Second, by trading insect derivatives, chemical companies will be able to smooth revenue streams from limited-use chemicals, thus increasing the likelihood that any risk-sensitive capital budgeting analysis will recommend their development. Third, to the extent that growers substitute derivatives for other methods of insect management, active trading in insect derivatives can result in reduced levels of insecticides or other biologically harmful control techniques.[5] Finally, if growers are able to trade instruments which rise in value with the demand for pest control, then they will have an incentive to use the most efficient pest management techniques available, thereby creating an "in-the-money" position with respect to the insect derivative.

Our pricing model relies on recent developments in the theory of "risk-neutral" pricing of derivative securities. Whereas financial options—options on stocks or commodity futures—are commonly priced using models derived from sophisticated arbitrage arguments, there are no complementary securities upon which to base similar methods in the case of insect derivatives. In the absence of such riskless hedging opportunities, it is often the case that analysts must resort to equilibrium pricing models that take into account the market price of risk, or the risk premium required by investors in order to purchase a security which is likely to add to the overall riskiness of their portfolio (Cao and Wei, 1999; Richards, Manfredo, and Sanders, 2004).

However, if insect population growth is independent of the returns to a broad market portfolio of other securities, then we can use a risk-neutral approach (Cox, Ingersoll, and Ross, 1985), which does not require an estimate of the market price of

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[4] In the application below, we consider insect options. An option contract would involve the right, but not the obligation, to either buy (call) or sell (put) the underlying index at a fixed value (the strike price). A call option, for example, would rise in value if the index rises above the strike price, while a put option would rise if the index falls. A grower who buys a call option would be protected in the event the pest population grows.

[5] Note that if chemical insecticides are priced competitively, growers should be indifferent between spraying and not spraying. Growers can either let insect populations grow unabated and accept payment on the derivative to offset real damage, or spray to control insect population growth and use the derivative payment to offset chemical costs. In the former case, derivatives and chemicals are substitutes, whereas in the latter they are complements. Using insect derivatives to reduce insecticide cost is similar to growers who may use rainfall derivatives to offset irrigation costs (Turvey, 1999). It is reasonable to assume, although substitution remains a possibility, most growers will use chemicals, or other integrated pest management (IPM) methods as part of a program of good farming practices, and use insect derivatives to offset the cost of doing so.

risk. Risk-neutral valuation involves finding the expected value of the population level at the agreed termination date of the derivative, comparing the expected value to an agreed "strike" or trigger population level, and discounting the difference (multiplied by a notional dollar figure) back to the contract date at the risk-free interest rate.

When the market price of risk does not enter the calculation, risk-neutral valuation is similar to the method used by insurance companies to determine insurance premia, or actuarial pricing (Hull, 2005). We demonstrate the simplicity of this method using two years of field-trial data of *Bemisia tabaci* (*Homoptera: Aleyrodidae*, also known as whitefly) populations in California cotton (Naranjo, Chu, and Henneberry, 1996).[6] After arriving at a price series for a family of derivatives at different strike population levels, a stochastic *pro forma* financial statement simulation model is used to demonstrate the effectiveness of insect derivatives in mitigating the financial risk caused by insect infestation.

The remainder of the paper is organized as follows. The first section describes the pest insect *B. tabaci* data. In the second section, we derive a bioeconometric model of insect population growth, including separate components for the stochastic and deterministic elements of population growth—or the random and nonrandom parts, respectively. This section also describes a simple model of cotton yield that incorporates both insect population and control activities. A third section describes the risk-neutral valuation model and the particular assumptions made in implementing it with the *B. tabaci* example. The fourth section provides an explanation of how we evaluate the effectiveness of insect derivatives in mitigating financial risk, including a description of a simple stochastic simulation model and the associated measures of risk exposure. A final section provides the estimation and simulation results and offers some general conclusions for the likely value of an insect derivative-based risk management program.

Empirical Model of Insect Population Growth

Insect Population Data

The data for this study consist of two years of experimental field-trial data on *B. tabaci* population growth and yield damage gathered by researchers based at the Western Cotton Research Laboratory (WCRL) in Phoenix, Arizona, using cotton fields in Brawley, California (Naranjo, Chu, and Henneberry, 1996; Naranjo et al., 1998). Weekly counts of adult *B. tabaci* were collected each year over a 16-week season for 11 different plots. Plots correspond to various insecticide treatment intensities, from no applications in a given week to 15 insecticide applications per week. By varying insecticide treatment levels, the field-trial data provide information on the impact of frequency and dose on population levels at different times during the season. Control efforts cause the data to exhibit greater variability than would otherwise be the case, which more clearly identifies the underlying population diffusion process.

B. tabaci is a particularly nefarious pest in the U.S. Southwest as they tend to travel large distances, reproduce quickly, and impair yields significantly by depriving the plant of vital nutrients. Yield samples taken at harvest for each plot provide data regarding the yield-injury relationship in cotton. Table 1 gives a summary of the experimental insect data.

Data for the risk management simulation model are taken from a representative Imperial County cotton farm budget prepared by University of California Cooperative Extension officials (University of California, 2005).

[6] Naranjo, Chu, and Henneberry (1996) report *B. tabaci* was responsible in 1994 for damaging 345,000 ha of cotton in Arizona and southern California, reducing total yield by 3.6 million kg.

Table 1. Summary of *Bemisia tabaci* Trial Data: Brawley, CA (1993–1994)

Description	N	Mean	Std. Dev.	Minimum	Maximum
Random Parameters:					
Treatments (no./week)	358	8.637	4.174	0.000	15.000
Eggs (no./cm^2)	358	7.640	19.879	0.000	136.280
Nymphs (no./cm^2)	358	1.814	4.546	0.000	34.180
Adults (no./leaf)	358	30.637	32.028	3.314	128.050
Yield (kg/ha)	25	1,515.094	377.683	601.750	2,007.250
Fixed Parameter Values:					
Risk-Free Rate	3.0%				
Cotton Price ($/kg)	1.32				
Days to Expiry	105				

Operating costs reflect all land preparation, seeding, growing, and harvesting costs, and are expressed in current, 2004 values. Growing costs include the material and labor costs for a number of insect treatments equal to the sample average from the *B. tabaci* trial data. Revenues, on the other hand, are calculated using 2004 harvest prices obtained from the USDA's Economic Research Service (2005).

Bioeconometric Model of Insect Population Growth

Insect populations at a particular location vary from week to week and from year to year. While some of the observed population growth within a season is predictable, there is a significant random component. In other words, the basic process driving the number of insects at one location consists of a deterministic and a stochastic component. Therefore, we follow the approach taken by Alaton, Djehiche, and Stillberger (2002) in their modeling of weather processes, and first remove the deterministic mean part of insect population growth before modeling random variations about the mean.

Insect populations are constrained by several biological factors: (*a*) growth rates depend on the number of adults available to reproduce; (*b*) reproduction takes time; (*c*) the environment has a finite capacity to support insect populations; and (*d*) control activities, typically through insecticides, tend to be quite effective in reducing population counts. Given these facts, the deterministic part of insect population growth can be modeled as an exponential function common to many other types of bioeconomic growth processes (Clark, 1990; Eiswerth and Johnson, 2002):

$$(1)\quad \frac{dB_t^m}{dt} = \alpha_1 B_t^m \left(1 - \frac{B_t^m}{K}\right),$$

for the mean insect population (B^m) growing at a rate α_1 in an environment with carrying capacity K. The differential equation (1) can be solved for the expected population level at any time t (see the Appendix), which provides a convenient expression for the mean insect population:

$$(2)\quad B_t^m = \left(\frac{K}{1 + de^{-\alpha_1 t}}\right) - g(c_t),$$

where insecticide applications (c) reduce insect numbers according to the control function g, and d represents the starting population value (B_0) relative to carrying capacity: $(K - B_0)/B_0$. In the empirical application below, g is assumed to be quadratic in order to capture the likely diminishing marginal returns to insecticide application. Entomological research finds that mean population may also be a function of temperature, host plant abundance, other non-chemical abatement efforts, or natural enemy population (Eisworth and Johnson, 2002).[7]

Insect population growth is not entirely deterministic. Random variations from the mean population level are assumed to be governed by a Brownian motion process:

(3) $dB_t = \mu dt + \sigma dz,$

where μ is the drift rate per unit of time (dt), σ is the standard deviation of the process, and dz is an increment of a standard Weiner process with zero mean and variance equal to dt.[8] As noted by Sunding and Zivin (2000), equation (1) captures several empirical regularities observed across insect groups.[9] Specifically, per period changes in the population as well as the population itself are normally distributed, population levels are always nonnegative, and short-run dynamics are dominated by the volatility component whereas long-term dynamics are dominated by trend.

It is not likely, however, that any trend away from the mean in (2) would be sustained over the long run as insect populations cannot grow without bound, nor is it likely that they disappear without some outside influence. Therefore, the process in (3) is modified to include a mean-reversion term whereby:

(4) $dB_t = \kappa(B_t^m - B_t)dt + \sigma dz,$

where κ is the rate of reversion to the mean. Further, insect populations are also subject to periodic "spikes" or periods of rapid growth driven by environmental factors otherwise not accounted for in the model. We model these instances as jumps in the stochastic process estimated above (Merton, 1976; Jorion, 1989; Naik and Lee, 1990), so the most general form of the population equation becomes:

(5) $$dB_t = \left(\kappa(B_t^m - B_t) - \lambda\phi\right)dt + \sigma dz + \phi dq,$$

where jumps occur according to a Poisson process q with average arrival rate λ and a random percentage shock ϕ. The random shock, in turn, is assumed to be lognormally distributed with mean $\phi - 0.5\delta^2$, and variance δ^2. The Poisson process q describes a random variable that assumes a value of zero with probability $1 - \lambda$, and a value of one with probability λ.

Estimates of (5) are obtained by maximum-likelihood estimation over the entire sample data set, using the likelihood function:

(6) $$L(B) = -T\lambda - \frac{T}{2}\ln(2\pi) + \sum_{t=1}^{T} \ln\left[\sum_{n=0}^{N} \frac{\lambda^n}{n!} \frac{1}{\sqrt{\sigma + \delta^2 n}} \times \exp\left(\frac{-\left(dB_t - \left(\kappa(B_t^m - B_t) - n\phi\right)\right)^2}{2(\sigma + \delta^2 n)}\right)\right],$$

where T is the total number of time-series observations, and N is defined as a number of jumps sufficiently large to include all potential jumps in the observed data (six proved sufficient in this application). Further, we approximate the change of B_t (dB_t) with a discrete change: ($B_t - B_{t-1}$). Richards, Manfredo, and Sanders (2004) demonstrate how this method can be used to estimate a similar type of process in an application to derivatives based on temperature indices (weather derivatives).

[7] In the empirical application described below, neither daily temperature nor precipitation were significant determinants of insect population levels. Data on other factors were not available. Estimation and hypothesis testing results of the growth models that included weather variables are available from the authors upon request.

[8] The drift term μ is the drift in the stochastic process away from the mean function described in (1). Therefore, it is fundamentally different from the natural growth rate (α) of the mean data-generating process.

[9] Sunding and Zivin (2000) model population growth as a geometric Brownian motion; however, in our model, the dependence of growth on existing population levels is captured through the mean function (2), so the remaining variation is likely independent of current population levels.

Pricing Insect Derivatives

An insect derivative is a contingent security based on the value of an underlying insect population index. If the derivative is specifically an option, then it will have a positive intrinsic value if the actual realized population is higher than the agreed strike level for a call option, or, conversely, lower for a put option. By buying an insect call option, a grower may be able to effectively protect himself or herself from financial loss should an insect population rise above the strike level.

There are five essential elements that form any insect derivative: (*a*) the underlying insect population index; (*b*) the length of time of the contract prior to expiration; (*c*) the location for where the underlying insect population is reported (e.g., farm, orchard, experiment station, or larger aggregation of farms); (*d*) the dollar value attached to each unit of the underlying index (marginal loss in revenue attributable to an additional insect); and (*e*) the strike population index value.

At the agreed expiration date of the option, a holder of a call option will receive payment if the insect population index is greater than the strike price, and the holder of a put option will receive payment if the insect population index is less than the strike price. The amount of payment is equal to the level of insect population that is greater (less) than the strike price multiplied by some notional dollar value per unit of the underlying insect population index. In the case where the option is not exercised, the option buyer will forfeit his or her option premium. Sellers of options, or option writers, receive a premium for providing this option to the option buyer.

As explained in the introduction, the proper pricing of such an instrument is critical for its successful trade. Indeed, if these derivatives are mispriced in the marketplace, traders will not be attracted to the contract, leading to liquidity problems. In addition, large bid-ask spreads in the absence of a commonly agreed pricing model could also hamper market liquidity. While insect derivatives are likely to be traded only over the counter, it is still critical that appropriate pricing models be used.

There are essentially three ways to price insect derivatives. First, "burn rate" or actuarial models use historical probabilities to form estimates of expected payout values at some time in the future. Discounting the expected payout to the present represents an "actuarially fair" derivative price. Although simple to use, burn rate models do not take into account the complex nature of insect growth processes, nor is there any way to update population estimates as the season progresses. Consequently, derivatives priced this way will trade infrequently, if at all (Dischel, 1998; Pirrong and Jermakyan, 1999; Zeng, 2000).

Second, if insects could be hedged, then it would be possible to price insect options using a traditional, no-arbitrage, Black-Scholes pricing model (Black, 1976). However, as in the case of weather derivatives (Richards, Manfredo, and Sanders, 2004), insect populations are not tradable assets. Without an effective hedge, we must consider the role of the market price of risk and devise a way of estimating its impact on derivative prices.

A third method for pricing insect derivatives provides a more viable alternative. Fortunately, because insect populations are not likely to be correlated with the market portfolio, we can use the risk-neutral valuation model of Cox, Ingersoll, and Ross (1985) and proceed by following a three-stage algorithm.[10] First, we "risk neutralize" the insect population

[10] Turvey (2005) uses a similar argument to price degree-day weather derivatives. Yet, in the case of weather, it is less obvious that weather is uncorrelated with the market portfolio. Can and Wei (1999) provide evidence to the contrary, as do Richards, Manfredo, and Sanders (2004). Turvey contends, however, that this finding is immaterial if traders are able to diversify weather risk across several local markets. If this is the case, then the "weather beta" will be zero and a risk-neutral approach can be used.

process by estimating the process defined in (5) and removing all dynamics that are explainable by changes in the mean, by mean reversion, or by jump processes. The remaining random variation is then a martingale $\mathcal{Q}$, and dz becomes dv, where v_t is a $\mathcal{Q}$-Weiner process (Alaton, Djehiche, and Stillberger, 2002). Second, we form an expectation of the intrinsic value of the derivative under the $\mathcal{Q}$-measure defined by our risk-neutralized process. Third, the expected payoff value is discounted back to the current date at the risk-free rate. This discounted expected payoff is the market equilibrium price of the derivative.[11]

More formally, given a constant market price of risk, a constant rate of interest r, and assuming each contract pays one dollar per unit of insect population, the martingale that defines the underlying index becomes:

$$(7)\quad dB_t = \left(\frac{dB_t^m}{dt} + \tau(B^{m_t} - B^m) - \lambda\phi - (\delta + \psi)\sigma \right) dt + \sigma dv + \phi dq,$$

where dv is now a $\mathcal{Q}$-Wiener process (Alaton, Djehiche, and Stillberger, 2002), and ψ is the market price of risk. As argued by Hull (2005), however, if the underlying is indeed statistically independent of the market portfolio, then the market price of risk is zero. Because this is likely to be the case for localized insect populations, we set $\psi = 0$ in (7) and proceed to price the derivative using the risk-free discount rate.

To demonstrate the third step of the pricing algorithm, we consider the specific case of a call option. The expected payoff to a call option is given by:

$$C_T = \max\left[B_T - \bar{X}, 0\right],$$

where $\bar{X}$ is the strike population value. This expectation must be found under the $\mathcal{Q}$-measure. Taking the expectation and discounting to the present from T at the rate r gives a call-option value of:

$$(8)\quad V_c = e^{-r(T-t)} \times \left((\mu_n - \bar{X})\Phi(B_t) + \frac{\sigma_n}{\sqrt{2\pi}} e^{-\sigma^2/n} \right),$$

where μ_n and σ_n are the mean and variance, respectively, of the insect process, and Φ is the standard normal distribution function.[12]

The expectation in (8) is found numerically using a Monte Carlo simulation with 100 random draws of the continuous diffusion process and 100 independent draws of the discrete Poisson jump process (for a total of 10,000 random combinations). Multiplying the expected insect population value that lies below the strike population value by a notional $1 "tick rate" and finding the present value yields an estimate of the value of a hypothetical call option. The value of a put option, or any other derivative where the payoff can be similarly defined, can be found the same way. With these prices, therefore, traders in the market can be fully confident that the price reflects full economic value to both buyers and sellers—or, in insurance terminology, that they are equivalent to an "actuarially sound" premium.

Simulating Risk Mitigation with Insect Derivatives

When pricing derivatives on "physical" quantities like insect populations or the weather, derivative prices depend only on

[11] Although risk-neutral valuation is typically applied in cases where the underlying is lognormally distributed, it is only required that the adjusted probability distribution under which the expectation is taken be the one which is consistent with the underlying following a martingale (zero drift stochastic process) (Harrison and Kreps, 1979). For a recent application of this approach, and a review of whether or not the martingale restriction holds in practice, see Turvey and Komar (2006).

[12] The mean and variance found under the $\mathcal{Q}$-measure include the market price of risk and jump terms, but their specific forms are not material here. They have been derived, however, and are available from the authors upon request.

forecasts of the underlying variable and interest rates, but their economic value to any particular grower depends on a number of other variables. Specifically, economic value is defined in terms of the utility created for a representative grower by the opportunity to use insect derivatives to reduce the variability of net income.

Utility rises in the level of net income, but at a declining rate (declining marginal utility of income). The rate at which marginal utility declines as net income increases is determined by the degree of risk aversion of the representative grower, γ.[13] Higher values of γ suggest a more rapid rate of diminishing marginal utility of income, and hence a greater degree of risk aversion.

Formally, define a power utility function where $U_g(\pi)$ represents the utility of a representative grower *g* from earning an uncertain level of profit π_g, and γ is the coefficient of risk aversion such that:

$$(9)\quad E\big[U_g(\pi)\big] = E\left[\frac{\pi_g^{1-\gamma}}{1-\gamma}\right],$$

where $0 < \gamma < 1$ for concavity and $E[\cdot]$ is the expectation operator. Power utility is an attractive alternative because it is a simple representation that possesses all the characteristics required of a well-behaved utility function: it is concave by construction, it implies a constant relative risk-aversion level (γ) and in profit provided $0 < \gamma < 1$, and decreasing absolute risk aversion as wealth rises. If $\gamma = 0$, then the grower is "risk neutral," or indifferent to the volatility of his or her income stream.

Most importantly, by using an expected utility framework, we are able to estimate the risk premium placed by a representative grower on the threat of yield loss due to insect damage (or higher cost of insect control). Define a grower's certainty equivalent (CE) value as the dollar amount he or she would accept with certainty in lieu of the risky prospect of receiving an uncertain amount of net income with expectation $E[\pi_g]$. In a power utility framework, a grower's CE value is found by solving (9) for π_g. The risk premium grower *g* is willing to pay, therefore, becomes:

$$(10)\quad R(\pi_g) = E[\pi_g] - CE(\pi_g)$$
$$= E[\pi_g] - \big((1-\gamma)E[U_g]\big)^{1/(1-\gamma)},$$

for an uncertain level of net income. For the *B. tabaci* example, net income from growing cotton is assumed to be equal to the difference between cotton revenue and total production cost, where revenue is the product of uncertain yields (y_g) and prices (p):

$$(11)\quad \pi_g = py_g - K(c_g),$$

and total production cost depends on the level of insect control activities, c_g. To capture the likely diminishing marginal returns to insect control activities, yield in year *t* is assumed to be a simple Cobb-Douglas (log-log) function of insect density, control activities, and a binary variable to account for year-specific population differences:

$$(12)\quad \ln(y_{g,t}) = \beta_0 + \beta_1\ln(B_{g,t}) + \beta_2\ln(c_{g,t})$$
$$+ \beta_5 D94 + \varepsilon_{g,t},$$

where *D94* is a binary variable for the year 1994 (*D94* = 1 if the year is 1994, and is zero otherwise); $\varepsilon_{g,t}$ is a grower-specific i.i.d. random error vector; and the remaining variables are as defined above.

Because we do not have data on other inputs, the yield function in (12) assumes all growers use best-practice technology so that β_0 represents their average yield, conditional on optimal input application.

[13] Parameterizing the degree of risk aversion in the simulation model is not inconsistent with the risk-neutral derivative pricing model because risk neutrality in the latter case refers to the equilibrium market outcome, not an individual trader's attitude toward risk. In the simulation model, we assume that a representative grower need not have preferences identical to any other.

Further, insect control, and hence populations, are assumed to be endogenous. Therefore, equation (12) is estimated using an instrumental variables procedure (two-stage least squares) where the set of instruments includes all exogenous and predetermined variables in the system. Because a least-squares procedure is used to estimate (12), we implicitly assume the error term ($\varepsilon_{g,t}$) is normally distributed. Consequently, the stochastic profit simulation model is driven by a Gaussian error process for yields, the parameters of which are determined from the estimation results.

The stochastic expected utility framework is then used to define three measures of the risk-return tradeoff generated by various risk management strategies: (*a*) a Sharpe ratio, (*b*) a 5% Value-at-Risk (VaR) measure, and (*c*) a certainty equivalent value.

The Sharpe ratio is a measure of return per unit of risk derived from an expected utility-maximization framework (Gloy and Baker, 2001). Specifically, it is defined as the ratio of excess returns to an asset to the coefficient of variation of its returns, where "excess returns" are defined relative to the risk-free rate of return. Formally, the Sharpe ratio is written as:

$$(13)\quad SR_g = \frac{R_g - R_f}{s_g / E[R_g]},$$

where R_g is the return to the asset or venture in question, R_f is the risk-free rate of return, s_g is the coefficient of variation of returns, and $E[R_g]$ is the mean return.[14]

Value-at-Risk (VaR) measures the maximum amount a firm can expect to lose at a certain confidence level for a certain period of time. For example, if a grower's VaR is -\$200 per acre at 5% on an annual basis, this means there is a 5% chance he or she will lose at least \$200 during the year. VaR provides a very intuitive notion of the monetary equivalent of the risk facing a firm as it immediately converts a notion of spread or dispersion into a dollar-equivalent figure (Jorion, 1997).

Finally, the CE value defined in equation (10) is compared for alternative insect-risk management strategies. From a grower's perspective, a higher CE value is preferred because it implies a lower "cost of risk" or risk premium that a rational investor would demand.

By comparing each of these three measures between hypothetical scenarios wherein growers do or do not use insect derivatives, it can be determined whether bug options represent potentially valuable risk management tools.

A number of assumptions are made in order to implement the insect-derivative simulation model. First, the number of contracts used to hedge insect-yield risk from a typical acre of cotton in California's Imperial Valley (the "hedge ratio") is 1.89 (Cecchetti, Cumby, and Figlewski, 1988). The hedge ratio is determined by estimating a simple linear regression of yield on insect densities. The slope parameter in this regression shows the marginal impact of a one-adult-insect-per-leaf rise in population, so multiplying the marginal impact of one insect by the price of cotton provides an estimate of the marginal revenue-loss, or the hedge ratio.

Second, the insect process is assumed to be a linear function of control activities and other random factors:

$$B_{g,t} = \alpha_0 + \alpha_1 c_{g,t} + \varepsilon_{g,t},$$

where $\varepsilon_{g,t}$ is an i.i.d. normal error term. Again, given that $c_{g,t}$ is an endogenous variable, we use an instrumental variables technique in order to remove any simultaneous-equations bias.

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[14] The financial return to a venture is defined as the ratio of net income, or profit, to the total amount of investment. We assume 100% equity financing throughout in order to abstract from decisions regarding the capital structure of the firm, which may introduce financial risk.

Third, to determine the independent effect of random insect growth on yields, the simulation is conducted with insect control activities held at their mean. While understanding the role of biological and chemical insect suppression is an important pursuit, the point of this research is to show how financial risk can be mitigated independent of traditional control methods.

Fourth, although cotton prices represent another source of economic risk in reality, prices are fixed at their long-term average—again in order to focus attention on the role of insect derivatives as a means of managing volumetric risk that arises from infestation.

Finally, the coefficient of relative risk aversion (γ) is allowed to vary from 0.1 (near-risk neutrality) to 0.9 (extreme risk aversion) to convey the importance of attitudes toward risk in determining the value of insect derivatives in terms of the expected-utility framework. The net income/expected utility model is simulated using Monte Carlo methods with @Risk stochastic simulation software (Palisade Corporation, 2005).

Results and Discussion

Recall, the objective of this study is to design an insect derivative and to develop and implement a model that can be used to arrive at a market value for any variation of the instrument we create. Because this objective involves several steps, our discussion of the results considers each in turn: (*a*) estimates of the deterministic insect population function; (*b*) estimates of the stochastic process that drives variation from the mean; (*c*) estimates of insect derivative price, herein defined as a call option on *B. tabaci* at the Brawley, California, site; (*d*) estimates of the impact of *B. tabaci* on cotton yields; and (*e*) simulation results regarding the feasibility of insect derivatives as risk management tools for insect-caused yield damage.

Table 2. Insect Population Mean Function Estimates (MLE), *Bemisia tabaci* Trial Data: Brawley, CA (1993–1994)

Parameter	Estimate	*t*-Ratio
$K_{0,1993}$	19.639*	6.454
$K_{0,1994}$	21.811	0.529
α	0.126*	11.633
g_{11}	2.277*	3.017
g_{12}	5.417*	4.230
g_{21}	-0.086	-1.714
g_{22}	-0.271*	-3.226
1994	30.792*	7.292
Log-Likelihood Function = -1,375.011		
χ^2 Statistic = 1,694.820		

Notes: A single asterisk (*) denotes statistical significance at the 5% level. The parameters are defined as follows: $K_{0,t}$ is the carrying capacity of the environment in year *t*; α is the rate of growth; g_{mn} is the linear (m = 1) or quadratic (m = 2) control parameter in 1993 (n = 1) or 1994 (n = 2); and 1994 is the regression coefficient of the binary variable for the trials conducted in 1994 (1994 = 1 if the year is 1994, and 0 otherwise). The χ^2 statistic compares the estimated log-likelihood function model to a null alternative and has a critical value of 15.51 with eight degrees of freedom at a 5% level of significance.

Table 2 presents estimates of the deterministic part of the insect growth model. In this model, carrying capacity is allowed to vary from one year to the next because we cannot otherwise control for the temperature, the amount of vegetation, or other factors that may influence the maximum supportable population. However, the results in Table 2 show that the maximum supportable population in 1993 was 19.639 insects per cm^2, but the maximum population in 1994 does not differ significantly.

The rate of growth was also initially allowed to differ between the two years but, perhaps due to the relatively small number of time-series observations available for each plot, the estimation procedure could not identify two separate growth rates. Therefore, we maintain an assumption throughout that the rate of population growth in both years averages approximately 12.6% per week.

Table 3. Insect Stochastic Process Model Estimates (MLE), *Bemisia tabaci* Trial Data: Brawley, CA (1993–1994)

MODEL #1 Brownian Motion (BM)			MODEL #2 BM with Mean Reversion (BM-MR)			MODEL #3 BM-MR with Jumps (BM-MR-J)		
Parameter	**Estimate**	***t*-Ratio**	**Parameter**	**Estimate**	***t*-Ratio**	**Parameter**	**Estimate**	***t*-Ratio**
σ_1	255.882*	12.991	σ_2	141.762*	13.163	σ_3	96.161*	11.746
μ_1	1.182	1.359	μ_2	1.031	1.704	μ_3	1.032*	3.961
			κ_2	0.728*	16.445	κ_3	0.370*	6.183
						λ_3	0.193*	6.524
						δ_3	28.143	1.511
						ϕ_3	43.451*	8.455
LLF = -1,404.08			LLF = -1,305.16			LLF = -1,291.87		

Notes: A single asterisk (*) denotes statistical significance at the 5% level. The parameters are defined as follows: σ_i is the standard deviation of the Weiner process i; μ_i is the drift rate of process i; κ_i is the rate of mean reversion; λ_i is the arrival rate of the jump process; δ_i is the standard deviation of the jump process; and ϕ_i is the percentage deviation during a jump.

Next, estimates of the control function suggest that insecticide applications were subject to diminishing marginal returns each year. Nevertheless, insecticide appears to have been significantly more effective during 1994, where the marginal effect (evaluated at sample means) was 1.081 fewer insects per application, versus 0.901 fewer in 1993.

Finally, for reasons of either weather, lack of natural enemies, or some other factor that we could not measure, the average population in 1994 was fully 30.8 more insects per leaf than in 1993.

After removing the deterministic mean from the observed insect series, three alternative stochastic processes were then estimated in an attempt to explain the remaining, random variation. Starting with the simplest, most parsimonious model, we estimated: (*a*) a simple Brownian motion (BM); (*b*) a Brownian motion with mean reversion (BM-MR); and (*c*) a mean-reverting Brownian motion with discrete, Poisson-distributed jumps (BM-MR-J).

Table 3 reports the parameters from each model and the results from testing among the competing models. Because each is nested within the more complicated alternative, likelihood ratio (LR) tests suffice for model selection.

For the first comparison (BM versus BM-MR), the resulting LR statistic is χ^2 distributed with one degree of freedom. At a 5% level, the critical χ^2 value is 3.84, while the test statistic value is 197.84. Thus, we clearly reject the BM model in favor of the BM-MR.

Second, the LR test statistic used to compare the BM-MR and BM-MR-J models has a critical value of 7.82, while the estimated LR χ^2 value is 26.58, again suggesting rejection of the more parsimonious model.

Based on these results, we therefore expect a drift rate away from the underlying trend of approximately one insect per leaf per week. Deviations from trend tend to return to the mean at a rate of 37% per week. Further, we expect to observe jumps in insect numbers of 43.45 insects per week approximately 20% of the time. Clearly, jumps this large and frequent are a dominant characteristic of the process driving *B. tabaci* growth, and so will be a major factor in pricing any derivative written for them.

Table 4. Insect Derivative Price Estimates Based on *Bemisia tabaci* Trial Data: Brawley, CA (1993–1994)

Strike Population	Call Option Value, V_c ($)	Standard Deviation ($)
20	46.37	7.44
25	41.44	7.91
30	36.99	7.65
35	31.73	7.54
40	24.94	7.99

Notes: Sample average population is 30.63 adults per leaf, so the first two call options are "in the money," while the third is "at the money," and the final two options are "out of the money" as the grower is better off with the expected number of insects than with that proposed in the hypothetical options with strike populations of 35 or 40 adults per leaf. Prices are obtained using the risk-neutral valuation method evaluated at the fixed parameter values given in Table 1. Monte Carlo simulations involve 10,000 draws from distribution of the random element in the insect population growth process.

Because the BM-MR-J model was found to dominate the others, we use this model to form expectations of the *B. tabaci* population value at contract expiry, as required by the pricing model in (8). Table 4 provides a summary of the price estimates for a range of strike population levels (20 adults per leaf to 40 adults per leaf) as well as their standard deviations.[15]

Conducting a sensitivity analysis of call option prices is necessary because the strike price is a significant element of the option contract that is subject to negotiation between both parties. Given that the average population value over the sample period is roughly 30 adults per leaf, options with strike populations above this value are termed "in the money" because they have a positive intrinsic value. In contrast, options with strike populations below 30 are "out of the money" because they have no intrinsic value to a potential purchaser. Further, the higher the strike price, the less financial insurance insect options provide their holder. As a result, we expect lower option values the higher the strike price.

The results in Table 4 show this to be the case. Specifically, if a grower expects significant economic damage if insect counts rise above 20 adults per leaf, then buying a call option for protection at any realized population above this level will cost $46.37. Because this price is fully justifiable on economic grounds, both the grower and counterparty (e.g., an insecticide company) will agree to this price and will enter the option contract willingly.

Given the equilibrium derivative prices in Table 4, we next examine whether a risk management program that incorporates insect derivatives is able to mitigate yield risk caused by insect infestation. According to equation (12), higher insect numbers reduce yields in a linear-quadratic manner, while chemical control activities affect insect numbers, and hence yield, in a similar fashion. Although this process is naturally recursive, because control activities do not affect yield directly but by reducing insect numbers, estimating with an instrumental variables procedure ensures that the parameter estimates are consistent. In this way, we control for the endogeneity of insect density and permit a direct estimate of the economic value of insect control.[16] The yield equation forms the core of a stochastic profit-simulation model in which growers are able to offset insect-borne insect damage (i.e., lower yields) by purchasing insect call options from an anonymous third-party market-maker.[17]

[15] Strike population levels are chosen so that the mean density is approximately in the middle of the upper and lower values. The early 1990s represented a peak-infestation period for *B. tabaci* in this area; thus, these values are not intended to be representative of current conditions.

[16] In observed economic data, control activities would also be endogenous. However, in a controlled experiment, chemical applications are predetermined and thus not correlated with the error in each equation.

[17] Commonly, derivative instruments that are not offered over a formal exchange are traded "over the counter" or between two parties in a privately negotiated transaction. A financial institution or trading firm (Bank of America is an example of the former, and Aquila Energy the latter) usually sells or "writes" the option for a party with a legitimate hedging interest taking the other side. Chemical companies may also sell options either directly to growers, or through financial market-makers.

Instead of offsetting the economic damage caused by insect infestation through derivative securities, clearly growers can also mitigate yield damage more directly through the use of chemical or biological treatment procedures. In the *B. tabaci* sample data, the intensity of insect control is measured by the number of applications of a fixed chemical regime throughout the growing season. However, allowing for chemical treatment means that growers can potentially manipulate the price of any derivative written on observed population counts. Therefore, to focus attention on the role and value of derivatives in the absence of such manipulation, we construct yield forecasts on the assumption that growers apply the sample-average number of treatments.[18] This assumption is analogous to requiring growers who purchase multiple-peril crop insurance contracts to follow certain planting, growing, and harvesting restrictions in order to minimize the moral hazard problem.[19]

The yield model results are reported in Table 5. Based on sample average population values, the marginal effect of an additional adult *B. tabaci* throughout the growing season is a loss of 4.656 kg/ha. Using the long-term average price for cotton of $1.32/kg, this implies that each additional adult costs cotton growers approximately $6.03 per ha. As also observed from this table, growers can reduce the damage from any given population level by spraying insecticide, but their ability to do so is subject to sharply diminishing marginal returns.

In order to implement the stochastic profit simulation model, it is also necessary to estimate the parameters of the Gaussian yield-error process. As required by the least-squares estimation procedure, the error process is indeed normally distributed with a mean of zero. However, yield-risk in Imperial Valley cotton is significant, as the standard deviation is 138.7 pounds of cotton. This yield model, and the estimated error distribution, are then used as the primary inputs to the stochastic profit simulation model.

Table 5. Cotton Yield Model (2SLS), *Bemisia tabaci* Field Trial: Brawley, CA (1993–1994)

Parameter	Estimate	*t*-Ratio
Constant	7.066*	32.129
$\ln(B_i)$	-0.084*	-2.891
$\ln(c_i)$	0.166*	4.036
1994	0.292	1.341
$R^2 = 0.747$		

Notes: A single asterisk (*) denotes statistical significance at the 5% level. Dependent variable = ln(*Yield*); independent variables are B = insect population, and c = level of control activities (number of applications). Instruments consist of all exogenous and predetermined variables in the system.

Table 6 shows the "base case" risk-return measures, under which no risk management activities are used, as well as those calculated under a simple risk management strategy. Although a wide range of derivatives can be defined, as well as strategies for trading them, we focus on an insect-derivative hedge in which the grower buys a call option with a strike population level equal to the average insect population value in the Brawley sample data set. As would be expected, if the options are fairly priced, net income does not differ between the hedge and no-hedge strategies in the simulation exercise (1,000 draws from the insect model error distribution).

The results reported in Table 6 show that the insect derivative provides a clear improvement in all risk and risk-return measures. Specifically, the Sharpe ratio under the hedge strategy is 0.15 points higher than in the unhedged scenario.

[18] The number of treatments in the experimental data used here was not based on perceived need, but rather based on experimental protocol. Although actual treatment values will likely vary from those reported here, the estimated parameters are nonetheless estimated without bias.

[19] Moral hazard refers to the tendency of insured growers to reduce their efforts to avoid yield losses. By including "best practice" restrictions in derivative contracts, the counterparties are essentially reducing growers' ability to use insect derivatives to substitute for chemical control (as described earlier in footnote 3).

Table 6. Risk Management with Insect Derivatives Stochastic Simulation Results: Representative Cotton Farm, Imperial Valley, CA (2004)

	Risk Management Strategy	
Risk Metric	**No Hedge ($/acre)**	**Call Option Hedge ($/acre)**
Net Income	$165.54	$165.54
Sharpe Ratio	1.99	2.14
VaR (5%)	$30.33	$117.95
Certainty Equivalent:		
$\gamma = 0.1$	$163.72	$164.32
$\gamma = 0.5$	$153.18	$160.01
$\gamma = 0.9$	$128.07	$156.46
Risk Premium:		
$\gamma = 0.1$	$1.82	$1.23
$\gamma = 0.5$	$12.37	$5.54
$\gamma = 0.9$	$37.47	$9.08

Notes: Simulation results are from 1,000 random draws from normal insect population model error distribution with mean zero and standard deviation of 0.85 adults per leaf. Sharpe Ratio is defined as the excess returns (expressed as a percentage of invested capital) over the risk-free rate divided by the coefficient of variation of returns. VaR is the "value at risk" and is interpreted as the maximum loss expected with a 5% probability. Certainty equivalent and risk premium values are calculated from the power utility function with a coefficient of relative risk aversion of γ, where $\gamma = 0.1$ indicates near-risk neutrality, $\gamma = 0.5$ is moderate risk aversion, and $\gamma = 0.9$ is strong risk aversion. All simulation data are taken from University of California Cooperative Extension (2005).

Therefore, purchasing an at-the-money call option provides a favorable risk-return tradeoff relative to relying on chemical or biological control methods alone.

Subtracting the 5% VaR from expected net income provides a measure of how much a grower can expect to "lose" relative to a normal year 5% of the time, or one year in 20. Because low yields are driven entirely by insect damage in this model, this "worst case" scenario means a year with a particularly high number of insects. With no options hedge, a grower can expect to lose $135.21 (= $165.54 - $30.33) 5% of the time relative to average net income. With a call-options hedge, however, the expected loss falls to $47.59 (= $165.54 - $117.95) because the insect option effectively truncates the revenue distribution below the point at which insect damage would otherwise cause significant yield losses.

Unlike the previous measures, a grower's certainty equivalent (CE) value depends upon his or her attitude toward risk, here summarized by the coefficient of relative risk aversion. Higher values of γ mean the grower is more risk averse, and so is willing to pay less for a risky prospect. At values of γ near risk neutrality ($\gamma = 0.1$), the difference in CE values between the hedged and unhedged scenarios is small. However, as the degree of risk aversion rises toward 0.9, the difference in CE values rises as our representative grower attaches a greater value to the stability of net income, relative to the magnitude.

Finally, the difference between net income and CE for each level of risk aversion gives the risk premium—or the amount a grower would willingly pay for insurance sufficient to remove any remaining net income risk. According to these simulation results, trading insect call options removes a significant part of the risk premium associated with growing cotton. Whereas a risk-averse grower who does not buy a call option can be expected to pay a $37.47 premium to transfer all yield risk, call option buyers are expected to pay an average of only $9.08. Based on these aggregate results, therefore, it is clear that insect derivatives can be effective in mitigating the economic risk caused by insect infestation.

Conclusions and Implications

Findings from this analysis reveal it is possible to design a financial instrument that allows growers to transfer the financial risk of insect damage to their crop. Further, because data on insect populations are readily available through rigorous scientific experimentation for many systems, it is possible to value derivative contracts written for a specific crop and location. Indeed, because insect numbers are independent of financial markets or other measures of broader economic performance, it is possible to use relatively simple risk-neutral valuation methods to price a wide range of insect derivatives.

As shown by this study, insect derivatives, designed according to the principles outlined here, can be effective risk management tools. Although derivatives must be purchased from a counterparty who is willing to assume the risk that is transferred, the cost is generally more than offset by the higher utility derived from a less volatile income stream. This is found to be the case for a particular type of derivative—a call option on the underlying insect population—but it remains to be demonstrated for other types of derivatives and for other insect populations.

Further work in this area is required in order to develop a better understanding of the practical aspects associated with creating and trading insect derivatives.

- First, although we have shown it is possible to design and price an insect derivative, future research in this area should investigate issues of basis risk—or how an individual grower's exposure differs from that measured at an experiment station or other monitoring point—and how this can impact the grower's risk management strategy with insect derivatives. In particular, the valuation method considered here addresses issues of spatial population variation only in an implicit way, namely by estimating the population process at a specific place. However, future research should work to incorporate stochastic processes in the spatial dimension as well. By explicitly linking population growth rates at varying distances, and with varying degrees of contiguity relative to one another, we will be able to price variation in both dimensions. This research represents an advance in both economic entomology and derivative pricing more generally, as it offers a means of explicitly pricing spatial basis risk.

  Another method of addressing basis risk is to use an algorithm based on the concept of forecast encompassing. With this approach, traders create optimal cross-hedges in the presence of spatial basis risk using contracts written on different insect monitoring stations, where optimality is defined in terms of the weight placed on contracts written at different locations. This method was developed by Sanders and Manfredo (2004) for determining the relative weights to place on different futures contracts in a composite hedge. By taking optimal positions in several different insect trap locations, traders will be able to create a portfolio that best mimics the risk at their particular location. While not likely to eliminate all basis risk, forecast encompassing offers an econometric-based means of creating effective hedge positions for traders.

- Second, while insect populations under the controlled conditions of the data used in this study do not appear to change with respect to heat or precipitation (see footnote 5), other insect and invasive species, including plants, nematodes, fungi, and locusts, do respond to specific weather conditions. Thus, in addition to the "bug options" presented here, there are a host of other possibilities, including a variety of weather derivatives, which could be used to offset economic losses to crops caused by insects.

- Third, more research should be conducted using other insect species to determine whether the growth processes estimated in this analysis are typical of insects in general, or if *B. tabaci* represent somewhat of an anomaly. This consideration is particularly important given that the densities of *B. tabaci* during the experimentation period used here were likely much higher than those experienced currently.

- Fourth, before insect derivatives become widespread, there is still much work to be done in designing institutions and markets that can facilitate their trade.

While weather derivatives are still in their infancy, interest from energy firms and others in the trading industry has led to the development of a significant pool of interest in their trade. Building similar interest is necessary to bring insect derivatives from theoretical possibility to a tradable reality.

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Appendix: Solution to Exponential Growth Equation

To solve the differential equation in (1) of the main text, use the separation-of-variables principle to rewrite as:

$$\text{(A1)} \quad \frac{dB}{B(K-B)} = \frac{\alpha_1}{K}dt,$$

after simplifying notation for the mean bug process. Next, rewrite this expression as:

$$\text{(A2)} \quad \left(\frac{1}{B} + \frac{1}{K-B}\right)dB = \alpha_1 dt,$$

and integrate both sides to obtain:

$$\text{(A3)} \quad \ln\left(\frac{B}{K-B}\right) = \alpha_1 t + \ln\left(\frac{B_0}{K-B_0}\right).$$

Next, solving for B gives:

$$\text{(A4)} \quad B = \frac{K}{1 + de^{-\alpha_1 t}},$$

where $d = (K - B_0)/B_0$. In the text, the control function g is assumed to be exogenous to the natural growth process described by the differential equation in (1), as given by (A1) above.

Loss-Given-Default on Farm Real Estate Loans: Probability of Full Recovery

Yan Yan and Peter J. Barry

Abstract

The non-depreciability characteristic of farmland value implies that farm delinquencies and default may not necessarily lead to loan loss. Considering this, a model under the framework of Value-at-Risk is developed to estimate probabilities of debt coverage by farmland that is mortgaged to secure a loan. Loss-given-default (LGD) under collateral risk is conceptualized and empirical estimation of land values considering time pattern and uncertainty is proposed. Given different economic situations, the probabilities of full recovery of loan balances under both loan-level and portfolio specifications are estimated using USDA data from selected states and regions. Results indicate that farmland pledged as collateral is expected to cover the loan balance with relatively high probability.

Key words: collateral risk, farm real estate, loss-given-default, recovery rates

Credit risk assessment by lenders is generally moving toward a dual rating approach that jointly considers the frequency and severity of potential losses. Under this approach, the borrower's risk ratings are based on probabilities of default (PD), while the characteristics of the loan transaction (e.g., collateral, seniority of claims, third-party guarantees) determine the loss-given-default (LGD). The product of PD, LGD, and exposure-at-default (EAD) then indicates expected loss (EL), and their volatilities determine unexpected loss (UL). These developments are consistent with best industry practices and with the internal ratings-based approaches to minimum capital requirements for financial institutions under the New Basel Accord (Barry, 2001).

The dual approach contrasts sharply with the single-dimension loss rating systems of the past. It allows separate consideration of factors affecting the frequency and severity of default, greater granularity in rating systems, potential trade-offs between the two types of ratings, and direct linkages to economic capital models. Thus, farm failures may not necessarily lead to loan losses, because strong, senior collateral or guarantee positions may provide for recovery of funds sufficient to cover the outstanding mortgage plus related handling costs.

Our study focuses on the LGD component of dual rating systems for farm real estate loans. Past studies in agricultural finance have primarily focused on single-dimension rating systems in which the incidence of borrower default is based on a combination of customer and loan-level

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characteristics (Turvey, 1991; Splett et al., 1994; and Miller and LaDue, 1988, among others). Exceptions are a Farm Credit Administration (2001) study estimating LGD rates of about 21% on mortgage loans by the Farm Credit Bank of Texas during the 1979–1992 period, Featherstone and Boessen's (1994) finding of LGDs of 6.6% for a major life insurance company's farm mortgage loans over the 1978–1991 period, and Katchova and Barry's (2003) estimate of 34% based on distance-to-default concepts for real estate and non-real estate loans using farm record data. [A recent study by Featherstone, Roessler, and Barry (2004) addresses the PD component of a dual rating system.]

In corporate finance, LGD rates have been estimated for bonds and large corporate loans, under various industry, security, guarantee, location, and claim positions (Altman and Suggit, 1997; Moody's Investors Service, 2003; Standard and Poor's, 2003). For example, loss-given-default rates reported by Moody's on defaulted corporate bonds averaged 66.2% over the 1982–2003 period, ranging from a low of 41.5% in 1997 to 74.8% in 2001, and averaging 53.8% for investment grade securities and 65.4% for speculative securities. The LGD rates were further ranged by industry from 43.6% for utility-gas to 82.9% for telecom. The measurement approach followed by the rating companies is usually based on comparisons between pre- and post-default market values on bonds, which is not possible for instruments lacking well-developed secondary markets.

In agriculture, farmland has several desirable properties as collateral for securing mortgage loans. First, the non-depreciability of farmland (with proper maintenance) implies that its value tends to grow over time as part of the economic return (Barry and Robison, 1985). In contrast, commercial real estate and depreciable assets in other industries will experience declining nominal and real values. Second, agricultural mortgage loans are generally amortized to reduce the principal balance over the life of the loan. Third, the re-marketability of farmland is relatively high in local real estate markets, with land seldom standing idle during crop seasons. Finally, the immobility of farmland avoids its possible theft or disappearance, thereby adding to its security value.

The methodology is based on a modeling approach that yields estimates of the probability of fully recovering the outstanding debt secured by farmland. This is similar to a Value-at-Risk concept based on levels and variabilities of farmland values securing loans under alternative payment plans and initial loan-to-value ratios. Empirical measures come from USDA data for selected states and regions of the United States, and are applied at loan and portfolio levels for financial institutions.

Loss-Given-Default Under Collateral Risk

The lender's expected return from a loan at time t can be expressed as:

$$(1)\quad E\pi_t = (1 - PD)(1 + r)(LB_{t-1}) + (PD)\big((1 + r)(LB_{t-1}) - ELGD_t\big) = (1 + r)(LB_{t-1}) - (PD)(ELGD_t),$$

where LB is the loan balance, r is the fixed interest rate on the loan, PD is the probability of default, and $ELGD$ is the expected loss-given-default.

For a given probability of default, the potential loss depends on the probability that loss-given-default is greater than zero. In a Value-at-Risk (or safety-first) framework, to lower the loss, the lender's goal is then to determine an initial loan-to-value ratio (γ_0) to ensure LGD will exceed zero less than α (say 5%) of the time, or to determine the probability of full recovery (PFR) of the loan and compare it to the $1 - \alpha$ confidence limit. That is:

$$(2)\quad \text{Prob}(LGD_t \geq 0) \leq \alpha.$$

Actually, expression (2) can be treated as a constraint in chance-constrained programming of modeling risk for the objective function (McCarl and Spreen, 1997).

In a collateralized real estate loan, LGD_t is defined as the outstanding loan balance minus the net collateral value at time t:

$$(3)\quad LGD_t = (1+r)(LB_{t-1}) - (\tilde{V}_t)(1-c),$$

where $\tilde{V}$ is the land value and c is the rate of transaction costs under loan foreclosure.

When the value of land as collateral at time t is random, the upper confidence limit for LGD_t is determined by the probability limit α and the distribution of land value. For a given probability limit α and a normal distribution of land values with mean $\bar{V}_t$ and standard deviation σ_t, the upper confidence limit for LGD_t is then:

$$(4)\quad LGD_t^u = (1+r)(LB_{t-1}) - \left(\bar{V}_t - (Z_\alpha)(\sigma_t)\right),$$

where Z is the standard normal deviate. For simplicity, the transaction cost is not considered in the expression. In this case, expression (2) is guaranteed as long as

$$(5)\quad (1+r)(LB_{t-1}) \le \bar{V}_t - (Z_\alpha)(\sigma_t).$$

Given Z_α, the maximum allowable loan-to-value ratio (γ_t) at time $t-1$ can be found by first solving expression (5) for LB_{t-1}:

$$(6)\quad LB_{t-1} = \frac{\bar{V}_t - (Z_\alpha)(\sigma_t)}{1+r},$$

and then dividing by $\bar{V}_t$:

$$(7)\quad \gamma_t = \frac{LB_{t-1}}{\bar{V}_t} = \frac{1-(Z_\alpha)(CV_t)}{1+r},$$

where CV_t is the coefficient of variation ($CV_t = \sigma_t / \bar{V}_t$). This value can be used to determine initial loan-to-value ratio γ_0 given the loan maturity T and the distribution of land values over the period. For example, expression (2) would be satisfied by taking γ_0 as $\min\{\gamma_t, t=1, \ldots, T\}$ within the whole period.

Alternatively, we may specify a value of γ_t based on initial loan-to-value ratio γ_0, and solve (7) for Z_t in order to determine the probability of full recovery of the loan balance at the time:

$$(8)\quad Z_t = \frac{1-(1+r)(\gamma_t)}{CV_t}.$$

To illustrate, if CV_t is 0.20, r is 0.05, and Z is 2.00 indicating a 5% confidence limit, then the upper acceptable bound on the loan-to-value ratio is written as:

$$\gamma_t = \frac{1-2(0.2)}{1.05} = 0.571, \text{ or } 57.1\%.$$

Similarly, if γ_t were set at 0.571, CV_t remains 0.20, and r is 0.05, the Z_t value is given by:

$$Z_t = \frac{1-(1.05)(0.571)}{0.2} = 2.00,$$

or a probability of full recovery of 95%.

According to classical statistics, estimation of a population parameter, such as mean or variance, is obtained from sample information, while Bayesian statistics state that posterior probability distributions about the parameter should be obtained by combining prior probability and sample information. Comparatively, Bayesian statistics emphasize the uncertainty about the parameter, and "because of this uncertainty, the parameter is an uncertain quantity, or random variable, and probability statements can be made about it" (Winkler, 1972, p. 386). However, the posterior density and the estimates thereof from the Bayesian method would converge to the sampling theory result as the amount of data increases (Greene, 2000).

In addition, under certain assumptions, such as diffuse prior distribution of the population parameter, the estimation results by the Bayesian method are the same as those obtained by the classical method, where "the difference is a matter of interpretation" (Greene, 2000, p. 406). As such, the following analysis will apply the Bayesian method but only consider the case of prior diffuse distribution of the population parameters.

Collateral Risk of Farmland

The probability of full recovery (PFR) for farm real estate loans is estimated by comparing a deterministic loan balance against the lower credible limit of projected land values, based on expression (3), while the expected land values and standard deviations are estimated from historic land value data compiled by the USDA's Economic Research Service (ERS).

The estimates are first illustrated for Illinois and then determined for the largest farm/gross revenue states in seven additional production regions utilized by ERS. For each state, the loan-level approach is implemented by first estimating the expected land values and standard deviations based on the non-depreciability of farmland value over the 1950–2002 period.

In the second step, projected land values and their standard deviations are compared to outstanding debt levels over each year of a 10-year projection period to obtain PFRs by using equation (8) to determine a Z value. The PFRs are derived for three initial loan-to-value ratios (60%, 70%, and 80%)[1] and two loan repayment plans—constant annual payment on principal plus interest, and equally amortized payments of principal and interest.

In each year of the 10-year period, the projected or expected land values are reduced by 10% to reflect transaction and handling costs incurred by lenders when acquiring and selling the collateral (Featherstone et al., 1993). The projected annual loan balances that are compared to annual loan values reflect the principal reduction due to payments in previous years, plus interest accrued since the last payment.

The 1950–2002 time period is long enough to cover several eras of change in land values. The 1950s and 1960s were characterized by low, steady rates of growth in land values. Growth rates skyrocketed in the 1970s as optimism for continued growth in farm income prevailed. The bubble broke in the 1980s, with land values plummeting nearly as fast as they had increased in the 1970s. After several years of recovery in the late 1980s, annual growth in land values resumed at moderate, stable rates, and this trend has continued into the 2000s.

From the non-depreciability of farmland value (Barry and Robison, 1986), the theoretical land value at time t for a given growth rate g can be written as:

$$(9) \quad V_t = (V_{t-1})(1 + g).$$

Writing the value as a function of initial land value V_0 and time t gives:

$$(10) \quad V_t = V_0 + V_0(1 + g + \ldots + g^{t-2})gt + V_0 g^t$$
$$= V_0 + \frac{V_0 g}{1-g}t - \frac{V_0}{1-g}g^t(t-1+g).$$

The measurement approach utilized here then applies a linear model based on expression (10) to project land values ($\tilde{V}_t$) and standard deviations (σ_t) over the 10-year projection period. The model takes the following form:

$$(11) \quad \frac{\tilde{V}_t}{V_0} - 1 = a + bt + \varepsilon_t,$$

where ε_t is the disturbance term, with $\varepsilon_t \sim$ i.i.d. $N(0, \sigma_\varepsilon)$. It can be shown that

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[1] The loan-to-value ratio for real estate (including residential real estate) as reported in the *Farm Credit Administration Handbook* (FCA, 2005) is limited by statute to 85%. As for Farmer Mac, its underwriting standards state that the "'loan-to-value ratio should not exceed 70% in case of a typical Farmer Mac loan secured by agricultural real estate, 75% in the case of qualified facility loans, 60% for loans greater than $2.8 million, or 85% in the case of part-time farm loans with private mortgage insurance coverage required for amounts above 70%" (U.S. General Accounting Office, 2003, p. 79).

this is a trend-stationary model, and thus can be used for prediction (Granger and Newbold, 1986) while the volatility has the feature of heteroskedasticity.

Following Zellner's (1971) approach, assume the parameters (a, b) and $\ln(\sigma_\varepsilon)$ are uniformly and independently distributed. The prior probability distribution is then expressed as:

$$(12)\quad P(a, b, \sigma_\varepsilon) \propto \frac{1}{\sigma_\varepsilon},$$

$$-\infty < a, b < +\infty,$$

$$0 < \sigma_\varepsilon < +\infty.$$

The estimated parameters ($\hat{a}$, $\hat{b}$) and the standard error (s) can be obtained from the sample data by the maximum-likelihood method. Given the estimates, the marginal posterior distributions for the parameters a and b are of t-distribution, and so are the projected land values. These results are identical to those obtained from the classical method (Greene, 2000; Zellner, 1971).

For the model specification and the property of time-series data, the autoregression process AR(1) is applied to the two-year average land values[2] to obtain the estimates in the empirical estimation. AR(1) also considers heteroskedasticity. Accordingly, the final model is then:

$$(13)\quad \frac{V_t}{V_0} - 1 = a + bt + \varphi_t,$$

where $\varphi_t = \rho\varphi_{t-1} + \nu_t$, with $\nu_t \sim N(0, \sigma)$, and ρ is the autoregressive parameter.

[2] For the 1950–2002 data period, the augmented Dickey-Fuller (ADF) test statistic (lag = 1) for unit root is −4.22 with a MacKinnon approximate p-value of 0.0041 for the two-year average land values. The ADF test is then applied to the two-year average land values from the other seven regions; a unit root problem arises for the data from Pennsylvania and Texas. Moreover, the same testing procedures are applied to the data of different time periods, but the ADF test results varied. For example, for the time period of 1970–1989, there is a unit root problem for the data from Colorado and Texas, while a similar problem occurs in the data from Colorado, Illinois, and Texas for the 1990–2002 time period.

Estimations and Projections

The estimated results for the linear model using the data from Illinois for the entire period (52 years) are reported in Table 1. The regression equation conveys high significance for each variable, and yields a projection model of

$$E(V_t) = 174 + \underset{(0.036)}{42.04\,t},$$

$$\varphi_t = 0.9422\varphi_{t-1} + \nu_t,$$

$$\text{Est. Var}(\nu_t) = 0.4832,$$

where the standard error is in parentheses. The projected standard deviation is then

$$\text{std.}(\varepsilon_t) = \sqrt{0.4832 \times \mathbf{x}_t'\mathbf{W}\mathbf{x}_t},$$

where $\mathbf{x}_t$ represents the vector for the independent variables at time t, and $\mathbf{W}$ is the 2×2 submatrix of $(J'J)^{-1}$ that corresponds to the regression parameters (SAS Institute, Inc., 1999). The average annual growth rate of the estimated land value is 4.81%, which is slightly lower than the geometric mean (5.42%) of the actual growth rate. Since the t-distribution approaches normal when the number of observations is large (Broemeling, 1985), it is reasonable to apply normal distribution of the projected land values in calculating PFRs.

For a fixed interest rate of 10%, the estimated loan-level PFRs for the Illinois case are reported in Table 2 for the two repayment schedules, the three loan-to-value ratios, and a 10-year maturity. The increasing expected land value and declining loan balance together with the standard deviations yield an increasing time pattern of PFRs. For example, under the 0.80 loan-to-value ratio and a constant payment schedule, the PFR increases from 65.32% in year 1 to 100% in year 10. Lower loan-to-value ratios increase the schedule of PFRs, as does the constant payment on principal method that yields a more rapid

Table 1. Autoregression of Average Value per Acre for Illinois Farm Real Estate (1950–2002)

MAXIMUM LIKELIHOOD ESTIMATES:

Description	Value	Description	Value
SSE	24.65	DFE	51
MSE	0.4832	Root MSE	0.6951
SBC	119.95	AIC	116.01
Regression R^2	0.4690	Total R^2	0.99
Durbin-Watson statistic	0.8423		

Variable	DF	Estimate	Standard Error	Approx. *t*-Value	Pr > |*t*|	Variable Label
t-Value	1	0.2416	0.0425	5.68	< 0.0001	Time Trend
AR(1)	1	-0.9422	0.0501	-18.81	< 0.0001	Autocorrelation Parameter

AUTOREGRESSIVE PARAMETERS ASSUMED GIVEN:

Variable	DF	Estimate	Standard Error	Approx. *t*-Value	Pr > |*t*|	Variable Label
t-Value	1	0.2416	0.036	6.71	< 0.0001	Time Trend

VARIANCE AND COVARIANCE MATRIX:

Variable	SSE	Standard Error	*t*-Value	AR(1)
t-Value	24.65	0.0069	0.0018	-0.0011
AR(1)	24.65	0.0405	-0.0011	0.0025

Definition of Terms: SSE = sum of squared errors, DFE = error degrees of freedom, MSE = mean squared error, SBC = Schwarz Bayesian Criterion, AIC = Akaike Information Criterion, and DF = degrees of freedom.

reduction in loan principal than does an amortized loan.[3]

Since the entire 52-year time period covers several eras of change in land values, we further break the data into three subperiods: 1950–1969, 1970–1989, and 1990–2002. Applying the same estimation and projection procedure as above provides a more detailed picture for assessing how the changes in economic situations might affect the land value and its volatility, and thus the associated PFRs. The results are illustrated in Table 3 for the case of constant payment. Given the same loan-to-value ratio, the results for the case of constant payment on principal are similar, but with higher PFRs due to the more rapid reduction in loan balance.

The results illustrate the same increasing time pattern of PFRs as well as higher PFRs associated with lower loan-to-value ratios. The steady growth periods of 1950–1969 and 1990–2002 are characterized by lower projected volatilities in land values, and thus higher PFRs. The continued growth in farm income in the 1970s followed by the agricultural crisis in the 1980s had an opposite effect on land values. Projected land values in the period are accompanied by higher volatilities. Thus the PFRs are lower, but are still acceptable, with an average PFR of 84.27% even under the 0.80 loan-to-value ratio.

[3] High payments earlier in the life of the loan could pressure the borrower's cash flow and increase the probability of default. This linkage, however, is not explicitly considered in the analysis.

Table 2. Probability of Full Recovery Given Different Payment Schedules and Loan-to-Value (LTV) Ratios, Illinois Data (1950–2002)

A. CONSTANT PAYMENT SCHEDULE WITH DIFFERENT LOAN-TO-VALUE RATIOS

			LTV Ratio = 80%		LTV Ratio = 70%		LTV Ratio = 60%	
Time (Year)	Expected Land Value ($)	Std. Dev. ($)	Ending Balance ($)	Probability of Full Recovery (%)	Ending Balance ($)	Probability of Full Recovery (%)	Ending Balance ($)	Probability of Full Recovery (%)
1	2,444	313	2,323	65.32	2,033	70.15	1,742	92.47
2	2,486	342	2,177	56.88	1,905	83.16	1,633	95.82
3	2,528	368	2,017	75.63	1,765	91.37	1,513	97.81
4	2,570	392	1,841	88.27	1,611	96.02	1,381	98.93
5	2,612	414	1,647	95.23	1,441	98.36	1,235	99.52
6	2,654	434	1,433	98.37	1,254	99.41	1,075	99.80
7	2,696	453	1,198	99.54	1,049	99.81	899	99.93
8	2,738	470	940	99.89	823	99.95	705	99.98
9	2,780	486	656	99.98	574	99.99	492	99.99
10	2,822	501	344	100.00	301	100.00	258	100.00

B. CONSTANT PAYMENT ON PRINCIPAL SCHEDULE WITH DIFFERENT LOAN-TO-VALUE RATIOS

			LTV Ratio = 80%		LTV Ratio = 70%		LTV Ratio = 60%	
Time (Year)	Expected Land Value ($)	Std. Dev. ($)	Ending Balance ($)	Probability of Full Recovery (%)	Ending Balance ($)	Probability of Full Recovery (%)	Ending Balance ($)	Probability of Full Recovery (%)
1	2,444	313	2,323	65.32	2,033	70.15	1,742	92.47
2	2,486	342	2,091	66.45	1,830	88.04	1,568	97.19
3	2,528	368	1,859	86.80	1,626	95.77	1,394	98.97
4	2,570	392	1,626	95.68	1,423	98.61	1,220	99.62
5	2,612	414	1,394	98.74	1,220	99.56	1,045	99.86
6	2,654	434	1,162	99.66	1,016	99.87	871	99.95
7	2,696	453	929	99.91	813	99.96	697	99.98
8	2,738	470	697	99.98	610	99.99	523	99.99
9	2,780	486	465	99.99	407	100.00	348	100.00
10	2,822	501	232	100.00	203	100.00	174	100.00

Note: Assumes a fixed interest rate of 10%.

In summary, at the individual loan level, the loan-level PFRs obtained under different initial loan-to-value ratios, economic situations, and repayment schedules show that farmland is a valuable source of collateral. Its value is expected to cover the loan balance with relatively high probabilities, reflecting the expected growth in land value and reduction in loan balance. These relationships imply that the loss-given-default rates on farm real estate loans are relatively low.

Moreover, the initial loan-to-value ratio is critical to the level of PFR. As initial loan-to-value ratio decreases, PFR continues to increase due to the widening trend between the expected land values and loan balances. A desired loan-to-value ratio at the beginning will yield higher PFRs thereafter.

Finally, different repayment schedules affect PFR, especially when the loan-to-value ratio is higher. Given the same loan, PFR under constant payment on principal

Table 3. Probability of Full Recovery Given Constant Payment Schedule and Different Loan-to-Value (LTV) Ratios for Three Time Periods

A. DATA PERIOD: 1950–1969

Time (Year)	Actual Land Value ($)	Expected Land Value ($)	Standard Deviation ($)	Probability of Full Recovery (%) 80% LTV Ratio	70% LTV Ratio	60% LTV Ratio
1970	441	477	45	78.28	96.81	99.79
1971	445	492	43	95.25	99.61	99.98
1972	470	508	48	98.99	99.91	99.99
1973	510	523	52	99.82	99.98	99.79
1974	648	538	55	99.97	100.00	100.00
1975	761	553	58	100.00	100.00	100.00
1976	956	568	62	100.00	100.00	100.00
1977	1,312	583	64	100.00	100.00	100.00
1978	1,463	599	67	100.00	100.00	100.00
1979	1,672	614	70	100.00	100.00	100.00

B. DATA PERIOD: 1970–1989

Time (Year)	Actual Land Value ($)	Expected Land Value ($)	Standard Deviation ($)	Probability of Full Recovery (%) 80% LTV Ratio	70% LTV Ratio	60% LTV Ratio
1990	1,265	1,587	698	67.13	73.80	79.63
1991	1,313	1,642	689	73.15	78.80	83.62
1992	1,382	1,696	732	77.26	81.71	85.53
1993	1,393	1,751	769	81.01	84.46	87.43
1994	1,503	1,806	801	84.41	86.99	89.24
1995	1,638	1,861	830	87.43	89.29	90.92
1996	1,710	1,916	857	90.07	91.33	92.46
1997	1,782	1,971	883	92.33	93.11	93.83
1998	1,917	2,026	907	94.21	94.63	95.03
1999	2,025	2,080	931	95.74	95.90	96.07

C. DATA PERIOD: 1990–2002

Time (Year)	Expected Land Value ($)	Standard Deviation ($)	Probability of Full Recovery (%) 80% LTV Ratio	70% LTV Ratio	60% LTV Ratio
2003	2,763	291	70.71	92.63	98.66
2004	2,860	313	88.41	97.19	99.40
2005	2,957	335	95.97	98.92	99.72
2006	3,054	356	98.66	99.58	99.86
2007	3,151	376	99.55	99.83	99.93
2008	3,248	396	99.84	99.93	99.97
2009	3,345	416	99.94	99.97	99.98
2010	3,442	435	99.98	99.99	99.99
2011	3,539	455	99.99	99.99	100.00
2012	3,636	474	100.00	100.00	100.00

Note: Assumes a fixed interest rate of 10%.

is comparatively higher due to a faster decline of loan balance and higher annual payment of principal plus interest.[4]

Loan Portfolio Effects

The PFRs reported in Tables 2 and 3 are determined at the loan level. Lenders, however, hold portfolios of loans that differ on average in maturity, size, and other characteristics. Consequently, the portfolio PFR levels are a weighted average of the loan-level PFRs using the respective loan balances as the weights.

To illustrate, we take the simplified approach of considering a portfolio of farm mortgage loans with steady-state characteristics such that all loans have 10-year maturities and interest rates of 10%, with 10% of the loans maturing each year. Maturing loans are replaced by new loans of the same size, interest rate, repayment, and maturity characteristics. The PFRs are found by determining how many standard deviations the average loan balance is below the mean, and calculating the cumulative probabilities associated with this *z*-value under different economic situations. The analysis will provide a basic framework in lenders' risk management by way of diversification over time of the loan portfolio.

In the illustrations to follow, the respective measures are on a per dollar of loan basis to further generalize the scope of potential applications. As shown in Table 4, under the constant payment schedule plan, the portfolio loan balance for the 10-year average maturity is the average of the outstanding balances at 11 points in time—the time point zero balance of $1.00, time point 1 balance of $1.10 prior to the amortized payment of $0.1627, time point 2 balance of $1.031, and so on to a prepayment loan balance of $0.1627 at the end of year 10. The average loan balance for the 11 time points is $0.7184 for the constant payment method compared to an average balance of $0.6409 for the constant payment on principal schedule.

Using the Illinois data from Table 2 for a loan-to-value ratio of 0.80 and average coefficient of variation of

$$0.164 = \left[\sum_t \sigma_t \Big/ \sum_t EV_t \right],$$

the average balance per dollar of loan is

$$LB = (\$1.00)(0.8)(0.7184) = 0.5747.$$

This average loan balance is 2.59 standard deviations below the mean ($z = 2.59 = (1 - 0.5747) \div 0.164$). The probability of land values exceeding this loan balance (the PFR) is 99.39%.

As for the constant payment on principal case, given the same average coefficient of variation of 0.164 and continuing with a 0.80 loan-to-value ratio, the average balance per dollar of asset value is then calculated as:

$$LB = (\$1.00)(0.8)(0.6409) = 0.5127.$$

This average loan balance is 1.56 standard deviations below the mean ($z = 2.97 = (1 - 0.5127) \div 0.164$), yielding a PFR of 99.78%.

Comparisons Across States

The final step in the analysis is to replicate the application of the portfolio methodology to the largest farm/gross revenue-generating states in seven additional ERS production regions and to the different time periods cited earlier. The added states are comprised of Arkansas, California, Colorado, Nebraska, Pennsylvania, Tennessee, and Texas. Included are calculations of expected growth and variability of land values in each state and time period, together with the same lending terms and steady-state specifications. For simplicity, however, the results are reported only for the loan-to-value ratio of 0.80.

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[4] This result is based on implied independence between LGD and PD; i.e., higher payments early in the life of the loan are not expected to increase the probability of default.

Table 4. Portfolio Loan Balance Under Two Payment Schedules (per $ of loan basis)

	Constant Payment Schedule				Constant Payment on Principal Schedule			
Time (Year)	Beginning Balance	Principal Payment	Interest Payment	Pre-payment Loan Bal.	Beginning Balance	Principal Payment	Interest Payment	Pre-payment Loan Bal.
0				1.0000				1.0000
1	1.0000	0.0627	0.1000	1.1000	1.0000	0.1000	0.1000	1.1000
2	0.9373	0.0690	0.0937	1.0310	0.9000	0.1000	0.0900	0.9900
3	0.8682	0.0759	0.0868	0.9551	0.8000	0.1000	0.0800	0.8800
4	0.7923	0.0835	0.0792	0.8715	0.7000	0.1000	0.0700	0.7700
5	0.7088	0.0919	0.0709	0.7797	0.6000	0.1000	0.0600	0.6600
6	0.6169	0.1011	0.0617	0.6786	0.5000	0.1000	0.0500	0.5500
7	0.5159	0.1112	0.0516	0.5675	0.4000	0.1000	0.0400	0.4400
8	0.4047	0.1223	0.0405	0.4452	0.3000	0.1000	0.0300	0.3300
9	0.2825	0.1345	0.0282	0.3107	0.2000	0.1000	0.0200	0.2200
10	0.1480	0.1480	0.0148	0.1627	0.1000	0.1000	0.0100	0.1100
Average				0.7184				0.6409

The relative magnitudes of differences in PFRs for the other loan-to-value ratios will be similar to the Illinois results reported above.

The PFRs for these states are reported in Table 5 for the full 52-year study period of 1950–2002, and for the three subperiods of 1950–1969, 1970–1989, and 1990–2002. The columns denoted "average coefficients of variation" assume a mean land value of one and standard deviations represented by the values in the respective corresponding columns. As anticipated, the PFRs are higher in those states with lower volatilities of land values given the same time period, are higher for steady growth periods of land values, and are higher for constant payment on principal schedules given the lower average loan balance.

To illustrate, for the constant payment method and the 1950–2002 conditions, the PFRs range from a low of 87.81% in Tennessee (with the highest relative variability in land values) to 99.92% in Texas. The higher volatility period of 1970–1989 yields PFRs ranging from 82.51% in Illinois to 99.95% in Pennsylvania. For these examples, the PFRs show a greater response to changing variabilities among time periods than to differences among states, although the ranking of state-level PFRs may change as well.

Discussion

This analysis has been conducted on the basis of three factors. First, the event of default for a farmland collateral loan does not necessarily induce loan loss due to relatively low levels of loss-given-default. Second, the value of farmland as collateral is non-depreciable. And finally, the probability of full recovery is dynamically investigated. In this sense, the study may provide some insights on the credit risk management and capital adequacy assessment in agricultural lending.

For example, the value of assets as collateral is random, and we need to consider the variability in collateral values when calculating loss-given-default (LGD) in capital adequacy assessment. Meanwhile, the initial loan-to-value ratio is also needed in calculating potential LGD. The value is determined dynamically as shown in the paper. Agricultural lending is characterized by "high capital intensity especially involving farm real estate" (Barry, 2001, p. 115). Lower levels of LGD, and thus required capital, are lower for the

Table 5. Probability of Full Recovery (PFR) of Loan Balance for Steady-State Loan Portfolios in Selected States from U.S. Production Regions (80% initial loan-to-value ratio)

	A. DATA PERIOD: 1950–2002			B. DATA PERIOD: 1950–1969		
	Average Coefficient of Variation	PFR (%)		Average Coefficient of Variation	PFR (%)	
State		Constant Payment	Constant Payment on Principal		Constant Payment	Constant Payment on Principal
Arkansas	0.165	99.36	99.76	0.226	96.11	97.68
California	0.202	98.00	99.03	0.055	100.00	100.00
Colorado	0.192	98.44	99.29	0.152	99.35	99.72
Illinois	0.164	99.39	99.78	0.103	99.96	99.99
Nebraska	0.147	99.72	99.92	0.183	98.32	99.15
Pennsylvania	0.242	95.77	97.54	0.240	95.22	97.03
Tennessee	0.361	87.81	90.87	0.258	94.08	96.15
Texas	0.128	99.92	99.98	0.136	99.68	99.88

	C. DATA PERIOD: 1970–1989			D. DATA PERIOD: 1990–2002		
	Average Coefficient of Variation	PFR (%)		Average Coefficient of Variation	PFR (%)	
State		Constant Payment	Constant Payment on Principal		Constant Payment	Constant Payment on Principal
Arkansas	0.299	91.27	93.85	0.139	99.50	99.78
California	0.196	97.72	98.78	0.048	100.00	100.00
Colorado	0.272	93.14	95.41	0.035	100.00	100.00
Illinois	0.442	82.51	85.69	0.120	99.77	99.90
Nebraska	0.358	87.37	90.36	0.150	99.24	99.65
Pennsylvania	0.106	99.95	99.99	0.140	99.48	99.77
Tennessee	0.163	99.05	99.57	0.146	99.35	99.70
Texas	0.182	98.38	99.18	0.199	97.29	98.45

non-depreciability of farmland value. This non-depreciable property also implies an increasing pattern of PFRs over the loan period for a farmland collateral loan. We cannot expect the same pattern to occur for a collateral loan on a depreciable asset that is common in other industries.

Credit risks do not completely originate from the borrower. Rather, they are determined by likelihood of default and by loan characteristics including the value of collateral such as the price of farmland. Therefore, information between the borrower and the lender is not completely asymmetric. The lender can take advantage of open-market information about the value of the collateral. A precise forecast of the collateral value is essential to provide accurate estimation of the loss-given-default component of possible loan loss.

The tendencies for the probabilities of full recovery to exceed 80% early in the loan period and 90% thereafter indicate that loss-given-default rates on farm real estate loans are relatively low even considering different economic situations. Each dollar of loan entering default is likely to recover more than 80% of its value or, conversely, lose less than 20% of its value. The LGD rates can be even higher at the portfolio level, reflecting the mix of loan maturities at any point in time. These magnitudes are consistent with the non-depreciability of farmland, its expectation to increase in value over time, and the reduction in debt due to the borrower's periodic repayments of principal. These low rates of loss-given-default compare favorably to those of other sectors. They also explain why relatively high rates of loan default in agriculture may be offset by low rates of loss-given-default, thus moderating the overall loss rates experienced by agricultural lenders.

The portfolio analysis occurs within a certain structure of term and size of loans over time, although the results generalize to longer terms, lower loan-to-value ratios, and more rapid repayment alternatives. The results also provide a framework for evaluating LGDs of loan portfolios with varied size structures. For example, an overall lower loan-to-value ratio would be preferred in keeping a desired level of PFRs against the economic conditions similar to those of 1970–1989, while increasing loan size by a higher loan-to-value ratio could occur in lower volatility periods like 1990–2002.

In the above estimation, past patterns of changes in land value show a tendency for land values to grow over time, and the estimated model is obtained by using average market prices at the state level. However, the collateral position faced by farmland lenders is usually local-market specific, and land values may not be the same as the average market values. Application of the methods employed in this study requires consideration of specific situations to obtain ideal results. Moreover, in portfolio management, accurate prediction of the aggregate economic situation is also important, even key, to successfully lower total credit risk.

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Business Start-Up Survival Challenges and Strategies of Agribusiness and Non-Agribusiness Entrepreneurs

Cesar L. Escalante and Calum G. Turvey

Abstract

The increasing demand for highly differentiated products in today's enterprise economies has emphasized the small firms' comparative advantage over larger firms. Business mortality rates, however, remained very high among more vulnerable start-up businesses still in their earliest stage of business development. The challenges experienced by agribusiness entrepreneurs and their counterparts from other industries in their start-up years are analyzed using case-study research techniques. Results indicate that highly differentiated start-up conditions between industries and among firms usually resulted in varied survival strategies. Notable differences include pricing policies dependent on market structures, more consultative management styles, inadequate start-up resources, and preferences for brand new equipment.

Key words: entrepreneurship, execution deficiency, innovation, market segmentation, product differentiation, product diversification, specialist or niche marketing, undercapitalization

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Global economic trends have transformed some of the world's advanced economies into enterprise economies (Ibrahim and Goodwin, 1986). Factors such as rapid technological change, innovation, and globalization have created a new economic imperative in these economies: a shift in demand from standardized to highly differentiated products, and the agricultural and food system is no exception.

Under this economic environment, small firms have a competitive advantage over larger firms (Burns, 2001). The less bureaucratic, more flexible operating structures of small businesses allow them to quickly adapt and respond to innovative advances in production, marketing, and other areas of operations. Moreover, larger firms ignore investment areas for highly specialized products whose limited market potential poses a constraint to the attainment of optimal production scale and profits. The small firms then step in to fill in these market gaps.

Despite their growing importance, small businesses face a difficult challenge in overcoming barriers in their early years of operation to be able to survive. Business mortality rates have always been highest among more vulnerable start-up business ventures that are still in the earliest stage of business development (Litvak and Maule, 1971).

This paper is dedicated to two facets of the business survival problem analyzed from the perspectives of agribusiness and non-agribusiness entrepreneurs. Using a case-study research approach, this study seeks to identify common barriers to growth and survival experienced by entrepreneurs during the early start-up years. Second, it provides profiles of strategies employed to cope with business survival.

The case-study research was conducted in Ontario, Canada, in the mid-1990s among six entrepreneurs from within the agricultural and food sector and, for comparison, six from outside the industry. The case studies permit an assessment of the barriers and opportunities for entrepreneurial growth in rural areas while providing storylines for presenting real-world case studies on entrepreneurship.

Moreover, this study is designed to determine any distinguishable differences between entrepreneurs in the agricultural and food sector and those from other industries. The logical expectation is that start-up conditions could be different for agribusiness ventures given the industry's exposure to greater uncertainty and volatility of business conditions attributed to weather, technological change, market structures, and financing constraints, among various sources of farm business risks.

The remainder of the paper proceeds as follows. In the next section a general start-up business paradigm is discussed, outlining the growth and survival barriers, along with a set of expected strategic decisions addressing such barriers. The real-life business experiences of the entrepreneurial cases are then analyzed and agribusiness and non-agribusiness venture situations are compared. The paper ends with summary remarks and conclusions.

A Hypothetical Entrepreneurial Strategy Model

A prototype of small business start-up cases is developed here by putting together early business survival barriers, in combination with a hypothetical set of strategies, cited in the literature. The ideas and concepts compiled in this analysis were derived from a wide geographical range of entrepreneurial experiences from Canadian, American, and European sources. The constraints they faced and the strategies they employed are summarized in Table 1 and separately discussed in this section under four functional areas: (*a*) management, (*b*) marketing, (*c*) production, and (*d*) finance.

Management

Survival efforts of small businesses can be impeded by the entrepreneur's execution and skill deficiencies. A study conducted by the Advisory Council for Applied Research and Development (ACARD) in the United Kingdom (UK) explains the execution deficiency barrier as the entrepreneurs' shield against potential threats to their personal control and prestige (Bosworth and Jacobs, 1989). Kets de Vries (1985) views this issue from a psychological perspective where the entrepreneur's overwhelming desire for recognition is transformed into an obsession with control. Empirical evidence from Canadian (Litvak and Maule, 1971) and U.S. (Alpander, Carter, and Forsgren, 1990) firms suggests that entrepreneurs in general are indeed reluctant to delegate tasks within their firms.

Managerial incompetence can also arise from skill deficiencies. Knight (1981) developed a hierarchy of entrepreneurial management styles which progressed from the craftsperson level, to the promoter, and ultimately the general manager level, at which the entrepreneur possesses all qualities of the lower two levels. Incompetence arises when the entrepreneur's skills conform only to either of the two lower skills levels in his hierarchy.

Similar to Knight's management style hierarchy, Lyons (2002) introduced the entrepreneurial league system (ELS) which refutes the contention that "successful entrepreneurs possess certain innate

Table 1. Barriers and Strategies in the Start-up Phase

Functional Area	Start-up Barriers	Strategic Action
A. Management	Execution deficiency	▸ Substantial delegation to subordinates
	Skill deficiency	▸ Democratic/consultative management ▸ Hiring external consultants
B. Marketing	Large, established competitors	▸ Specialist/niche marketing ▸ Product diversification ▸ Competitive pricing strategies ▸ Product promotion
C. Production	Low labor quality	▸ Latent labor shortage ▸ Formal in-house training
	High labor turnover	▸ Formal in-house training
	Inadequate facilities	▸ Second-hand equipment ▸ Equipment leasing ▸ Subcontracting
	Limited in-house technology (single-track production)	▸ External, technical consultancy services
D. Finance	Undercapitalization and liquidity constraints	▸ Ownership sharing ▸ External credit ▸ Inventory, receivable, and payable management

Source: Authors' adaptation of published findings in the literature.

traits" (p. 4) and recognizes differences in skill levels possessed by entrepreneurs (these include, in their hierarchical order, technical, managerial, entrepreneurial, and personal maturity skills) when they first embark on their business ventures. Lyons' framework emphasizes skill building where entrepreneurs progress through the ELS stages, patterned after the professional baseball league system, as experience and maturity accumulate. It follows from Lyons' model that entrepreneurs categorized in the Rookie League (the lowest level in the ELS) are primarily challenged with significantly more execution and skill deficiencies needing to be resolved in order for them to catch up with the Single A, Double A, Triple A, and Major Leaguers.

Management strategies designed to address such barriers include the formation of management teams within the business, as verified by Hoad and Rosko (1964) in their study focusing on Michigan firms. Stevens (1988) justifies such strategy by emphasizing linkages between increased revenues (and profits) and decisions to adopt job delegation and collegial management strategies. O'Neill and Duker (1986) provide empirical evidence from small firms in Connecticut that correlate the use of external advisors and the small firms' successful operations.

Marketing

Start-up firms often have to deal with market competitors who are relatively larger in size and have already established some reputation in the industry. These large competitors' dominant market presence allows them to enjoy captive markets for their products. As Hoad and Rosko (1964) clarify, however, it is not necessarily correct to blame the failure of a business on the effects of more established competition. Rather, failure may instead be attributed to the owners' lack of aggressiveness, poor marketing abilities, and substandard workmanship. The following marketing strategies are usually prescribed for owners of fledgling firms who are trying to gain entry into a new market.

Specialist or niche marketing strategies, which could be either market- or product-based, are commonly prescribed to address marketing concerns. A market-based specialist marketing strategy requires a market segmentation approach that entails the division of a market into homogeneous consumer groups and tailoring the marketing mix for specific target markets. McGee (1989), in the UK ACARD study, describes market segmentation as the conventional recommendation to small firms, although he warns that conditions within an industry must allow the existence of segmented and protectable markets.

In contrast, a product-based niche marketing strategy requires product differentiation—a strategy where a product is modified and enhanced to differentiate it from the competitors' products to produce a more attractive and unique appeal to potential customers. Among small firms, product differentiation usually can be achieved through good product engineering and development or by emphasizing the "non-price elements of the marketing mix" (McGee, 1989; Burns, 2001) such as more personalized services that could be customized to suit each individual customer's needs and preferences. However, certain market niches could sometimes offer limited revenue potentials for a start-up firm. In this case, small firms could consider employing product or service diversification strategies to mitigate the market's revenue limitation (Burns, 2001; Knight, 1981).

In addition to specialist or niche marketing strategies, certain pricing policies (such as offering price discounts) can be made to translate prices into more effective revenue-generating tools (Knight, 1981; Bruce, 1976). Moreover, small firms should not overlook the long-term investment value of promotional campaigns (Karlson, 1994). Findings of empirical studies indicate a direct correlation between investments in marketing campaigns and the resulting market share of the promoter's products (O'Neill and Duker, 1986).

Production

An entrepreneur usually has to deal with a myriad of production issues related to human and physical resource supply and endowments in the early years of business operations. These concerns often require serious considerations of tradeoffs between what the start-up firm can afford given its financial capability and what the envisioned production plan requires in order to offer high-quality, competitive products in the market.

The prevalent labor concerns among small firms are low quality and high turnover of labor. Bosworth, in the ACARD study in the UK (1989), confirms that new small firms indeed are often obliged to employ unskilled (low quality) workers who can be paid at wage rates affordable to the new business. Correspondingly, Barber, Metcalfe, and Porteous (1989) cite high labor turnover as a common phenomenon among start-up firms primarily due to these firms' inability to offer competitive wage rates.

The inadequacy of start-up facilities is also a serious concern among start-up firms. Karlson (1994) notes that new firms tend to allocate more of their limited start-up financial resources to money-making activities like marketing and promotions instead of setting up adequate facilities. The new firm is also constrained to operate under limited in-house technology. El-Namaki (1990) identifies a single-track approach among Dutch firms in his study whereby there is a tendency to depend on a single product and technology combination.

Among possible strategies for addressing labor quality and turnover concerns, Barber, Metcalfe, and Porteous (1989) recommend the latent labor shortage strategy. The strategy entails downgrading of production technology to coincide with the workforce's skill level in order to avoid problems of overcoming actual shortages of skilled labor. Bosworth (1989) also recommends the implementation of formal in-house training programs with higher "firm-specific content" as a way of locking the employees into the small firm for a certain period of time.

Davidson (1988) prescribes either the purchase of second-hand equipment or the property lease option to address the issue of inadequate start-up facilities. This strategy will allow the start-up firm to avoid huge capital investment outlays necessary for setting up the required physical plant for production and operations. Knight (1981) suggests new firms could consider subcontracting a portion of production to other suppliers while the more expensive production facilities are not yet in place.

Examining the issue of limited in-house technology, Barber, Metcalfe, and Porteous (1989) note that small firms could access external technology either through production subcontracting arrangements or availing of services provided through external consultants. Knight (1981) also proposes that new small firms should consider buying from suppliers certain intermediate products needed for the production of their final outputs during the early stages of business operations, and gradually move into the production of such products over time.

Finance

The entrepreneur's reluctance to share ownership, in combination with the firm's limited access to credit, creates financial constraints for the new small firm which, in turn, cause operational difficulties. Business control issues preclude equity investors as possible sources of additional funds for the firm. Inadequate credit histories and collateral properties are translated to poor credit risk ratings for the new small firm, influencing lenders' decisions to deny most of these entrepreneurs' loan applications.

Meanwhile, liquidity conditions during the start-up years could deteriorate due to, among other factors, low initial revenue levels (during the market introduction phase of the firm's new product), slow collection of receivables (since a longer collection period could be used as a marketing ploy to generate customer interest in the product), and difficulty in obtaining credit from input suppliers (again for the same reasons that new firms are unable to obtain credit from institutional lenders). As a result, the funding requirements within the start-up firm could increase due to these cash flow-related problems. Specifically, the firm may end up undercapitalized because funding available from owners' equity investments and limited external debt sources fall short of the actual funding requirements.

A logical strategy for addressing undercapitalization in the early business start-up years is the sharing of ownership with other prospective investors. This strategy, however, will require the entrepreneur to give up some business control—usually a difficult, sensitive issue for entrepreneurs. Moreover, the small firm might wish to consider starting at a reasonable size/scale and ensure that prudent financial controls (for inventory, receivable, and payable management) are in place to manage its cash position at all times.

Agribusiness versus Non-Agribusiness Entrepreneurs

The incidence and relevance of these start-up barriers and business survival strategies, which have been derived from empirical models with general business applications, are expected to vary among entrepreneurs from agribusiness and non-agricultural sectors. Agricultural businesses often are more challenged to deal with highly risky business situations than businesses in other industries. Business risks in agriculture due to weather and pest infestations, among other risks, could cause wide swings in farm production. Moreover, farm producers must confront additional risks caused by fluctuating resource and commodity prices. Lenders are cognizant of the risky nature of farm operations, and hence are known to be more cautious about lending to farmers. In this research we recognize these structural differences between the agricultural and non-agricultural sectors. Specifically, our analysis tests the hypothesis that the barriers to the survival of new firms in the agribusiness sector are qualitatively different from those experienced by non-agribusiness firms.

Even when agribusiness and non-agribusiness entrepreneurs confront the same set of start-up business barriers, a set of predictable strategies is unlikely to be identified that would be employed by both of these classes of businessmen. In a 2003 workshop conducted by the Henry A. Wallace Center for Agricultural and Environmental Policy, participants agreed that farmers in general are risk intolerant, resistant to change, and do not consider themselves as business people. In a paper presented at this same workshop, Macke (2003) noted that while "[farmers and ranchers] have significant entrepreneurial traits ... they lack competencies in marketing, business management, product development, and networking" (p. 13).

In this research, we investigate these differences as we validate the hypothesis that the strategies for overcoming barriers to business survival employed by agribusiness entrepreneurs are qualitatively different from those pursued by non-agribusiness entrepreneurs.

Research Method

The case-study approach is used in this analysis to develop individual profiles of start-up business barriers and the strategies employed by entrepreneurs in surviving the difficult start-up phase of their business operations. The case-study approach has often been criticized for its lack of rigor and statistical base, and has traditionally been relegated as a teaching tool (Kennedy and Luzar, 1999). The case-study approach, however, provides an alternative method for analyzing research issues that have "more variables of interest than data points ... [by using] replication logic, [instead of] sampling logic" (Kennedy and Luzar, p. 584).

The approach is ideal for answering more of the "how" and "why" questions than the more objective queries and predictive analysis often employed by statistically based models (Yin, 1994). Howard and MacMillan (1991) elaborate on this point by arguing that the case-study method would be able to clearly identify the research problem and produce generalizations, exploratory problem-solving techniques, and insights/ relationships not suggested by theory.

This method is appropriate for our research given the uniqueness of each entrepreneurial experience of start-up business conditions. Moreover, personality differences among entrepreneurs could define various action plans for coping with challenges, consequently reducing the need for general growth or survival paradigms outlining ready-made solutions for the entrepreneurs. Baetz and Beamish (1993) aptly describe the entrepreneurial problem as rarely being solved by one right decision, or by implementing just one optimal or approved plan of action.

This study analyzes the experiences of 12 entrepreneurs in Southern Ontario. The sample has an even composition of firms involved in agribusinesses and those affiliated with industries outside of agriculture. All these firms were established around the mid-1980s to the early 1990s. The six agribusiness cases were engaged in equipment manufacturing, marketing, production, and consultancy services at the time this research was undertaken. The set of six non-agribusiness firms belonged to the glass, human resource, computer, and hardware industries. To maintain anonymity of the respondents, the firms will be identified in this study as "agribusiness firms #1 to #6" and "non-agribusiness firms #1 to #6."

The interviews for the case studies were conducted with the founding owners of the participating firms. A list of interview questions, formulated to include the barriers presented in the earlier section and summarized in Table 1, focused on the conditions of the business start-up years (approximately the first five years of operation). The respondents were asked to validate the existence of the barriers identified in this study in their own start-up business experiences and discuss the strategies they employed to address such difficulties.

Case reports were written for each firm based on the interview transcripts, and were reviewed by the interviewees for accuracy and proper representation. The following section provides a summary of the salient information compiled from the case studies.

The Barriers to Business Survival

Table 2 provides a summary of the business start-up conditions related to management, marketing, production, and finance recognized by respondents as barriers to the survival of their business during its early years of operation. The list of barriers in this table coincides with the list provided in column 2 of Table 1. The following discussions compare and contrast the experiences of the agribusiness and non-agribusiness entrepreneurial cases featured in this study.

In the area of general business management, most of the agribusiness entrepreneurs experienced execution and skill deficiencies. In contrast, these were not the major concerns of the majority of their non-agribusiness counterparts. Agribusiness firms tended to start with smaller scale operations due to the competitive structure of their industry (which will be corroborated later by marketing-related information). As a result, the entrepreneurs did not feel the need to organize management teams more complex than their initial one-person start-up teams. The non-agribusiness entrepreneurs, on the other hand, had more extensive previous work experience which provided them with more training and skills in different areas of management and business operations. Thus, they encountered fewer skill deficiency problems than the agribusiness entrepreneurs.

The two groups of entrepreneurs operated under contrasting market structures. In devising their marketing plans, most of the agribusiness entrepreneurs were faced with relatively smaller firms as competitors, while the non-agribusiness firms generally were in competition with larger, more established market rivals.

Among the production issues discussed with the respondents, labor-related problems were not prevalent within either group of entrepreneurs. A more common concern for both groups was the inadequacy of business start-up facilities. In general, these firms initially operated relatively small businesses and later felt the pressure to expand as new target markets were identified. The pressure to expand was apparently more significant among non-agribusiness firms whose rivals were larger market competitors.

In the area of finance, non-agribusiness firms reported more concerns about undercapitalization and liquidity than did their agribusiness peers. This trend is a result of the structure of the industries under which they operated. Again, larger market competitors created the pressure for these start-up firms to consider immediate expansion plans entailing larger investment cost outlays. Moreover, illiquid conditions arose from more aggressive marketing plans implemented by the non-agribusiness firms that involved more sale discounts and favorable collection terms as a means to compete effectively in the market.

Table 2. Start-up Conditions of Respondent Firms

	Agribusiness Firms						Non-Agribusiness Firms					
Barriers to Business Survival	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**
A. Management												
‣ Execution deficiency	✓	✓	✓		✓							
‣ Skill deficiency	✓	✓		✓		✓	✓				✓	
B. Marketing												
‣ Large estab'd competitors		✓					✓	✓	✓	✓		
C. Production												
‣ Low labor quality	✓	✓			✓				✓			✓
‣ High labor turnover		✓			✓							✓
‣ Inadequate facilities	✓	✓	✓		✓	✓			✓	✓	✓	✓
‣ Single-track production												
D. Finance												
‣ Undercapitalization	✓	✓					✓		✓		✓	✓
‣ Liquidity constraint	✓	✓					✓		✓	✓		✓

Survival Strategies

Faced with these barriers, the entrepreneurs devised strategies to survive through the first few years of operation. The following discussions outline the operating plans implemented by the respondents in each of the four functional areas.

Management

Table 3 presents a tabulation of management-related difficulties experienced in the start-up years and their corresponding solutions as implemented by the respondents. Execution deficiency, a condition dominant among the agribusiness firms, was usually resolved through higher levels of job delegation among subordinates. As observed from Table 3, one agribusiness entrepreneur (firm #1), however, still insisted on monopolizing the management tasks and responsibilities.

Letting go of some tasks and relying on employees to perform them has not been easy for most of the respondents. Non-agribusiness entrepreneur #2 articulated this hesitation by explaining that the subordinate would probably just "produce as much as he does." Non-agribusiness entrepreneur #5 worried about product quality and thought about some mechanism to "[double check] what [goes out] of the door." Nonetheless, agribusiness entrepreneur #5 felt "burned out" and realized he "just could not be superman who could do everything." This realization and the goal of expanding operations were the overwhelming motivations for the entrepreneurs who decided to delegate certain tasks (which were mostly backroom operations), giving them the freedom to visit clients and attend to their managerial responsibilities.

Skill deficiency was resolved through a more democratic style of management that fosters skill complementation and allows for a consultative type of interaction between the entrepreneurs and their employees. For instance, agribusiness entrepreneur #4 practiced empowerment where key employees made daily business decisions, except for important strategic issues assigned to formal meetings for deliberation.

Table 3. Management Barriers and Strategies Employed by Respondent Firms at Start-up

A. EXECUTION DEFICIENCY MATRIX	Agribusiness Firms		Non-Agribusiness Firms	
Strategies:	With Execution Deficiency	No Execution Deficiency	With Execution Deficiency	No Execution Deficiency
‣ Substantial delegation of tasks to subordinates	Firm #2 Firm #3 Firm #5	Firm #4 Firm #6		Firm #1 Firm #3 Firm #5 Firm #6
‣ Little or no delegation of tasks to subordinates	Firm #1			Firm #2 Firm #4

B. SKILL DEFICIENCY MATRIX	Agribusiness Firms		Non-Agribusiness Firms	
Strategies:	With Craftsperson and/or Promoter Skills Only	With General Manager Skills	With Craftsperson and/or Promoter Skills Only	With General Manager Skills
‣ Democratic, consultative type of management	Firm #2 Firm #4 Firm #6	Firm #5	Firm #1 Firm #5	Firm #3 Firm #6
‣ Autocratic management style	Firm #1	Firm #3		Firm #2 Firm #4

Non-agribusiness entrepreneur #1 ensured the success of the empowerment approach by "hiring the best people [that his] company's money can buy." Non-agribusiness entrepreneurs #3 and #5 started out with management teams consisting only of their business partners, but later expanded these teams to include other key employees.

Interestingly, eight of the respondents (four from each business group) adopted this management style, although only five from this group had skill deficiency problems. Notably, the agribusiness firms resorted to more informal consultations with their key employees while the consultation process among the non-agribusiness firms was more formal and structured (e.g., formation of management teams). In contrast, four entrepreneurs (three of whom possessed general manager skills) were more autocratic and remained the sole decision makers of their respective firms.

Marketing

The matrix of marketing problems and strategies is presented in Table 4. In general, the entrepreneurs' decisions to adopt production, marketing, and pricing policies were usually dictated by the size and structure of their market competition. Most non-agribusiness firms employed product specialization, niche marketing, and aggressive pricing policies to compete with larger, more established firms. Agribusiness firms, on the other hand, implemented product diversification strategies and sold their products at low-to-moderate prices to compete with smaller, less established market players.

All five agribusiness firms having to compete with businesses that were relatively new in the industry, had no commanding presence yet in the market, and were relatively of the same size as the respondent firms, chose to diversify their production in order to be able to offer a wider range of products and services to

Table 4. Marketing Barriers and Strategies Employed by Respondent Firms at Start-up

A. Product and Marketing Matrix	Agribusiness Firms		Non-Agribusiness Firms	
Strategies:	**Smaller Market Competitors**	**Larger, Well Established Competitors**	**Smaller Market Competitors**	**Larger, Well Established Competitors**
▸ Specialist product/niche marketing		Firm #2	Firm #5 Firm #6	Firm #1 Firm #3 Firm #4
▸ Product diversification	Firm #1 Firm #3 Firm #4 Firm #5 Firm #6			Firm #2
B. Pricing Matrix	**Agribusiness Firms**		**Non-Agribusiness Firms**	
Strategies:	**Smaller Market Competitors**	**Larger, Well Established Competitors**	**Smaller Market Competitors**	**Larger, Well Established Competitors**
▸ Competitive (low to moderate) pricing	Firm #3 Firm #4 Firm #5 Firm #6			
▸ Aggressive (moderate to high) pricing	Firm #1	Firm #2	Firm #5 Firm #6	Firm #1 Firm #2 Firm #3 Firm #4

their target clientele. Agribusiness entrepreneur #1, for instance, immediately went back to the drawing board to design and develop six more products after his first invention received favorable market attention. Agribusiness entrepreneur #3 ventured into offering financial consultancy services, in addition to his primary line of business.

Only non-agribusiness firm #2, with larger market competitors, employed the product diversification strategy out of necessity. The firm initially worked on contracts from commercial establishments, but problems with receivable collections prompted the owner to diversify into residential projects to resolve cash-flow shortfalls.

The remaining agribusiness firm, along with three non-agribusiness firms faced with more established market competitors, opted to sell a highly differentiated product/service and implemented a niche marketing strategy. The goal of product differentiation was to offer products with quality enhanced by technological inputs, the service component, or both, which the market competitors would find difficult to duplicate. Examples of this strategy include agribusiness entrepreneur #2, whose firm gave up its illusion of being a "full-line seed company" and instead focused on developing its proprietary variety of soybeans, which, after all, was "what [his company] knows best!"

Non-agribusiness entrepreneur #3 concentrated on market segments that "were too small for the competition" and maintained a smaller product line to preserve the edge of having "higher knowledge on [their] products." Non-agribusiness entrepreneurs #5 and #6, who had smaller market competitors, also adopted the specialist product/niche marketing strategy by adding "customized, personalized services" for each product sold to every client, which for them was "a conscious attack against [their] mass marketing competitors."

Four of five agribusiness firms with small market competitors implemented pricing policies that probably coincided with their rivals' practices. These firms charged low to moderate prices to attract more new clients. On the other hand, all firms dealing with large competitors (four non-agribusiness and one agribusiness) charged moderate to high prices. Except for non-agribusiness firm #2, these are the same firms that introduced highly differentiated products under a specialist/ niche marketing scheme. For instance, agribusiness firm #2 charged a premium price for its high-quality seeds, which tested well for vigor and high germination rate. Non-agribusiness entrepreneur #3's pricing depended on the hassle factor where "high hassle accounts" were priced higher than good clients.

Two exceptions to the diversification-competitive pricing combination are agribusiness firm #1 and non-agribusiness firm #2, both of which implemented aggressive pricing policies. Agribusiness entrepreneur #1 revealed he would usually "test the waters by raising the price anytime" and take signals from the market on whether or not further price increases were warranted. Non-agribusiness entrepreneur #2 claimed he won contract bids regardless of his 5% mark-up in materials' prices because of his firm's reputation for getting projects done in the shortest possible time frame.

Production

While labor-related concerns such as low labor quality and high turnover rates were not cited as serious concerns by the majority of the respondents, the entrepreneurs implemented preventive measures by conducting both formal and informal in-house training programs (Table 5). Most of the interviewees considered formal training programs as a "lock-in mechanism" for ensuring the trained employees would continue working for their businesses for a certain period of time. The entrepreneurs interviewed provided informal on-the-job or hands-on training to most workers.

The popular notion that small firms would start business operations with more affordable second-hand or leased equipment was not supported by the responses obtained in this study, even though a total of nine respondents (five agribusiness and four non-agribusiness entrepreneurs) acknowledged the inadequacy of their start-up facilities. Among these firms, only one firm (agribusiness firm #1) considered a downgrade in production technology, while three other firms (all agribusinesses) resorted to subcontracting a portion of their production because start-up facilities were inadequate to sustain market demand. Interestingly, four of the six agribusiness firms resorted to at least one of the three strategies (purchase of used equipment, leasing, and subcontracting) to remedy the inadequacy of start-up facilities compared to only two (firms #3 and #6) of the six non-agribusiness firms (Table 5). Most of the non-agribusiness respondents cited obsolescence and non-familiarity with the used equipment as their primary reasons for purchasing new machineries instead.

Finance

Regardless of industry affiliation and initial capitalization condition, the majority of firms expressed willingness to share ownership and use external credit to increase available capital for their start-up businesses. Of the six firms claiming to have inadequate capital ("undercapitalized") during their start-up years, four (three non-agribusiness and one agribusiness) considered inviting business partners to obtain much needed equity capital investments (Table 6). Two other undercapitalized firms (one for each business group) continued to value highly their independence and control of business power and remained reluctant to raise equity capital from prospective investors.

Table 5. Production Barriers and Strategies Employed by Respondent Firms at Start-up

A. Labor Quality Matrix	Agribusiness Firms		Non-Agribusiness Firms	
Strategies:	Low Labor Quality	Adequate Labor Quality	Low Labor Quality	Adequate Labor Quality
▸ In-house training	Firm #1 Firm #2 Firm #5	Firm #3 Firm #4 Firm #6	Firm #3 Firm #6	Firm #1 Firm #2 Firm #5
▸ External training	Firm #1 Firm #2	Firm #3 Firm #4 Firm #6		Firm #5
B. Labor Turnover Matrix	**Agribusiness Firms**		**Non-Agribusiness Firms**	
Strategies:	High Labor Turnover	No Turnover Issues	High Labor Turnover	No Turnover Issues
▸ In-house training	Firm #2 Firm #5	Firm #1 Firm #3 Firm #4 Firm #6	Firm #6	Firm #1 Firm #2 Firm #3 Firm #5
▸ External training	Firm #2	Firm #1 Firm #3 Firm #4 Firm #6		Firm #5
C. Facilities Matrix	**Agribusiness Firms**		**Non-Agribusiness Firms**	
Strategies:	Inadequate Facilities	Adequate Facilities	Inadequate Facilities	Adequate Facilities
▸ Used equipment purchase	Firm #5	Firm #4	Firm #3	
▸ Equipment leasing	Firm #3		Firm #3	
▸ Subcontracting	Firm #1 Firm #2 Firm #5		Firm #6	

As a result, initial capital cost outlays for these two firms were reduced through adjustments in the original business plans. Specifically, agribusiness firm #1 resorted to downgrading of production technology, while non-agribusiness firm #6 subcontracted some production to other suppliers.

Those entrepreneurs who were reluctant to share ownership of their firms agreed that business partners only complicate decision-making and profit-sharing arrangements, as "unequal partnerships could bring frustrations to the hard-working minority owner." Those who welcomed investors into their businesses cited the advantage of complementary skills that could be offered by the new partners and the need for more capital to be infused in order for their business to grow. As non-agribusiness entrepreneur #1 explained, he would rather own 16% of a $50 million company than 76% of a bankrupt company.

Table 6 also provides a tabulation of the respondents' perception of the use of external credit as a possible remedy to the firms' financing needs. All undercapitalized

Table 6. Financial Barriers and Strategies Employed by Respondent Firms at Start-up

A. Ownership Sharing Matrix	Agribusiness Firms		Non-Agribusiness Firms	
Strategies:	**Under-capitalized**	**Adequately Capitalized**	**Under-capitalized**	**Adequately Capitalized**
▸ Has shared ownership and is willing to share ownership in the future	Firm #2	Firm #5 Firm #6	Firm #1 Firm #3 Firm #5	
▸ Reluctant to share ownership	Firm #1	Firm #3 Firm #4	Firm #6	Firm #2 Firm #4
B. External Debt Use Matrix	**Agribusiness Firms**		**Non-Agribusiness Firms**	
Strategies:	**Under-capitalized**	**Adequately Capitalized**	**Under-capitalized**	**Adequately Capitalized**
▸ Used external debt and is willing to consider external debt in the future	Firm #1 Firm #2	Firm #3 Firm #4 Firm #6	Firm #1 Firm #3 Firm #5 Firm #6	Firm #2
▸ Reluctant to apply for external debt		Firm #5		Firm #4

firms (four non-agribusiness and two agribusiness firms) expressed their intentions to borrow funds from institutional lenders, in the event their credit records would allow them to do so.

Five of six firms in each group had incurred debts previously, although some of their experiences with lenders had not been favorable. For example, non-agribusiness entrepreneur #6 stated she received a call from her banker demanding payment as she lay in her hospital bed waiting to undergo surgery. Non-agribusiness entrepreneur #1 was traumatized as he went from being a millionaire to being bankrupt when his Canadian banker gave him only 30 days to settle his $3 million loan. Two other respondents (agribusiness firm #5 and non-agribusiness firm #4) refused to consider external debt financing. They disliked the idea of "signing [their] life away [to lenders]" who would "lean their heads on [their] shoulders" to dictate what they should and should not do with their firms.

Firms that experienced liquidity problems (i.e., most non-agribusiness firms) had to periodically scrutinize the activities of their expenditure accounts to identify cost items which could be deferred, reduced, or removed. The popular remedy had been for the entrepreneurs themselves to make the biggest sacrifice by receiving reduced or zero pay during critical periods of low liquidity. The input suppliers were also usually contacted to negotiate for either the postponement or restructuring of their trade payable accounts. The respondents considered these latter two strategies as very effective for resolving liquidity problems.

Summary and Conclusions

Through a case-study approach, this analysis provides a microscopic view of the challenges faced by entrepreneurs from the farm and non-farm sectors. Our findings indicate that start-up conditions tend to be qualitatively different between firms belonging to the two industry groups as well as among firms within these groups. Execution and skill deficiencies tend to be more prevalent among agribusiness entrepreneurs. Non-agribusiness firms, on the other hand, often are faced with larger, more established market competitors, are more pressured to implement immediate expansion plans, and hence are more prone to experiencing liquidity and funding shortfalls.

The agribusiness owners interviewed in this study have shown certain tendencies to adopt specific action plans that did not always coincide with those implemented by their non-agribusiness counterparts. For instance, non-agribusiness owners tended to resort to more formal, consultative decision-making procedures, usually involving the creation of management teams. Agribusiness firms, however, were less structured as they often conducted more informal consultations with their key employees. Their production, marketing, and pricing policies were most often dictated by the size and structure of their market competition.

For most non-agribusiness firms, product specialization, niche marketing, and aggressive pricing policies were appropriate and effective strategies for dealing with large market competitors. Agribusiness firms diversified their production and sold their products at low-to-moderate prices to compete with smaller, less established market players. Moreover, while inadequacy of start-up facilities was an overriding concern for a majority of the interviewees, agribusiness firms had shown a greater tendency to resolve the problem through acquisition of used equipment, leasing, and subcontracting options. In contrast, non-agribusiness firms persisted in using new machinery to avoid compromising product quality and production efficiency.

Although there appears to be a pattern of strategic responses among the firms in these two business groups, there have always been cases where strategies have been employed which deviate from the identified strategies peculiar to each group. These deviant cases are consistent with popular theories on entrepreneurship (such as Mischel's social learning person variables and Harre's situation act model) that recognize variability in entrepreneurial business decisions due to differences in personalities and situations (Chell, 1986). After all, as Mintzberg (1989) insightfully notes, the strategies that entrepreneurs choose to implement are usually reflective of their implicit vision of the world, which, in turn, is an "extrapolation of his or her own personality."

Future research efforts could focus on validating these results using a greater variety of qualitative research data, if not by statistical analytical techniques applied to a more extensive database of quantifiable measures of entrepreneurial business situations and strategic plans.

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Ledger Provision in Hog Marketing Contracts

David A. Hennessy and Donald Lien

Abstract

Price-dependent loan agreements at low interest rates have sometimes been included in North American hog sector long-term marketing contracts. We show that a general form of this stipulation can be viewed as a hybrid between a forward rate agreement and a bundle of commodity spot options. In some cases, the provision amounts to a commodity swap. These observations provide an approach to valuing the provision. Historical data are used to estimate expected payouts to the producer under the contract feature.

Key words: commodity option, contract production, forward rate agreement

Tighter integration in the North American hog production sector has given rise to unfamiliar risk-sharing and financing arrangements. In some cases, marketing contracts of up to 10 years duration specify that a downstream contractor, often a packing company, shares downside and upside market hog and feed price risks with the producer. In other cases, the contractor and producer agree to maintain a ledger account whereby the pair lends to each other at specified rates. The extent of transfers depends on how market hog and feed prices evolve over the contract duration.

These various provisions are not readily valued, and this has been a significant problem for the industry (Buhr, 2000; Lawrence and Vontalge, 2000). Producers will wish to know if the proposals do reduce risk and if expected returns are acceptable. Contractors will have the same concerns, but from their own perspective. Third-party lenders will seek to know the true nature of assets and liabilities of the entity they are financing. Even though third-party lenders generally prefer that a hog producer has a long-term contract (Godley, 1996), potentially large but poorly understood liabilities always concern financiers.

Quite apart from the implications for efficient planning, when contractual relations terminate then valuation of assets and obligations will be an issue in settlement. Valuation may also be important when designing and implementing public policy. The Livestock Mandatory Reporting Act of 1999 asserts that promoting price transparency in agricultural markets is U.S. federal policy.

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Yet the loan terms of some ledger contracts cloud the true price to be paid. In addition, some policy setters offer ledger-style interventions to producers. Continuing an intervention mechanism used in 1998–99, the provincial government in Saskatchewan made price-contingent loans available to hog producers over a period in 2003–04. The rate, prime, was lower than commercial rates available to small businesses.

The issue to be addressed in this analysis is the application of valuation methods in the derivative contracts literature to the valuation of contractually provided price-contingent loans in hog marketing contracts. Our work extends the observations reported by Unterschultz et al. (1998), and Shao and Roe (2003). Unterschultz et al. decomposed a popular feature of a hog marketing contract, the market hog price window, into a combination of a put and a call at the same maturity but different strike prices. Shao and Roe, focusing on price-averaging provisions in marketing contracts, modeled the conditions as Asian-Basket options.

Neither of these papers examined the main theme of this article—the valuation of ledger lending provisions in marketing contracts. In ledger contract provisions, commodity prices over the duration of the loan determine the directions and magnitudes of cash flows, while the principal must be repaid at contract maturity. In one contract we consider, whether the balance is repaid depends on the sign of the balance.

A literature does exist on valuation of loans where the repayment terms are conditioned on future commodity prices (Schwartz, 1982; Carr, 1987; Jin and Turvey, 2002). These papers have considered a bond in which the principal to be repaid depends upon the maturity price of a commodity. This is not the case for the instruments we seek to value since commodity prices determine loan amounts and not payment amounts.

The study most closely related to the present work is authored by Lien and Hennessy (forthcoming), who model recent Saskatchewan hog loan programs. There, by contrast with the ledger provision, the loans are only from one party (the province). In addition, the repayment schedule depends in an involved way on the evolution of cash prices.

In this article we show that ledger-style provisions can be viewed as hybrids between forward (interest) rate agreements and commodity spot options. For a particular contract offered by Morrell, the conditions amount to a commodity swap where the quantities underpinning the swap are determined by time to contract termination as well as the difference between the ledger interest rate and the market interest rates. These observations allow for valuation using standard derivative pricing and interest rate arbitrage arguments. An empirical methodology is implemented for assessing the value of the contract feature.

Valuing the Ledger Provision

Some relevant provisions of two ledger-style contracts offered by John Morrell & Co. and posted on the Iowa Attorney General's website (Iowa Attorney General) are studied. In both contracts, the true hog price paid is supplemented with a loan from the contractor to the producer when prices are below a reference price. The loan is paid off when prices are higher, and then a reserve balance may also be built up in anticipation of lower future spot prices.

Contract #1 settles the balance regardless of the sign of the ledger balance at contract termination, and we model this first. Contract #2, which was offered when problems arose with Contract #1, settles the balance only when the producer owes Morrell. This provision is modeled at the section conclusion. In each contract the interest rate is zero. The relevant parts of the contracts are provided in the appendix.[1]

Two-Way Settlement

Let $t = 0$ denote the current time with S_t as the time t spot price. A ledger contract expires at time $t = T$ in the future. Let $T = N\Delta$, and deliveries take place Δ time periods apart, i.e., at $t = n\Delta$, $n \in \{1, 2, ..., N\}$. In our analysis we normalize by assuming that one hundred weight (cwt) of live hogs is delivered at each of $t = n\Delta$, $n \in \{1, 2, ..., N\}$. The effect on cash flow is decomposed into a price floor effect and a price ceiling effect.[2]

The price floor F in the ledger contract generates the time $t = n\Delta$ cash flow for the producer as follows:

$$(1) \quad \pi_{n\Delta,F} = \begin{cases} S_{n\Delta} & \text{if } S_{n\Delta} > F, \\ F & \text{if } S_{n\Delta} \leq F. \end{cases}$$

When the spot price is greater than the floor, the producer receives the market price. On the other hand, if $S_{n\Delta} \leq F$, then $\pi_{n\Delta,F} = S_{n\Delta}$ and the producer would receive cash flow transfer $F - S_{n\Delta}$ from the contractor so that net cash inflow at time $t = n\Delta$ would be F, i.e., a floor on cash inflows would be set.

In contracts #1 and #2 (as provided in the appendix), the interest rate charged on the ledger account balance is zero. Let r denote the finite, instantaneous, market interest (and discount) rate to the producer at time t when quoted at the current time point. The time $t = n\Delta$ discounted value of $F - S_{n\Delta}$ paid at $t = T$ is $\exp[-r(T - n\Delta)](F - S_{n\Delta})$. Thus the actual present discounted payoff (at $t = n\Delta$) to the producer is:

$$(2) \quad \pi^*_{n\Delta,F} = \begin{cases} S_{n\Delta} & \text{if } S_{n\Delta} > F, \\ F - \exp[-r(T - n\Delta)](F - S_{n\Delta}) & \text{if } S_{n\Delta} \leq F. \end{cases}$$

The gain to the producer from a price floor is $\pi^*_{n\Delta,F} - S_{n\Delta} = Z(n\Delta, T)\max(F - S_{n\Delta}, 0)$, with $Z(n\Delta, T) = 1 - \exp[-r(T - n\Delta)]$. The latter represents the payoff from $Z(n\Delta, T)$ European put options with strike price F and maturity date $t = n\Delta$. The value of the price floor at $t = 0$ is $Z(n\Delta, T)p(F, n\Delta)$, where $p(F, n\Delta)$ is the premium for a European put option with strike price F and maturity date $t = n\Delta$. This calculation applies for all $n \in \{1, 2, ..., N\}$.

As a result, the total value of the price floor to the producer is:

$$(3) \quad V_F(t = 0) = \sum_{n=1}^{N} Z(n\Delta, T)p(F, n\Delta).$$

Clearly, $V_F > 0$. The agreement to provide loans in the future (a forward rate agreement) at zero interest rate is to the producer's advantage.[3]

On the other hand, a price ceiling K provides the following payoff to the producer: $\pi_{n\Delta,K} = S_{n\Delta}$ if $S_{n\Delta} < K$, and $\pi_{n\Delta,K} = K$ otherwise, at time $t = n\Delta$. Once again, the difference, positive or negative, will return to the producer at $t = T$. The actual payoff is expressed as:

$$(4) \quad \pi^*_{n\Delta,K} = \begin{cases} S_{n\Delta} & \text{if } S_{n\Delta} < K, \\ K + \exp[-r(T - n\Delta)](S_{n\Delta} - K) & \text{if } S_{n\Delta} \geq K. \end{cases}$$

Differencing, the loss to the producer from a price ceiling amounts to $\pi^*_{n\Delta,K} - S_{n\Delta} = -Z(n\Delta, T)\max(S_{n\Delta} - K, 0)$. This represents the payoff from $Z(n\Delta, T)$ written European call options with strike price K and maturity date $t = n\Delta$. The value of the price ceiling at $t = 0$ is $-Z(n\Delta, T)c(F, n\Delta)$, where $c(K, n\Delta)$ is the premium for a European call option with strike price K

[1] Our criterion for inclusion is that the excerpt pertains to cash flow. We do not model all of the many features in the ledger provisions of these contracts.

[2] In the Morrell contracts to be considered later in some detail, the ledger floor and ceiling prices are the same. In order to provide a more robust treatment of ledger-style accounts, we maintain the distinction for the moment.

[3] On forward rate agreements, see Hull (2005) or McDonald (2006).

and maturity date $t = n\Delta$. Again, this calculation applies for all $n \in \{1, 2, ..., N\}$. The total value of the price ceiling to the producer is:

$$(5) \quad V_K(t = 0) = -\sum_{n=1}^{N} Z(n\Delta, T)c(K, n\Delta),$$

which is always negative.

Finally, the value of a ledger contract is $V_L = V_F + V_K$; that is:

$$(6) \quad V_L(t = 0) = \sum_{n=1}^{N} Z(n\Delta, T)[p(F, n\Delta) - c(K, n\Delta)].$$

The expression $p(F, n\Delta) - c(K, n\Delta)$ represents the value of purchased collars (McDonald, 2006, p. 73). In Morrell Contract #1, $F = K = \$40$/cwt, while in Morrell Contract #2, $F = K = \$36$/cwt. If $F = K$, then the collar is said to have zero width and the ledger contract position represented in (6) reduces to loans and borrowings that are triggered by what might be viewed as a constant forward price. Forward-pricing relationships allow us to write (6) as:[4]

$$(7) \quad V_L(t = 0) = \sum_{n=1}^{N} \left(1 - \exp[-r(T - n\Delta)]\right) \times [F - F_{n\Delta,0}]\exp[-rn\Delta]$$
$$= \sum_{n=1}^{N} \left(\exp[-rn\Delta] - \exp[-rT]\right) \times [F - F_{n\Delta,0}],$$

where $F_{n\Delta,0}$ is the $t = 0$ forward price for the commodity. If the provision, when considered by itself, is fair, then $V_L(t = 0) = 0$ in (6).[5] Condition $p(F, n\Delta) \geq c(K, n\Delta)\ \forall\ n \in \{1, 2, ..., N\}$ would, were it true, ensure that the ledger provision has positive financial value to the producer at $t = 0$. The validity of this inequality on put and call value relations depends upon price distributions. After $t = 0$, the provision will likely assume positive or negative value as spot prices decrease or increase.

We have yet to place values on the options. Subject to acknowledging the true nature of the options, standard procedures may be applied. The options are on spot prices and one needs to be careful in modeling future commodity spot prices, especially with distant maturities. Equilibrium adjustments suggest that mean reversion, rather than standard geometric Brownian motion, is appropriate as a characterization of price stochastics. Hilliard and Reis (1998), and also Miltersen and Schwartz (1998), provide valuation procedures that accommodate commodity price mean reversion.[6]

A more problematic issue is that readily traded price contract markets of any kind are thin beyond three years forward. The contractor may have difficulty in setting off assumed risks because of low liquidity in spot and near-term forward markets. Grimes and Plain (2006) report that sales in hog spot markets have fallen to account for about 10% of total market hogs in early 2006. In this light, the assumption of risk-free arbitrage with spot markets is quite tenuous, although imperfect substitutes (processed meats) may be available. Valuation will depend upon the asset positions and risk preferences of the contract holder. Recent work, for example, by Hall and Murphy (2002) or Ammann and Seiz (2004), suggests ways of accounting for valuation when it is costly or impossible to eliminate risk.

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[4] When $F = K$, then ledger cash flows resolve to cash flows from a sequence of short forward contracts. A short forward contract with delivery price F, maturity date $n\Delta$ hence, and prevailing forward market price $F_{n\Delta,0}$, has value $[F - F_{n\Delta,0}]\exp[-rn\Delta]$ (see Hull, 2005, p. 108).

[5] One may wonder how the derivative compares with a commodity swap. Note first that any cash flows are not permanent claims on wealth, but rather loans. In addition, a commodity swap is really a package of forward contracts along a sequence of maturity dates. Equation (6) represents two packages along a sequence of maturity dates, one of purchased put spot market options and the other of written call spot market options. Equation (7) represents a package of forward contracts where the underlying quantity is $1 - \exp[-r(T - n\Delta)]$, increasing in r and decreasing in n.

[6] There is not a consensus on what, if any, stochastic laws commodity price processes follow. See Cashin, Liang, and McDermott (2000), as well as Cromwell, Labys, and Kouassi (2000), and Turvey (2004) for evidence against mean reversion.

A further issue we have not considered is default risk. The literature on measuring and mitigating exposure is large. We refer the interested reader to Duffie and Singleton (2003) on methodologies, but offer a comment about relevant aspects. Some contractors require that a reserve be built up as a ledger balance due the producer when prices are high (see Contract #1 in the appendix). This provision, which is not modeled here, performs like a futures market margin account in reducing contractor credit risk exposure.

One-Way Settlement

Attention is now turned to the contract provision whereby the contractor receives any balance owed in the ledger account but does not pay any balance owing at termination. Then the value of the ledger contract to the producer is equal to:

$$(8)\quad V_L(t=0) = V_A + \sum_{n=1}^{N} Z(n\Delta, T)\left[p(F, n\Delta) - c(K, n\Delta)\right],$$

where V_A is the value of a compound Asian option that provides the following payoff to the producer at $t = T$:

$$(9)\quad \pi_A = -\max\left[\sum_{n=1}^{N}\left[\max(F - S_{n\Delta}, 0) - \max(S_{n\Delta} - K, 0)\right], 0\right].$$

When $F = K$, then (8) simplifies in the manner of (7) while (9) simplifies to

$$(10)\quad \pi_A = -\max\left[NF - \sum_{n=1}^{N} S_{n\Delta}, 0\right].$$

Equation (9) is arrived at by first assuming that the two-way ledger account provision applies. After repaying any outstanding loans, the producer may also have to repay an amount at contract termination. If and only if the undiscounted accumulation of loans received in low-price spot markets, $\max(F - S_{n\Delta}, 0)$, exceeds the undiscounted accumulation of loan reversions in high-price spot markets, $\max(S_{n\Delta} - K, 0)$, then the difference is due to the contractor at maturity. Standard procedures to value Asian options involve Monte Carlo simulation because closed-form solutions are generally not possible. Procedures are outlined in Hull (2005) and in McDonald (2006).

While the two-way contract is offered independently, Morrell offered the one-way contract as a follow-up agreement to the two-way contract. Thus, if the producer pays down the existing ledger balance by 50%, he/she is entitled to the one-way contract for 36 months. A 75% (respectively, 100%) payment entitles the producer to a one-way contract of 42 (respectively, 48) months. The lender also agrees to reduce the amount of paydown by 10% and credit the ledger balance for the full amount. For example, with a $100,000 balance, then the producer needs to pay $45,000 (= $100,000 × 0.5 × 0.9) to be eligible for the 50% payment, $67,500 (= $100,000 × 0.75 × 0.9) to be eligible for the 75% payment, and $90,000 (= $100,000 × 1 × 0.9) to be eligible for the 100% payment.

In addition, two other distinctions between contracts warrant attention. Whereas $F = K =$ $40/cwt in the two-way contract, $F = K =$ $36/cwt in the one-way contract. Also, the Contract #1 price was the Iowa Minnesota plant practical top price on a three-day average prior to the kill date plus (+) $1/cwt, while the Contract #2 price was just the Iowa Minnesota weighted average price over the three prior days. Note that the two-way settlement ledger contract begins with a zero balance. A one-way contract most likely begins with a debt for the producer. Also, the producer may choose whether or not to enter a contract and which one to enter.

Empirics

In this section, we provide a simulation study to evaluate the values of the ledger contracts. It is assumed a ledger contract is written at the end of December 2002, and is effective from January 2003 to

December 2004. To simulate ex ante prices for this period, Iowa Southern Minnesota weekly average prices in \$/live cwt are collected on barrows and gilts from January 1972 to December 2002. A monthly average price series is then constructed by averaging four consecutive weekly prices to obtain 405 observations. Autoregressive time-series models are applied to examine the monthly price behavior.

More specifically, let p_t denote the price in month t. We examine the statistical behavior of $\Delta \log p_t = \log p_t - \log p_{t-1}$. Based upon the Akaike Information Criterion (AIC), an AR(4) model is chosen. The squared residuals, however, reveal the prevalence of conditional heteroskedasticity. Consequently, the GARCH (1,1) model is adopted to describe the error term. The estimated model is written as:

(11)
$$\Delta\log(p_t) = \underset{(0.0654)}{0.2627}\Delta\log(p_{t-1}) - \underset{(0.0622)}{0.1767}\Delta\log(p_{t-2}) - \underset{(0.0638)}{0.0677}\Delta\log(p_{t-3}) - \underset{(0.0489)}{0.1057}\Delta\log(p_{t-4}) + \varepsilon_t,$$

$$\sigma_t^2 = \underset{(0.0006)}{0.0013} + \underset{(0.0622)}{0.2152}\varepsilon_{t-1}^2 + \underset{(0.1465)}{0.5942}\sigma_{t-1}^2,$$

where numbers in parentheses are standard errors for the obvious parameter estimates, σ_t^2 is the conditional variance of ε_t, and e_{t-1} is the realized value of ε_{t-1}. Also, the estimated values for σ_{405}^2 and e_{405} are 0.0168 and -0.0671, respectively.

To generate the prices for N months in the future, the following procedure is adopted:

- N random samples are generated from a standard normal random variable. Denote these samples by $\{u_1, u_2, \ldots, u_N\}$.
- Next, obtain σ_{406}^2 from $\sigma_{406}^2 = 0.0013 + 0.2152 e_{405}^2 + 0.5942\sigma_{405}^2$. From this, generate $e_{406} = u_1\sigma_{406}$.
- The price in month 406 is calculated as follows:

$$p_{406} = p_{405}^{1.2627} p_{404}^{-0.4394} p_{403}^{0.1091} p_{402}^{-0.0380} \times p_{401}^{0.1057} \exp(e_{406}).$$

- Given σ_{406}^2 and e_{406}, calculate $\sigma_{407}^2 = 0.0013 + 0.2152 e_{406}^2 + 0.5942\sigma_{406}^2$, and obtain $e_{407} = u_2\sigma_{407}$.
- The price in month 407 is calculated as follows:

$$p_{407} = p_{406}^{1.2627} p_{405}^{-0.4394} p_{404}^{0.1091} p_{403}^{-0.0380} \times p_{402}^{0.1057} \exp(e_{407}).$$

- Repeating the above procedure, a price path of $\{p_{406}, p_{407}, \ldots, p_{405+N}\}$ is generated for the future N months.

Given a future price path, we can calculate the benefits of ledger contracts. Specifically, in month 406, the producer receives π_{406}, which equals:

(12)
$$\pi_{406} = \begin{cases} F & \text{if } p_{406} < F, \\ p_{406} & \text{if } F \le p_{406} \le K, \\ K & \text{if } p_{406} > K. \end{cases}$$

At the same time, a debt/savings account is established such that the account value in month 406, denoted by D_{406}, equals:

(13)
$$D_{406} = \begin{cases} p_{406} - F & \text{if } p_{406} < F, \\ 0 & \text{if } F \le p_{406} \le K, \\ p_{406} - K & \text{if } p_{406} > K. \end{cases}$$

In month 407, the producer receives π_{407}, which equals F if $p_{407} < F$, and K if $p_{407} > K$. Otherwise, $\pi_{407} = p_{407}$. Meanwhile, the debt/savings account value changes to:

(14)
$$D_{407} = \begin{cases} p_{407} - F + D_{406} & \text{if } p_{407} < F, \\ D_{406} & \text{if } F \le p_{407} \le K, \\ p_{407} - K + D_{406} & \text{if } p_{407} > K, \end{cases}$$

since no interest is charged on the debt. More generally, for any future month, 406 + n, the producer receives F when $p_{406+n} < F$, p_{406+n} when $F \le p_{406+n} \le K$, and K when $p_{406+n} > K$. The dynamics of the debt/savings account are described by:

(15) $D_{406+n} =$

$$\begin{cases} p_{406+n} - F + D_{405+n} & \text{if } p_{406+n} < F, \\ D_{405+n} & \text{if } F \le p_{406+n} \le K, \\ p_{406+n} - K + D_{405+n} & \text{if } p_{406+n} > K. \end{cases}$$

Under the ledger contract with a two-way settlement, the present value of total receipts is written as:

$$(16) \quad A = \sum_{n=0}^{N-1} (1+r)^{-n} \pi_{406+n} + (1+r)^{-N}(\pi_{406+N} + D_{406+N}).$$

Without the contract, the present value of total receipts is

$$C = \sum_{n=0}^{N} (1+r)^{-n} p_{406+n}.$$

The value of the two-way settled ledger contract is measured by $W = A - C$. In case of a one-way settlement beginning with a zero balance, the present value of the total receipts is:

$$(17) \quad B = \sum_{n=0}^{N-1} (1+r)^{-n} \pi_{406+n} + (1+r)^{-N} \times [\pi_{406+N} + \min(D_{406+N}, 0)],$$

and the value of the one-way settled ledger contract is measured by $V = B - C$.

We choose $N = 48$ and simulate 500 future price paths to derive 500 observations of W and V under different parameter configurations. The mean of the 24,000 (= 48 × 500) prices is 43.15 and the standard deviation (SD) is 10.18. Three parameter configurations for K and F are considered: (*a*) K = mean + 0.8(SD) and F = mean - 0.8(SD) - the benchmark case; (*b*) K = mean + 1.5(SD) and F = mean - 0.8(SD); and (*c*) K = mean + 0.8(SD) and F = mean - 1.5(SD). In addition, the rate paid on ledger balances is allowed to differ from zero. Table 1 provides the estimated values for W and V.

Table 1. Estimated Values of *W* and *V* (assuming zero initial balance)

PANEL A:

Parameter Values	K, F	W	V
$\bar{r} = 0$	51.29, 35.01	44.10	3.559
$r = 0.15/12$	58.42, 35.01	48.59	16.44
	51.29, 27.88	7.991	-37.20
$\bar{r} = 0$	51.29, 35.01	49.64	6.449
$r = 0.20/12$	58.42, 35.01	56.70	41.15
	51.29, 27.88	13.77	-12.37
$\bar{r} = 0.05/12$	51.29, 35.01	27.99	-26.32
$r = 0.15/12$	58.42, 35.01	35.02	5.316
	51.29, 27.88	4.487	-45.27

PANEL B: (β = 0.5)

Parameter Values	K, F	W	V
$\bar{r} = 0$	51.29, 35.01	23.00	3.753
$r = 0.15/12$	58.42, 35.01	25.20	13.43
	51.29, 27.88	5.090	-15.05

The empirical findings are in accord with intuition, and are summarized as follows: (*a*) As K increases, the values of one-way and two-way settlement ledger contracts both increase; (*b*) as F increases, the values of one-way and two-way settlement ledger contracts also increase; (*c*) when r increases, the values of one-way settlement and two-way settlement contracts both increase; and (*d*) as expected, the value of the one-way settlement contract is smaller than that of a two-way settlement contract.

Items (*a*), (*b*), and (*d*) are not empirical findings in that they are direct consequences of the cash flow structures we have modeled. Item (*c*) is an empirical finding in that the effect of an increase in the market interest rate will be beneficial to the party who tends to borrow. In this case, the grower tends to borrow.

For the purpose of comparison, we consider the case where the lender in the ledger account charges an interest rate of 5% per year. As is to be expected, when $\bar{r}$ increases, the values of one-way settlement and two-way settlement contracts are both found to decrease. In addition, suppose there is a liquidity sharing arrangement such that $\pi_t = F + \beta(p_t - F)$ when $p_t < F$; $\pi_t = p_t$ when

$F \le p_t \le K$; and $\pi_t = K + \beta(p_t - K)$ when $p_t > K$.[7]

Panel B in Table 1 reports the result for the case of $\beta = 0.5$. It is found that the liquidity sharing arrangement reduces the value of the two-way settlement contract. The value of the one-way settlement contract tends to increase if the value is negative and decrease if the value is positive. Thus, in the presence of a two-way contract, the producer prefers not to have a liquidity sharing component in the contract. A similar conclusion applies to a positively valued one-way contract because sharing tends to reduce access to the low interest rate loans that the ledger account supports. In contrast, if the one-way contract has a negative value, the producer prefers to have a liquidity sharing arrangement in the contract specification because the low interest rate loans tend to be in favor of the contractor.

To incorporate the contingent nature of the one-way settlement contract, we consider the following scenario. A two-way contract (Contract #1) expires after two years. At expiration, the producer with debts may choose one of three versions of Contract #2. The producer's three options are: (*a*) pay to the lender 45% of the debt, be credited with 50% paydown, and undertake a one-way contract for 36 months; (*b*) pay to the lender 67.5% of the debt, be credited with 75% paydown, and undertake a one-way contract for 42 months; or (*c*) pay to the lender 90% of the debt, be credited with 100% paydown, and undertake a one-way contract for 48 months.

To evaluate the value of the one-way contract, we consider four scenarios. In Scenario I, the producer must choose the first option. In Scenarios II and III, the producer must choose the second and third options, respectively. Scenario IV assumes that an indebted producer will choose the best among the three one-way contract options at expiration of Contract #1.

Table 2 presents the simulation results where Contract #1 sets $K = F = 40$, and Contract #2 sets $K = F = 36$. Relative to Table 1, one further adjustment was made. In accord with Contract #2 specifications, we set prices when Contract #2 commences as the three-day lagged mean price $\bar{p}_t = (p_t + p_{t-1} + p_{t-2})/3$.

From comparing panels A and B for W in Table 2, when $K = F = 40$, then the producer should prefer to exclude liquidity sharing arrangements in the two-way contract. The contingent one-way contracts reinforce this result. The minimum difference between the 12 entries in columns I–IV of Panel A and the corresponding entries in Panel B is 51.82. Another interesting finding, clear from comparing columns in Panel A, is that Scenario II is almost always the optimal paydown scheme for the producer. Specifically, the producer with debt at the expiry of the two-way contract should pay back 67.5% of the debt and enter a 42-month one-way contract. The value of this option is much larger than the other two options.

To understand why the 42-month contract should be preferred, note that a large percentage paydown increases the probability of the final account value being positive to the producer. In a one-way contract, the producer will not be able to extract any of this surplus. On the other hand, a small percentage paydown provides the producer with a short duration one-way settlement contract. A short duration contract has a lower value because the ledger contract charges zero interest. Trading off the two factors, the 75% paydown contract is on average most valuable to the grower. Other than that, the properties observed in Table 1 tend to prevail in Table 2 as well.

[7] These liquidity sharing provisions are not included in either Morrell contract. We model them because sharing features (for payment and not for loans) in contracts are common in other hog marketing contracts (see Unterschultz et al., 1998).

Table 2. Estimated Values of *V* (with contingent initial balance)

PANEL A:

Parameter Values	*W*	Scenarios I	Scenarios II	Scenarios III	Scenarios IV	*N*
$\bar{r} = 0$, $r = 0.15/12$	74.13	140.9	223.2	113.9	229.1	417
$\bar{r} = 0$, $r = 0.20/12$	77.55	153.7	216.7	132.0	221.5	406
$\bar{r} = 0.05/12$, $r = 0.15/12$	47.83	123.8	213.0	109.3	217.4	421

PANEL B: (β = 0.5)

Parameter Values	*W*	Scenarios I	Scenarios II	Scenarios III	Scenarios IV	*N*
$\bar{r} = 0$, $r = 0.15/12$	37.75	74.08	155.9	62.08	155.9	412
$\bar{r} = 0$, $r = 0.20/12$	38.73	78.66	140.3	69.43	140.3	418
$\bar{r} = 0.05/12$, $r = 0.15/12$	22.37	57.26	137.1	47.22	137.1	410

Notes: *W* is the corresponding value of the two-way contract that lasts for two years with $K = F = 40$, and *N* is the number of cases, out of 500 simulations, that the producer is in debt at the end of the two-way contract.

Conclusion

When compared with spot market trading, more opportunities exist for involved financial arrangements between trading parties when a formal contract supports the trades. In hog markets, contracting parties have traditionally had limited familiarity with assessing the financial implications of possible financial arrangements.

It should not be surprising that credit risks have materialized when commodity prices deviate significantly from anticipated levels. This article has considered variants on one financial arrangement, a ledger contract in which spot price dynamics can lead to low interest loans in either direction.

For the various parameters over which we have simulated, the ledger provision is generally found to be favorable to the grower. This is because the ledger balance tended to reflect debt owed to the contractor, and the interest rate was zero. If prudent growers have difficulty paying off the debt, they are also likely to have difficulty financing their operations absent the ledger provision. Stated differently, the problem with ledger accounts is not the ledger per se because the low interest rate actually reduced the extent of debt. Rather, it is with the terms of trade where the ledger account merely conveyed the message.

We have not addressed why contracting parties might include liquidity provisions when a variety of alternative approaches are available. It is our opinion that inquiries into motives for demanding ledger-style contracts are needed because they might provide telling insights on contractual relations in North American hog production.

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Appendix: Relevant Provisions of Two John Morrell & Co. Ledger Contracts

Extracts from Morrell Ledger Contract #1 (later referred to as MLC)

How the Program Works

"A participating producer agrees to sell 100% of his production of market hogs to Morrell for the contract period that this program is in effect. During this period, the contract price for the producer's hogs will not be less than an established floor of $40.00/cwt. Morrell will maintain a separate ledger account reflecting Morrell's purchase of market hogs from the producer. At the beginning of the contract period, the producer's ledger account will have a balance of zero but at any time during the contract period, the account may have a positive or negative balance."

"Whenever the market price of live hogs is less than or equal to the floor price, Morrell will pay the producer based on the $40.00/cwt floor price, and will reduce the balance of the producer's ledger account by the difference, if any, between the market price and the floor price per hundred weight of delivered hogs. Conversely, whenever the market price of live hogs is greater than the floor price, Morrell will first apply 100% of the difference between the market price and the floor price per hundred weight of delivered hogs to reduce or eliminate a negative balance, if any, in the producer's ledger account. If the ledger account does not have a negative balance (or as soon as the negative balance has been reduced to zero), Morrell will pay the balance of the market price to the producer, except that, whenever the balance of the market price payable to the producer (after reducing any negative balance in the producer's ledger account to zero) exceeds $43.00/cwt, Morrell will first apply 20% of the difference between the market price and $43.00/cwt to build up a reserve (i.e., a positive balance) in the producer's ledger account. The positive balance in the producer's ledger account will never be allowed to exceed an amount equal to $5.00 times the number of market hogs the producer has projected to produce over the contract period."

"At the end of the contract period, if the producer's ledger account shows a positive balance, then Morrell will pay this amount to the producer in cash, without interest, within 30 days; or, if the producer's ledger account shows a negative balance, then the producer will pay this amount to Morrell in cash, without interest, within 30 days."

Market Price Defined

"For purposes of this program, market price refers to the mid-morning (11:00 am) Iowa Minnesota plant practical top (as quoted on the DTN)[8] on a three-day average prior to the kill date plus (+) $1.00/cwt."

"All prices referenced herein are for plant-delivered market hogs at Morrell's facilities at either Sioux Falls, South Dakota, or Sioux City, Iowa."

Termination

"Morrell reserves the right to terminate a producer's right to participate in this program before the end of the contract

[8] DTN is an information platform operated by DTN, a company that sells near real-time market price information.

period if the producer defaults in his obligation to deliver 100% of his marketable production of market hogs or if he otherwise fails to perform any material obligations hereunder."

"Upon any such termination, if the producer's ledger account shows a positive balance, then Morrell will pay this amount to the producer in cash, without interest, within 30 days; or if the producer's ledger account shows a negative balance, then the producer will pay this amount to Morrell in cash, without interest, within 30 days."

Extracts from Morrell Ledger Contract #2 (also later referred to as MLC #2)

[This contract was represented as FOR DISCUSSION ONLY: SAMPLE FORMAT.]

Who May Participate

"Producers who are currently enrolled in either the MVP or MLC."[9]

How the Program Works

"1. Producers that pay down the existing ledger balance by 50% are entitled to participate in the MLC #2 Contract for 36 months.

2. Payment of 75% entitles them to an MLC #2 Contract of 42 months.

3. Payment of 100% entitles them to an MLC #2 Contract for 48 months.

4. Morrell will reduce the amount of paydown by 10% and credit the ledger balance for the full amount, i.e., $500,000 balance, 50% payment equals $250,000 less 10% ($25,000) equals $225,000 to qualify as 50% payment.

5. At the beginning of the new contract period, the producer's ledger account may have a carry forward balance from the existing contract.

6. The ledger balance due from the producer may be limited to a maximum of 100% of net worth or $15.00 per head based on delivered hogs."

Additional Requirements

"1. Producers agree to provide a copy of their most recent financial disclosure and annually thereafter unless requested with greater frequency.

2. Producer agrees to issue a Personal Guarantee for any debt due John Morrell & Co. arising from the ledger contract.

3. A participating producer agrees to sell 100% of his production of market hogs to Morrell for the contract period that this program is in effect. During this period, the contract price for the producer's hogs will be not less than an established price of $36.00/cwt. Morrell will maintain a separate ledger account reflecting Morrell's purchases of market hogs from the producer. At the beginning of the contract period, the producer's ledger account may have a balance of zero but at any time during the contract period, the account may only reflect a balance due Morrell or zero. It will not reflect a balance due the producer from Morrell."

"Whenever the market price, plus or minus premiums, of live hogs is less than or equal to $36.00/cwt, Morrell will pay the producer based on a $36.00/cwt price, and will increase the balance due Morrell on the producer's ledger account by the difference. Whenever the market price, plus or minus premiums, of live hogs is greater than $36.00/cwt, Morrell will apply the difference between the amount paid and $36.00/cwt to reduce or eliminate the balance due Morrell in the producer's ledger account."

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[9] MVP refers to a different contract with ledger provision that was offered by John Morrell & Co. A facsimile was available on the Iowa Attorney General website on May 14, 2006.

"At the end of the contract period, if the producer's ledger account shows a negative balance, then the producer will pay this amount to Morrell in cash, without interest, within 30 days."

Market Price Defined

"For purposes of this program, market price refers to the mid-morning (11:00 am) Iowa Minnesota weighted average (as quoted on the DTN) on a three-day average prior to the kill date."

"All prices referenced herein are for plant-delivered market hogs at Morrell's facilities at either Sioux Falls, South Dakota, or Sioux City, Iowa."

Termination

"Morrell reserves the right to terminate a producer's right to participate in this program before the end of the contract period if the producer defaults in his obligation to deliver 100% of his marketable production of market hogs or if he otherwise fails to perform any material obligations hereunder."

"Upon any such termination, if the producer's ledger account shows a balance due Morrell, then the producer will pay this amount to Morrell in cash, without interest, within 30 days."

Rates of Return on U.S. Farm Investments, 1940–2003: A Comparison of Imputed Returns versus Residual Income Approaches

Charles B. Moss, Ashok K. Mishra, and Kenneth W. Erickson

Abstract

The rate of return on farm assets is a key indicator of the profitability of farm sector investments. The residual income approach is most commonly used to estimate the returns to farm assets, farmland, and labor and management. However this approach may be sensitive to the underlying assumptions. This study examines the implications of the residual return assumption by using alternative formulations for computing the rate of return to farm assets. Specifically, we develop the rate of return on agricultural assets using an alternative imputation method. We demonstrate that the presence of multiple quasi-fixed factors implies the rate of return to farm assets may be understated by the residual income approach.

Key words: imputation method, quasi-fixity, residual income approach, returns to farm assets

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The rate of return on farm assets is a key indicator of the profitability of farm sector investments. It is estimated as the (percent) return per dollar invested in farm assets. Since investors and others compare the (historic) rates of return on farm versus nonfarm assets to help assess expected returns, it is important that these comparisons be conceptually valid. Rates of return and asset values must be estimated comparably (Erickson, Moss, and Mishra, 2004), and estimation procedures must accurately reflect the opportunity costs of productive factors (farm assets, labor, and management).

The first issue is straightforward. Rates of return must be compared either based on historic costs (cost basis) or on current market values. The second issue—conceptually valid pricing of assets—is more problematic and is the focus of this analysis.

Hottel and Gardner (1983) and Gardner (1992) discuss the difficulty in estimating returns attributable to farmland and capital, as well as returns to labor and management. There is no direct market observation for most of these returns. Since land and other capital assets are the most fixed factors, returns to labor and management are typically imputed, with the returns to farm assets (land and other capital) as the residual claimant. This allocation of total returns to farm assets and operators' labor and management is based on the assumption that each factor is paid the value of its marginal product.

From an economic context, farmland is a quasi-fixed asset whose value cannot be instantaneously varied. As such, the instantaneous price of farmland and of other quasi-fixed assets may not truly reflect their value of marginal products. If this is the case, then estimates of the profitability of farm sector investments will be mis-stated.

Several procedures are used to infer the return to farm assets. One of these procedures is the residual income approach. By this method, the rate of return to farm assets is measured as gross returns to agriculture less all other expenses. This approach is sensitive to additional assumptions, namely that all other quasi-fixed assets besides farmland (such as farm machinery, labor) earn a return equal to their market-based opportunity costs. The residual income approach forces all disequilibria in agriculture into the farm asset market (e.g., farmland, farm machinery).

This paper examines the evidence for such distortions using historical balance sheet and income data. Specifically, we develop the rate of return on agricultural assets (farmland and non-farmland) using an alternative imputation approach. This involves estimating the return to farm assets through an imputation (rather than as a residual claimant) and estimating the returns to labor and management as the residual income claimants. In the next section, the theory of Ricardian rents and returns to quasi-fixed factors is presented.

Euler Theorem, Ricardian Rents, and Returns to Quasi-Fixed Factors

Since net farm income includes more than just a return to land, Melichar (1978, 1979) derives a return to land plus other production assets. Melichar's "residual return to assets" equals net farm income less the imputed returns to management and family labor. Hottel and Gardner (1983) argue that measuring returns as a residual creates inevitable choices among alternative procedures, none of which are exactly suitable, and yet they make a substantial quantitative difference.

As noted by Phipps (1984), Ricardian rent theory posits that the residual return accrues to the most fixed factor, land. However, agricultural land has many alternative uses. A nonzero opportunity cost of farmland has important implications for the relationship between farmland prices and farm-based returns. A further review of this literature can be found in Schmitz (1995); Moss (1997); Melichar (1978, 1979, 1984); Hottel and Gardner (1983); Doll and Widdows (1982); Phipps (1982, 1984); and Moss and Schmitz (2003).

The literature suggests that farmland values are determined by market fundamentals or returns and discount rates in the long run, but farmland values are subject to boom-bust cycles in the short run (Featherstone and Moss, 2003). Recent attempts to understand this phenomenon have focused on transaction costs (Chavas and Thomas, 1999; Chavas, 2003; Lence and Miller, 1999; Lence, 2003; Miller, 2003).

An alternative explanation for the presence of short-run deviations involves the disequilibria in the returns to other quasi-fixed assets (i.e., labor and machinery). This section develops the impact of these disequilibria on the typical valuation formula using the Euler theory result from production economics. The general approach is similar to the quasi-fixity formulation of Mishra, Moss, and Erickson (2004).

The Euler theorem was initially developed as a part of the debate regarding the distribution of returns across factors of production. Clark (1923) and Wicksteed (1933) used the Euler theorem result to infer that the distribution of factor returns generated by the market was optimal. It is important to note that application of its theoretical results requires constant returns to scale and perfect competition.

The significance of the assumption of constant returns to scale will become evident below, while the significance of perfect competition is discussed by Robinson (1934).

Euler's theorem implies that under constant returns to scale and competitive markets, the revenue from production is completely exhausted if each factor is paid the value of its marginal product. Specifically, Euler's theorem can be stated as:

$$(1) \qquad t^{k-1} f(x) = \sum_{i=1}^{N} \frac{\partial f(tx)}{\partial x_i} x_i,$$

where t is any positive number, $f(x)$ is a function homogeneous of degree k, and the x_i ($i = 1, \ldots, n$) are real valued variables. In an economic context, $f(x)$ is a production function mapping n inputs (x_i) into a single output. The production function is usually assumed to be homogeneous of degree one, implying constant returns to scale. Therefore,

$$(2) \qquad t f(x) = \sum_{i=1}^{n} \frac{\partial f(tx)}{\partial x_i} x_i,$$

leading to the typical explanation that doubling all inputs results in a doubling of output. Taking the limit of equation (2) as $t \to 1$, and multiplying each side by the output price yields:

$$(3) \qquad p f(x) = \sum_{i=1}^{n} p \frac{\partial f(x)}{\partial x_i} x_i.$$

Finally, using the profit-maximization condition that the value of the marginal product, $p(\partial f(x)/\partial x_i)$, for each input equals its input price at optimum,

$$(4) \qquad p f(x) = \sum_{i=1}^{n} r_i x_i,$$

where r_i is the price of the ith input.[1] Equation (4) implies that under constant returns to scale and competitive markets, the revenue from production is completely exhausted if each factor is paid the value of its marginal product.

The Euler theorem result in equation (4) has implications for the rate of return to farmland (as well as other fixed factors). Specifically, if we let input 1 through $n-1$ be variable inputs, and input n represent the quasi-fixed inputs, the appropriate factor payment for farmland and other fixed inputs can be derived by subtracting the payments to other factors from gross returns:

$$(5) \qquad r_n x_n = p \frac{\partial f(x)}{\partial x_n} x_n = py - \sum_{i=1}^{n-1} r_i x_i.$$

Letting $x_n \to 1$, or evaluating the return to farmland per acre, the value of marginal product for each acre of farmland is equal to gross sales less the amount paid for other factors of production. The mathematical result presented in equation (5) is consistent with the traditional concept of Ricardian rent and farmland values—i.e., Ricardian rent typically defines the amount remaining after all variable factors have been paid their market price as the return accruing to the most fixed factor, farmland. Further, the market value of farmland is typically assumed to be the present value of these expected or future Ricardian rents.

One approach to estimating the return to farmland and other farm assets based on equation (5) is to subtract the imputed returns to labor and management from total factor returns. This approach, referred to as the residual income approach, is subject to several caveats. Some of the most general caveats involve the assumption of constant returns to scale and competitiveness of input and output markets. These assumptions follow directly from the Euler theorem derivation. Further, a more nebulous assumption may be the implicit assumption that all other inputs are variable. Specifically, a critical assumption in the derivation of the residual income methodology is that all other factors (labor and management) are

[1] The firm-level optimization problem can be stated as follows:

$$\max_x \; p f(x) - \sum_{i=1}^{n} r_i x_i,$$

which implies n first-order conditions for optimality.

paid their value of marginal product. However, if more than one quasi-fixed variable is used in the production process, it may fail to earn its value of marginal product. This failure introduces an error term in the residual value equation, causing the value of quasi-fixed factors (land and other fixed assets) to be mis-stated.

Another approach to estimating the return to farmland and other non-farmland assets is to impute the return to farm assets and then subtract this from total factor returns. Based on the recommendation of one reviewer, we imputed the return to farm assets by summing the imputed returns to farmland and non-farmland assets. Returns to farmland were calculated by multiplying the (net) cash rent to value of farmland ratio and the value of farmland (see Table 1 for details). Returns to non-farmland assets were calculated by multiplying the value of non-farmland assets (such as machinery, buildings, and equipment) to the T-bill rate. The imputed return to farmland and non-farmland assets is a proxy for the opportunity cost of farm investments (Table 1).

Returning to equation (4), we assume that two inputs are quasi-fixed (land $i = n$, and labor $i = n - 1$). The residual return expression in equation (5) is then reformulated as:

$$(6)\quad r_n x_n = p \frac{\partial f(x)}{\partial x_n} x_n = py - \sum_{i=1}^{n-2} r_i x_i - p \frac{\partial f(x)}{\partial x_{n-1}} x_{n-1},$$

where x_{n-1} is the level of the labor input. Normalizing on the return per acre yields:

$$(7)\quad p \frac{\partial f(x)}{\partial x_n} = p \frac{y}{x_n} - \sum_{i=1}^{n-2} r_i \frac{x_i}{x_n} - p \frac{\partial f(x)}{\partial x_{n-1}} \frac{x_{n-1}}{x_n} = p\bar{y} - \sum_{i=1}^{n-2} r_i \bar{x}_i - p \frac{\partial f(x)}{\partial x_{n-1}} \bar{x}_{n-1},$$

where $\bar{y}$ is the output yield per acre and $\bar{x}_i$ is the input use per acre. Next, we add and subtract the market price per acre times the labor use per acre, yielding:

$$(8)\quad p \frac{\partial f(x)}{\partial x_n} = p\bar{y} - \sum_{i=1}^{n-2} r_i \bar{x}_i - r_{n-1}\bar{x}_{n-1} - \left(p \frac{\partial f(x)}{\partial x_{n-1}} - r_{n-1} \right) \bar{x}_{n-1} = p\bar{y} - \sum_{i=1}^{n-1} r_i \bar{x}_i - \left(p \frac{\partial f(x)}{\partial x_{n-1}} - r_{n-1} \right) \bar{x}_{n-1}.$$

Equation (8) then depicts the measurement error given that the value of marginal product for a second quasi-fixed input is not equal to its market price. If the quasi-fixed input is constrained below its optimum, the residual return methodology overstates the rate of return to farmland. On the other hand, if the quasi-fixed input exceeds its optimum, the residual return methodology understates the rate of return to farmland.

The measurement error in equation (8) has implications for the valuation of farmland if farm labor is also quasi-fixed. Following the general model presented by Schmitz (1995), the value of farmland can be derived by first differencing the present-value formula as:

$$(9)\quad \Delta V_t = - \frac{E[CF_t \mid \Omega_{t-1}]}{1 + r_t} + \frac{r_t}{1 + r_t} V_t + \gamma_t,$$

where V_t is the value of farmland at time period t, ΔV_t is the first difference in farmland per acre, $E[CF_t \mid \Omega_{t-1}]$ is the expected cash flow in period t given the information available in period $t - 1$, r_t is the interest rate in period t, and γ_t represents the change in expectations. This formulation yields two sets of testable hypotheses. The first hypothesis is that farmland values are based on expected returns in the long run. Under this scenario, observed cash flows are used in place of expected cash flows. Thus, equation (9) is reestimated as:

$$(10)\quad \Delta V_t = \beta_0 + \beta_1 \frac{CF_t}{1+r_t} + \beta_2 \frac{r_t}{1+r_t} V_t + \nu_t,$$

where β_0, β_1, and β_2 are estimated parameters, and ν_t is a random error term. Under long-run assumptions, farmland is appropriately priced if $\beta_0 = 0$, $\beta_1 = -1$, and $\beta_2 = 1$. Schmitz (1995) reports that these parameter values cannot be rejected at any conventional confidence level. Thus, farm asset values appear to be appropriately priced in the long run. The second set of asset valuation conditions is based on the assumption that no information remains in the error term, or that γ_t is not systematic. Schmitz rejects this hypothesis, finding the residual in equation (11) contained significant information.

Integrating the results from equation (8) into the present-value formulation presented in equation (10) yields:

$$(11)\quad \Delta V_t = \beta_0 + \beta_1 \frac{CF_t + \varepsilon_t}{1+r_t} + \beta_2 \frac{r_t}{1+r_t} V_t + \nu_t,$$

where ε_t is the measurement error introduced by the quasi-fixity of labor. Given our expectation that $E[\varepsilon_t] = 0$, or that the value of the marginal product of quasi-fixed assets is equal to the observed market value in the long run, this reformulation is consistent with Schmitz's basic results on the long-run consistency of farm asset values.

The question then arises: Is the introduction of measurement error a possible explanation for the persistence of short-run correlations? The answer to this question involves the time-series nature of measurement error. If the measurement error persists over time, then the measurement error could contribute to the existence of short-run violations of the capitalization model.

An alternative to formulating the imputed value approach to farmland and non-farmland assets would be to derive the imputed value of labor from equation (6), as follows:

$$(12)\quad r_{n-1}x_{n-1} = p\frac{\partial f(x)}{\partial x_{n-1}} = py - \sum_{i=1}^{n-2} r_i x_i - p\frac{\partial f(x)}{\partial x_n} x_n .$$

Normalizing on x_{n-1}, the imputed value of labor can then be calculated as:

$$(13)\quad p\frac{\partial f(x)}{\partial x_{n-1}} = p\frac{y}{x_{n-1}} - \sum_{i=1}^{n-2} r_i x_i - p\frac{\partial f(x)}{\partial x_n}\frac{x_n}{x_{n-1}} = p\tilde{\tilde{y}} - \sum_{i=1}^{n-2} r_i \tilde{\tilde{x}}_i - p\frac{\partial f(x)}{\partial x_n}\tilde{\tilde{x}}_n,$$

where $\tilde{\tilde{y}}$ is defined as the output per unit of labor, and $\tilde{\tilde{x}}_i$ is the relative input per unit of labor. As in the valuation of farm assets, we can add and subtract the market price of farmland (i.e., the net cash rent) to yield:

$$(14)\quad p\frac{\partial f(x)}{\partial x_{n-1}} = p\tilde{\tilde{y}} - \sum_{i=1}^{n-2} r_i x_i - r_n \tilde{\tilde{x}}_n - \left(p\frac{\partial f(x)}{\partial x_n} - r_n\right)\tilde{\tilde{x}}_n .$$

Equation (14) depicts the impact of disequilibria in the farmland market (i.e., difference between the cash rental market for farmland and the true marginal value of farmland) on the imputed value of labor.

Data and Methods

Data are USDA/Economic Research Service's farm sector estimates of returns to farm business assets, labor, and management over the period 1940–2003. We examine the residual return assumption by using alternative formulations for computing the rate of return to farm assets and the return to farm labor and management. First, the residual returns to farm assets are estimated after imputing the returns to operators' labor and management [equation (8)]. Second, a return to farm assets is imputed and returns to operators' labor and management are estimated as the residual income claimant [equation (14)]. The methodology and steps used in calculation of various returns, as well as data sources, are presented in Table 1.

Pricing of the Labor and Management Inputs

The residual returns to farm assets equals total returns to all factors less the imputed returns to farm labor and management [i.e., the imputed return to farmland presented in equation (8)]. Labor's return is estimated as the average price of farm labor (hired and unpaid family labor) times labor hours [USDA/National Agricultural Statistics Service (NASS)]. Management's return is estimated as 5% of the sum of cash receipts plus net inventory change plus government payments minus livestock and feed purchases. But what is the appropriate price for labor and management? A well-defined market for operators' labor and management does not exist; hence, the option of using actual market prices does not exist. The choice involves selecting a suitable proxy for the true opportunity cost of operator labor and management.

As noted by Melichar (1984), published USDA data for income imputed to operators' labor and management appear to have substantially understated the value of farm labor performed by operators and unpaid family labor. Further, Melichar (1979) reported that (over the last 25 years) the proportion of the total return to operators' labor dropped from 63% to 17%, while the proportion of the total return to production assets rose from 25% to 69%.

Rates-of-return estimates for agriculture depend on imputing a wage rate to the farmer's own labor use. The USDA/ERS uses a wage rate equal to the hired farm worker's wage rate. Schultz (1972); Phipps (1982); Hottel and Gardner (1983); Gardner (1992); and Huffman (1996) independently conclude that the average wage rate for hired farm labor almost surely underestimates the opportunity cost of farmers' time. Huffman (1992) adds that raising the farmers' imputed wage rate to incorporate managerial effort and capacities reduces the measured return to investment by about 2%. This is because farm operators and members of their households have on average a much larger stock of human capital than do their hired farm workers.

Phipps (1982) also suggests the related problem of factor immobility must be considered. If there is an excess of labor and other resources in the farm sector (due to transaction costs of shifting resources, imperfect information, segmented labor markets), the marginal product, and consequently the wages of labor, would be lower than its opportunity cost in other sectors of the economy. Following the traditional argument, excess resources in agriculture lead to overproduction. This lowers output price because of inelastic final product demand, and depresses income and factor returns below their equilibrium level.

Phipps (1982) adds an additional criticism of the "Melichar methodology." It is an ex post (backward-looking) and not an ex ante study of the relationship between annual returns to farm assets and their prices. In essence, Melichar's ex post approach tells us what a farmer would have earned if he/she had repurchased the assets at the beginning of each year.

This is interesting from a historical perspective, as it gives one measure of the performance of the farm sector. However, from the standpoint of asset valuation, the proper perspective is an ex ante one, as the price of a durable input is directly related to the expected income stream to be earned over its economic life.

Estimating Labor Inputs (Labor Hours)

Another key variable in the estimation of returns to farm labor is farm labor hours. Prior to 1984, the USDA/ERS used the Bureau of Labor Statistics (BLS) estimates of labor hours.

Table 1. Rates of Return Data, Methodology, and Data Sources, 1940–2003

Item	Method of Estimation and Data Source(s)
Average Farm Assets (t, $t-1$) ($000s) (*AVFASSETS*)	http://www.ers.usda.gov/data/FarmBalanceSheet/Def_Bsht.htm Farm business assets include the current market value of farm real estate and non-real estate assets. Non-real estate assets include the value of inventories (crops, livestock, and poultry), financial assets, machinery and equipment, and purchased inputs associated with the farm business. Land value estimates are based on USDA/NASS estimates of value/acre of land and buildings and of land in farms. Non-real estate asset estimates are based on data from NASS and ERS [i.e., *Census of Agriculture*, Agricultural Resource Management Survey (ARMS), and the Agricultural Economics Land Ownership Survey].
Returns to Farm Assets, Operator Labor, and Management ($000s) (*YFRMASET*)	Estimated as: *YFRMASET* = *RETOPER* + *NOLL* + *INTEREST*, where *RETOPER* = returns to operators; *NOLL* = net rent to non-operator landlords; *YFRMASET* = returns to farm assets, operator labor, and management; and *INTEREST* = interest expenses
Residual Income to Farm Assets ($000s) (*RETASETS*)	Estimated as: *RETASETS* = *YFRMASET* − *OPERLABR* − *MGMENT*, where *OPERLABR* = average wage rate × labor hours, and *MGMENT* = imputed returns to management
Imputed Returns to Farm Assets ($000s) (*IRFASST*)	Estimated as: Returns to farmland (value of farmland multiplied by the ratio of net cash rents to farmland value) plus returns to non-farmland (value of non-farmland assets × T-bill rate)
Residual Returns to Operator Labor and Management ($000s) (*RROLM*)	Estimated as: *YFRMASET* − *IRFASST*
Imputed Returns to Operator Labor and Management ($000s)	Estimated as: *OPERLABR* + *MGMENT*, where *OPERLABR* = imputed returns to labor (estimated as average price of hired and unpaid family labor × labor hours as reported by NASS); and *MGMENT* = imputed returns to management (estimated as 5% of the sum of cash receipts + net inventories + government payments − livestock and feed purchases)
Wage Rate ($/hour)	Source: USDA/NASS
Residual Rate of Return on Farm Assets (%) (*RRFA*)	Estimated by USDA/ERS as: [*RETASETS* ÷ *AVFASSETS*] × 100, where *AVFASSETS* = average value of farm assets
Imputed Rate of Return on Farm Assets (%) (*IRFA*)	Estimated as: [*IRFASST* ÷ *AVFASSETS*] × 100

In 1980, the American Agricultural Economics Association Task Force on Measuring Agricultural Productivity reviewed the concept and measurement of agricultural productivity with special reference to USDA multi-factor productivity statistics. With respect to the existing labor input series, the task force recommended that USDA replace the existing "requirements approach" by direct sampling. Now the USDA/ERS derives estimates of labor hours for hired and unpaid family labor from its Agricultural Resource and Management Survey (ARMS).

Results and Discussion

Using the above methodology as presented in Table 1, returns to farm assets and to operators' labor and management were estimated for the United States during 1940–2003. The two scenarios examined here were (*a*) return to farm assets is the residual income claimant, and (*b*) return to operators' labor and management is the residual claimant. The results are presented in Table 2.

As expected, returns to the "imputed" factor are more stable than are returns to the factor considered the residual income claimant. When the residual income claimant is farm assets (Figure 1), the imputed returns to operators' labor and management follow the secular increase in U.S. average annual wage rates, labor hours, and farm income. Imputed returns to labor and management are always positive. The residual returns to labor and management exhibited a downward trend from their highest level ($13 billion) in 1948 to lowest level (-$28 billion) in 1980 (Figure 2). Note, however, the residual returns to labor and management were negative for an extended time during the 1963–1971 and 1976–1984 periods (Figure 2).

When comparing the rate of return on farm assets using the two methods (residual and imputed), Figure 3 shows that the imputed rate of return on farm assets exceeds the residual rate of return on farm assets. Years in which the two approaches give differing results (1973–1981) correspond to years in which both short- and long-term interest rates rose rapidly. Increases in expected future returns to farmland and rising real interest rates increased the price of farmland and its imputed return. The presence of multiple quasi-fixed factors implies that the rate of return to farm assets may be understated by residual measurement.

As observed from Figure 3 and Table 2, the imputed rate of return on farm assets was highest during 1965 and 1966, averaging about 8.81%. This level of return on farm assets has not since been observed. However, there are distinct periods in American agriculture when the rate of return on farm assets has been high when using the imputed method to estimate returns on farm assets. On the other hand, rate of return on farm assets is generally low when estimation is done using the residual method. The highest returns on farm assets were obtained in 1942 (8.68%), and thereafter generally declining returns continued until 1959. Another high rate of return on farm assets was observed in 1973 (7.71%), followed by lower returns thereafter.

An examination of key periods in the American economy shows considerable difference in the rates of return on farm assets using the two approaches (Table 3). On average, during different periods, the rate of return on farm assets, using the residual approach, was lower than the rate of return obtained from the imputed approach.

There are two important periods in both approaches. For example, using the residual approach, the farm crisis period (1979–1984) recorded the lowest return on farm assets (2.09%), a period when land values fell dramatically in American agriculture (Cochrane, 1979). In contrast, using the imputed approach, the Vietnam War and increased agricultural exports period (1964–1973) recorded the highest rate of return on farm assets (7.38%).

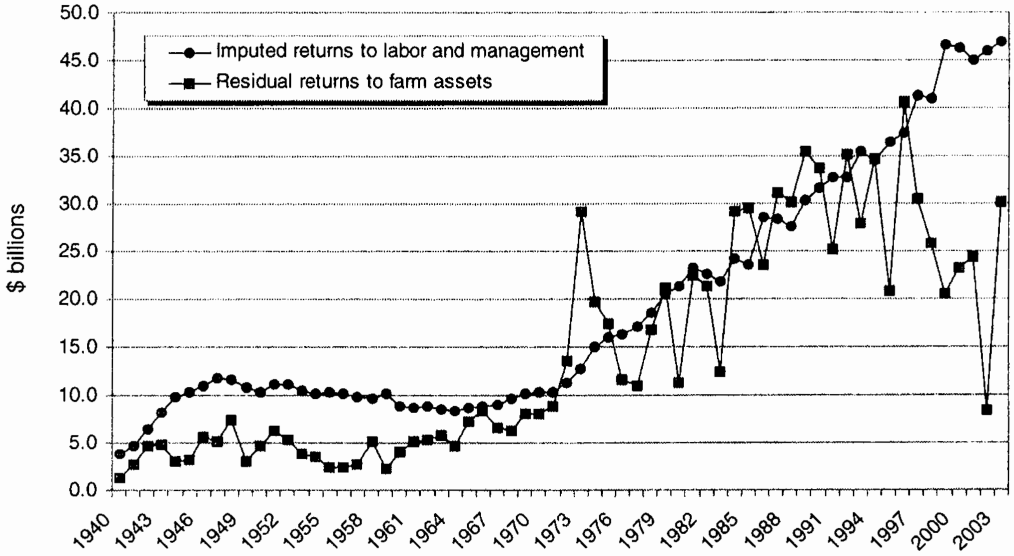

Figure 1. Residual Returns to Assets and Imputed Returns to Labor and Management

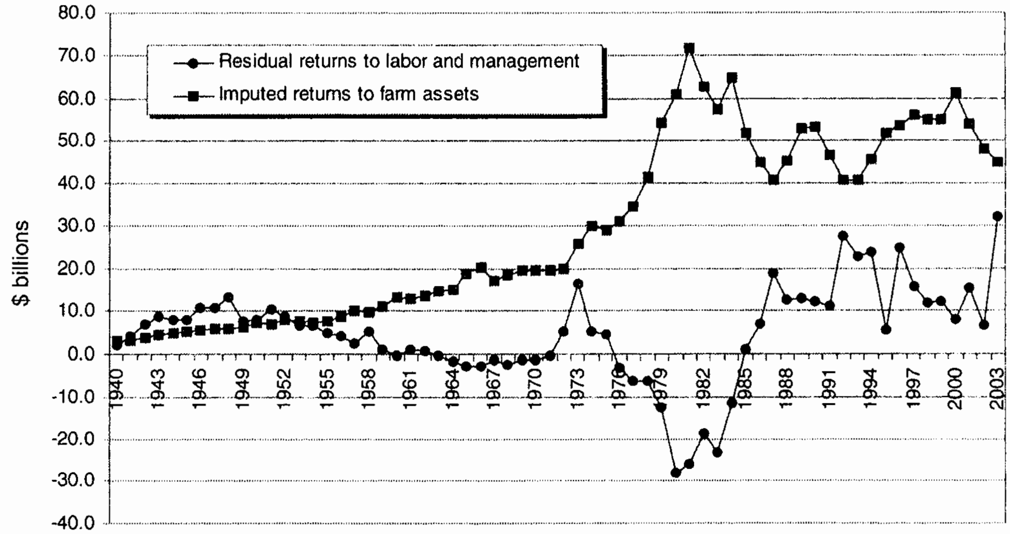

Figure 2. Imputed Returns to Assets and Residual Returns to Labor and Management

Table 2. Rates of Return Data: Imputed Returns and Residual Income Approaches

Year	Average Farm Assets (*t*, *t*−1) ($000s)	Returns to Farm Assets, Operator Labor, and Management ($000s)	Residual Returns to Farm Assets ($000s)	Imputed Returns to Farmland ($000s)	Imputed Returns to Non-farmland Assets ($000s)
1940	41,627	5,193,000	1,347,950	3,056,400	1,516
1941	45,325	7,437,000	2,747,050	3,177,000	11,095
1942	53,560	11,038,000	4,647,200	3,899,800	66,493
1943	62,854	13,058,000	4,795,250	4,325,100	98,280
1944	70,379	12,953,000	3,045,950	4,870,800	97,937
1945	77,478	13,522,000	3,236,250	5,243,000	106,514
1946	81,324	16,520,000	5,630,250	5,490,800	99,299
1947	91,135	16,859,000	5,094,050	5,745,200	239,490
1948	102,971	19,120,000	7,429,950	5,538,500	405,348
1949	103,708	14,004,695	3,120,855	5,697,500	543,103
1950	111,963	15,017,943	4,675,781	6,418,340	759,077
1951	128,805	17,501,651	6,356,255	5,991,280	1,052,685
1952	134,535	16,543,573	5,344,955	6,893,028	1,007,325
1953	130,843	14,342,593	3,858,541	6,739,479	998,400
1954	130,653	13,765,101	3,562,606	6,734,903	515,822
1955	134,828	12,645,991	2,378,332	6,736,847	986,410
1956	141,360	12,693,853	2,493,634	6,948,542	1,734,185
1957	150,113	12,515,962	2,750,140	8,005,965	2,169,315
1958	161,630	14,775,101	5,144,475	8,492,983	1,153,227
1959	170,615	12,271,534	2,182,542	9,091,550	2,179,819
1960	173,425	12,907,816	3,975,807	11,368,435	1,774,087
1961	177,992	13,940,055	5,206,342	11,567,834	1,457,868
1962	185,251	14,272,815	5,381,128	11,799,126	1,918,790
1963	192,782	14,271,485	5,757,229	12,515,741	2,208,398
1964	200,467	13,150,713	4,737,638	12,498,866	2,477,513
1965	212,528	15,958,341	7,203,656	15,732,613	3,005,697
1966	227,420	17,318,438	8,372,916	16,193,143	3,826,479
1967	240,048	15,739,734	6,631,337	13,589,291	3,516,232
1968	251,617	15,957,691	6,309,853	13,985,424	4,479,624
1969	262,492	18,186,977	8,070,040	13,590,766	5,963,389
1970	273,323	18,403,040	8,068,331	13,475,042	6,160,482
1971	290,292	19,142,457	8,791,813	14,834,055	4,517,866

(extended/continued . . .)

Table 2. Extended

Year	Imputed Returns to Farm Assets ($000s)	Residual Returns to Operator Labor and Management ($000s)	Imputed Returns to Operator Labor and Management ($000s)	Residual Rate of Return on Farm Assets (%)	Imputed Rate of Return on Farm Assets (%)
1940	3,057,915	2,136,600	3,845,050	3.24	7.35
1941	3,188,095	4,248,905	4,689,950	6.06	7.03
1942	3,966,293	7,071,707	6,390,800	8.68	7.41
1943	4,423,380	8,634,620	8,262,750	7.63	7.04
1944	4,968,737	7,984,263	9,907,050	4.33	7.06
1945	5,349,514	8,172,486	10,285,750	4.18	6.90
1946	5,590,099	10,929,902	10,899,750	6.92	6.87
1947	5,984,690	10,874,310	11,764,950	5.59	6.57
1948	5,943,848	13,176,152	11,690,050	7.22	5.77
1949	6,240,603	7,764,092	10,883,840	3.01	6.02
1950	7,177,418	7,840,525	10,342,161	4.18	6.41
1951	7,043,965	10,457,686	11,145,396	4.93	5.47
1952	7,900,353	8,643,221	11,198,618	3.97	5.87
1953	7,737,879	6,604,714	10,484,052	2.95	5.91
1954	7,250,725	6,514,376	10,202,496	2.73	5.55
1955	7,723,257	4,922,734	10,267,660	1.76	5.73
1956	8,682,727	4,011,126	10,200,219	1.76	6.14
1957	10,175,280	2,340,682	9,765,822	1.83	6.78
1958	9,646,210	5,128,891	9,630,626	3.18	5.97
1959	11,271,369	1,000,165	10,088,991	1.28	6.61
1960	13,142,522	-234,706	8,932,009	2.29	7.58
1961	13,025,702	914,353	8,733,713	2.93	7.32
1962	13,717,916	554,899	8,891,687	2.90	7.41
1963	14,724,139	-452,654	8,514,256	2.99	7.64
1964	14,976,379	-1,825,666	8,413,075	2.36	7.47
1965	18,738,309	-2,779,968	8,754,685	3.39	8.82
1966	20,019,622	-2,701,184	8,945,522	3.68	8.80
1967	17,105,522	-1,365,788	9,108,398	2.76	7.13
1968	18,465,048	-2,507,357	9,647,838	2.51	7.34
1969	19,554,155	-1,367,178	10,116,937	3.07	7.45
1970	19,635,524	-1,232,484	10,334,709	2.95	7.18
1971	19,351,921	-209,464	10,350,644	3.03	6.67

(extended/continued . . .)

Table 2. Continued

Year	Average Farm Assets (t, t−1) ($000s)	Returns to Farm Assets, Operator Labor, and Management ($000s)	Residual Returns to Farm Assets ($000s)	Imputed Returns to Farmland ($000s)	Imputed Returns to Non-farmland Assets ($000s)
1972	320,847	24,761,193	13,524,148	15,190,623	4,500,359
1973	379,214	41,987,395	29,233,535	15,664,034	9,990,816
1974	433,838	34,793,416	19,727,144	18,562,568	11,184,450
1975	479,984	33,301,317	17,382,729	19,802,949	9,041,893
1976	550,752	27,844,014	11,612,345	22,453,894	8,486,560
1977	621,112	28,079,713	10,961,257	25,417,396	9,077,915
1978	714,626	35,272,706	16,794,089	25,921,166	15,470,254
1979	846,213	41,738,280	21,190,599	28,199,949	26,231,479
1980	957,552	32,568,165	11,292,995	30,902,798	29,942,115
1981	999,160	45,763,287	22,492,585	33,391,210	38,361,424
1982	980,193	43,899,262	21,270,100	35,264,351	27,257,405
1983	960,894	34,123,603	12,384,556	34,770,470	22,604,273
1984	928,556	53,332,770	29,165,414	36,709,895	28,068,386
1985	836,860	53,103,888	29,497,056	33,591,770	18,341,042
1986	748,963	52,121,133	23,524,139	30,964,111	14,055,382
1987	739,248	59,466,272	31,135,334	27,287,967	13,531,401
1988	772,502	57,740,764	30,216,282	28,249,821	16,974,265
1989	801,128	65,793,783	35,444,387	30,314,372	22,637,732
1990	827,170	65,480,842	33,788,826	31,506,187	21,633,041
1991	842,388	57,826,479	25,099,220	31,054,778	15,480,558
1992	855,965	67,989,314	35,229,937	30,518,097	10,054,947
1993	888,469	63,409,025	27,855,595	31,965,098	8,675,462
1994	921,950	69,118,209	34,679,208	33,455,833	12,020,212
1995	950,233	57,395,460	20,865,974	34,626,197	17,076,404
1996	984,329	78,044,985	40,627,841	36,943,924	16,475,385
1997	1,027,099	71,729,738	30,437,411	38,586,159	17,360,330
1998	1,067,318	66,759,387	25,728,614	38,824,479	16,224,993
1999	1,111,091	66,994,927	20,413,263	38,562,833	16,314,711
2000	1,171,021	69,492,518	23,259,522	40,121,527	21,233,174
2001	1,229,571	69,319,589	24,361,049	39,924,004	14,122,218
2002	1,279,988	54,401,538	8,388,686	41,700,046	6,158,535
2003	1,341,403	77,139,664	30,135,121	41,062,810	3,970,778

(extended/continued . . .)

Table 2. Continued/Extended

Year	Imputed Returns to Farm Assets ($000s)	Residual Returns to Operator Labor and Management ($000s)	Imputed Returns to Operator Labor and Management ($000s)	Residual Rate of Return on Farm Assets (%)	Imputed Rate of Return on Farm Assets (%)
1972	19,690,982	5,070,211	11,237,045	4.22	6.14
1973	25,654,849	16,332,546	12,753,860	7.71	6.77
1974	29,747,019	5,046,397	15,066,272	4.55	6.86
1975	28,844,842	4,456,475	15,918,588	3.62	6.01
1976	30,940,454	-3,096,440	16,231,669	2.11	5.62
1977	34,495,311	-6,415,598	17,118,456	1.76	5.55
1978	41,391,420	-6,118,714	18,478,617	2.35	5.79
1979	54,431,427	-12,693,147	20,547,681	2.50	6.43
1980	60,844,913	-28,276,748	21,275,170	1.18	6.35
1981	71,752,634	-25,989,347	23,270,702	2.25	7.18
1982	65,521,756	-18,622,494	22,629,162	2.17	6.38
1983	57,374,742	-23,251,139	21,739,047	1.29	5.97
1984	64,778,281	-11,445,511	24,167,356	3.14	6.98
1985	51,932,812	1,171,076	23,606,832	3.52	6.21
1986	45,019,493	7,101,640	28,596,994	3.14	6.01
1987	40,819,368	18,646,904	28,330,939	4.21	5.52
1988	45,224,086	12,516,678	27,524,482	3.91	5.85
1989	52,952,104	12,841,679	30,349,396	4.42	6.61
1990	53,139,228	12,341,614	31,692,016	4.08	6.42
1991	46,535,335	11,291,144	32,727,259	2.98	5.52
1992	40,573,044	27,416,270	32,759,378	4.12	4.74
1993	40,640,560	22,768,465	35,553,430	3.14	4.57
1994	45,476,045	23,642,164	34,439,002	3.76	4.93
1995	51,702,600	5,692,860	36,529,486	2.20	5.44
1996	53,419,309	24,625,676	37,417,144	4.13	5.43
1997	55,946,489	15,783,249	41,292,326	2.96	5.45
1998	55,049,471	11,709,915	41,030,773	2.41	5.16
1999	54,877,544	12,117,383	46,581,664	1.84	4.94
2000	61,344,701	8,147,817	46,232,997	1.99	5.24
2001	54,046,222	15,273,367	44,958,540	1.98	4.40
2002	47,858,581	6,542,957	46,012,852	0.66	3.74
2003	45,033,588	32,106,077	47,004,544	2.25	3.36

Source: Authors' calculations.

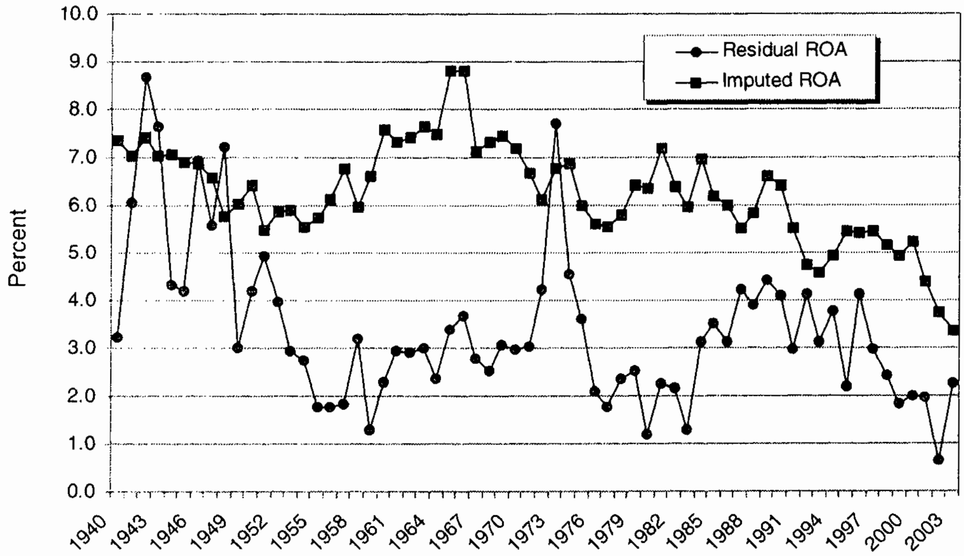

Figure 3. Comparison of Rates of Returns on Assets: Residual and Imputed

Table 3. Comparison of Rates of Returns on Farm Assets Using the Residual and Imputed Approaches

Period	Description [a]	Average Rate of Return on Farm Assets: Residual Approach (%)	Average Rate of Return on Farm Assets: Imputed Approach (%)
1940–1948	World War II	5.98	6.89
1949–1959	Post-WWII boom, Korean War and post-war readjustment period	3.01	5.99
1964–1973	Vietnam War and increased agricultural exports period	3.57	7.38
1979–1984	Farm crisis period	2.09	6.55
1985–1995	Post-farm crisis period	3.59	5.62
1996–2002	Post-FAIR Act [b]	2.28	4.90
2002–2003	FSRI Act [c] of 2002	1.45	3.55

Source: Calculated from Table 2.

[a] Selection of periods was made on landmark dates in American history, in terms of both agriculture and the economy as a whole.

[b] Federal Agriculture Improvement and Reform Act of 1996.

[c] Farm Security and Rural Investment Act of 2002. This Act was signed into law on May 13, 2002; the first payments under the Act were made in October 2002.

This finding is consistent with the fact that during this period opportunity cost of farm investment was high, resulting in a higher cash rent-to-land value ratio. Further, as Cochrane emphasizes, it was a time of expansion in American agriculture led by expanding Soviet grain imports. Demand for farmland increased, as farmers sought to increase their land holdings. During this period real net farm income[2] per farm increased from $12,399 in 1964 to $34,473 in 1973 (see Mishra and Sandretto, 2000). Interest rates generally rise during a time of war, due to increased production and demand for competing resources, and the opportunity cost of farm investment increases, resulting in higher returns on farm assets. This is evident from Table 3, regardless of the approach used—but is more evident when rate of return is computed using the imputed method.

Summary and Concluding Remarks

This study has reviewed the methods used by the USDA/ERS to estimate residual returns to farm assets, and the reasons for their use. Several key assumptions are identified regarding land, labor, and capital that should be considered when imputing a return to factors of production and rate of return on U.S. farm investment. This analysis has also examined how the presence of quasi-fixed factors (such as land) in production affects returns to farming, and a method to properly account for them is outlined.

Results show that returns estimates vary greatly depending upon whether farm assets, or operators' labor and management, are considered the residual claimant to income. The basic imputed value approach of Neoclassical economics was discussed. Letting farm assets (farmland and other farm capital) be the residual claimant is consistent with the Ricardian notion of allocating residual returns to the most fixed factor of production. Huffman (1996) argues that farm capital (farm assets) be the residual income claimant because the implicit rental rate and even the farm capital stock numbers are weak. This is consistent with the current approach used by the USDA/ERS.

Because a well-defined market for operators' labor and management does not exist, there are no actual market prices. Therefore, one must select a suitable proxy for the true opportunity cost of operator labor and management. Both Huffman (1996) and Phipps (1982) have suggested that pricing self-employed and unpaid family labor at the hired farm workers' wage rate underestimates the opportunity cost of the farmers' time. They contend this is because farm operators and members of their households have, on average, a much larger stock of human capital than do their hired farm workers. Thus, additional attention to imputing this wage rate may be warranted.

Another key variable in the estimation of returns to farm labor is farm labor hours. USDA/ERS has followed recommendations of the AAEA Task Force on Measuring Agricultural Productivity and now uses the ARMS survey to estimate labor hours for hired and unpaid family labor. Since the USDA has aligned ARMS survey questions to "match" those asked on the (five-year) *Census of Agriculture*, the agency's estimates of farm labor hours are being further improved.

This study demonstrates the linkage between multiple quasi-fixed factors and the imputed return to farmland. The formulation shows that the imputation procedure implicitly assumes all other quasi-fixed factors are paid their market price. Our findings reveal that if any other of the quasi-fixed factors (such as land and intermediate capital) do not earn their market price, then the imputed returns approach misrepresents the return to farmland.

[2] The authors used 1992 dollars (i.e., 1992 = 100).

The empirical dominance of the imputed returns approach over the residual returns approach is based on the Euler theorem. However, the imputed returns approach requires an estimate of the opportunity cost of operators' labor and management. Market-based prices for operators' labor and management are not always readily available. Although these, too, may have associated measurement errors [e.g., Mishra, Moss, and Erickson (2004) found labor could also be a quasi-fixed factor], they nonetheless are market based. Any measurement errors in imputing returns to operators' labor and management, by the Euler theorem, are reflected in the residual return to the most fixed factors—farmland and other farm assets, resulting in additional noise in returns to farmland and to other farm assets. Further, recognition should be given to the fact that farmland values are increasingly (over time) influenced by nonfarm factors such as urbanization and spatial factors, and these must also be considered. Finally, returns to farmland may have additional noise in them. Use of the measurement error process in estimating returns to farmland may yield better results.

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Accounting for Loan Amount and Credit Rating When Calculating Lifetime Value of Agricultural Lending Relationships

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Abstract

Using empirical default probabilities and profitability distributions, a simulation model is developed to identify the long-term value of relationships among differing credit rating and loan amount groups. According to the results generated from a set of lending relationships, agricultural lenders are pricing low and moderate credit rating customers such that similar long-term values are found among the groups. Also, large loan amount relationships generate more dollars of lifetime value. The large relationships, however, earn fewer dollars of lifetime value per dollar of loan amount among risk peers. Implications are also drawn for the retention rates of existing customers.

Key words: agricultural lending, lending relationships, lifetime value

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Structural change and consolidation in production agriculture are forcing agricultural lenders to reevaluate how they serve borrowers. These changes have increased the market power of borrowers with large loan amounts and concentrated risk among these borrowers in agricultural lenders' total loan portfolios. Borrowers with larger loan amounts frequently negotiate lower interest rates and demand more and better service. Moreover, risk was once typically spread among a large number of borrowers who required smaller loan amounts, but now, default by a single customer with a large loan amount could have a more significant impact on the financial strength of the lender.

Lending relationships generate earnings over several years. Thus, it is critical for lenders to understand how changes in the borrower's operation and creditworthiness impact the revenues generated and costs incurred by serving and maintaining a customer relationship. Lenders can calculate the differences between these revenues and costs to arrive at relationship profitability.

While loan defaults are rare, when they do occur the lender may incur substantial collection costs in addition to any lost principal and interest. As a result, higher risk borrowers pay increased rates, and lenders enjoy a higher interest rate margin on these borrowers. This fact means higher risk borrowers generate more profit for lenders in the short run, when default does not occur. If default occurs, however, one must consider whether the increased up-front returns are enough to offset any future default costs.

The interest rate margin must compensate the lender for risk and cover the costs of extending credit to borrowers. One of the most challenging aspects of loan pricing is determining the amount of compensation the lender should demand for different amounts of credit risk. While there have been numerous studies aimed at understanding how credit risk evolves over time (Barry, Escalante, and Ellinger, 2002; Phillips and Katchova, 2004; Escalante et al., 2004; Gloy, LaDue, and Gunderson, 2005; Zech and Pederson, 2004), none have examined how these changes impact long-term lending relationship profitability.

Barry (2001) notes there are two major approaches to measuring credit risk: the default-mode and the mark-to-market approach. While the default-mode approach is only interested in the probability of defaults and their severity when they occur, the mark-to-market approach considers the influence that changes in credit risk have on the market value of the loan relationship.

In the agricultural marketing literature, the concept of customer lifetime value has been introduced (Gloy, Akridge, and Preckel, 1997) and is similar to a mark-to-market approach in that it considers the future cash flows of a customer relationship. Based upon historical customer transition probabilities and profitability, customer lifetime value calculates a relationship value using expected revenue and costs data. This process can be employed by lenders to assess how the changes in credit risk and loan amount influence the long-term profitability of agricultural loans.

The goal of this paper is to quantify the impact of changes in loan amount and credit risk on the long-run returns to a loan relationship. Specifically, the paper aims to identify whether the increased risk of default among moderate-risk borrowers offsets the higher profits these borrowers generate in the short run. A simulation model is developed to investigate these issues. The method is described in enough detail so that agricultural lenders can apply the model to their data. Depending upon the data available, lenders can use more credit risk categories, size categories, and their customer retention rates to assess customer lifetime value in their own loan portfolio.

The remainder of the paper proceeds as follows. First, the lender-borrower relationship and the importance of loan quality and quantity are explained. Next, we describe how credit risk migration, loan amount growth (or decline), and customer retention influence the lifetime value of a lending relationship. This is followed by a description of the data and a discussion of the methods used to simulate the lifetime value of a lending relationship. The results are then presented, highlighted by a discussion of their implications. Concluding remarks are offered in the final section.

The Lender-Borrower Relationship

The use of debt as an input in an operation has been described as unique from other commodity inputs because it adds financial risk to the borrower's operation and business risk to the lender's operation (Turvey and Weersink, 1997). Adding complexity to the problem for the lender is the ability of borrowers to limit their downside risk through limited liability. Thus, default on a loan can be very costly to borrowers. As a result, lenders will be inclined to separate borrowers by risk, specifically the risk of the loan not being repaid (Bester, 1985). If the lenders charge higher risk borrowers higher rates, then all loan demand will be met in equilibrium, assuming borrowers are unconstrained on the amount of collateral they can provide. It is essential, then, that lenders correctly categorize their loan relationships to earn optimal profits over the life of a loan relationship.

Correctly categorizing loan relationships is important because costs arise when misspecification occurs either by assigning the borrower to a higher (or lower) risk category than warranted (Nayak and Turvey, 1997). If the lender incorrectly categorizes a loan relationship at a lower level of risk than is actually present (Type I error), the costs are foregone interest which would have been earned with a higher interest rate. In addition, the lower risk categorization fails to account for the increase in probability of default, so the expected profit is also decreased by the increased probability of default. Moreover, this default could mean larger losses of principal because less collateral might have been required.

The other incorrect categorization occurs when lower risk loans are categorized into a higher risk group (Type II error) and assessed a higher interest rate than warranted. Thus, the borrower will refuse the loan and the lender will consequently forego some revenue which would have been earned had the loan relationship been correctly categorized and priced. Furthermore, it seems reasonable to assume that the lender then provides these funds to another loan relationship. If this new relationship, in turn, is potentially incorrectly classified as low risk when it is in fact high risk with any probability, there will be an additional opportunity cost incurred when a Type II error occurs.

Clearly, categorizing the credit risk of a loan relationship is important. Moreover, Hansen and Thatcher (1983) emphasize that any credit transaction has two characteristics: loan quality (credit risk) and loan quantity (amount of dollars lent to a relationship). Turvey and Weersink (1997) illustrate how these two characteristics are related to each other through the financial risk of the borrower's operation and the limited liability of the borrower. Specifically, high-risk borrowers will be lent fewer dollars at a higher interest rate. Lenders might allow lower risk borrowers to increase the debt-to-asset ratio, but only with accompanying incremental increases in the interest rate to offset the additional financial risk. As lenders evaluate their existing loan relationships and consider adding new relationships, it will be important for them to determine how these two characteristics interact to influence the long-term profitability of their loan portfolio.

Implementing Customer Lifetime Value in Agricultural Lending

Loan quality (credit risk) and quantity (amount) have been identified as two of the most important elements of agricultural lending profitability. Loan amount establishes the base amount from which revenues will be generated. Differing interest rates are then charged to cover the costs financial institutions incur while financing the borrower. When setting interest rates, lenders consider the risk of default by the borrower. The lender charges higher rates for borrowers with a higher likelihood of default because the lender faces greater repayment risk and must also spend more time monitoring borrowers. Another important aspect the lender should consider is the likelihood that the loan relationship is maintained for a long period of time, i.e., customer retention. The lender must allocate resources to maintain the relationship and satisfy the borrower to avoid losing the business to a competitor.

Using loan amount, interest charged for differing credit risk ratings, and customer retention rates, a lending institution can calculate a value for a loan based upon the discounted future cash flows associated with that particular loan. Such an approach is similar to the mark-to-market method outlined by Barry (2001). His mark-to-market example is only for one loan agreement and considers only the transition in credit risk ratings. However, a lender typically holds several loan agreements with one borrower, a factor which influences both the loan amount and the credit rating of a "borrowing relationship." A more detailed model of the long-term value of a lending relationship, therefore, would incorporate loan amount, credit ratings, and the likelihood of maintaining the relationship for an extended period of time.

Credit Rating and the Value of a Lending Relationship

The credit rating is one of the key determinants of the interest rate charged a relationship and, as a result, the lifetime value. Using the credit rating as one indicator of the default risk of the loan, the lending institution sets the interest rate such that it will generate an adequate return to compensate for the additional default risk. Gloy, Gunderson, and LaDue (2005) found that the increased costs of monitoring and servicing moderate-risk loans over low-risk loans were more than offset by higher interest rate margins, making moderate-risk loans, on average, more profitable for the lender than low-risk loans. However, they do not account for the long-term impact of credit risk migration and the costliness of default by a large borrower. By examining costs and returns over a longer time period, it is possible to accurately account for the tradeoff of risk for return.

Recent studies of agricultural credit risk migration have been aimed at assessing the likelihood that a loan will undergo a change in credit quality (Barry, Escalante, and Ellinger, 2002; Phillips and Katchova, 2004; Escalante et al., 2004; Gloy, LaDue, and Gunderson, 2005; Zech and Pederson, 2004). Results of these analyses tend to show that while farm loans have some chance of changing risk strata, they most frequently maintain their existing credit risk rating. Notably, however, agricultural borrowers maintain credit risk ratings at rates lower than corporate bonds and commercial loans.

Credit risk influences customer lifetime value directly in at least three ways. First, credit risk influences the costs of monitoring and maintaining the lending relationship. Borrowers who have higher risk of default require lenders to allocate additional time and resources to monitor the operation for sustainability. Second, higher credit risk means a higher likelihood of incurring costs associated with default. And third, when default or a loan loss situation occurs, the lender incurs a number of costs, such as lost interest and principal payments and legal fees, which need to be included when figuring loan relationship profitability. When valuing lending relationships, these three factors need to be explicitly incorporated into the model.

Loan Amount and the Value of a Lending Relationship

Increasing loan amounts can increase revenues but also concentrate default risk, which should raise some concerns for lenders. Traditionally the total agricultural loan portfolio had been lent to a large number of borrowers, spreading risk of default among the many borrowers. However, as loan amounts become increasingly large, so does the concentration of risk invested in any one borrower. This increase in concentration risk does not seem to deter lenders from aggressively pricing large loans (Gloy, Gunderson, and LaDue, 2005). While there are considerable economies of size in the direct costs of lending, such as loan officer, credit analyst, and review committee time, it could be the case that the increasingly concentrated exposure to large loan amount relationships is not worth the additional revenues generated.

In lending, the loan amount is the revenue-generating base. As farm size grows, so too do the size of loans which are needed to purchase capital and sustain operations. Therefore, resources should be allocated to establishing and maintaining relationships with borrowers who have large growth potential to help grow the lender's loan portfolio. Borrowers contemplating growth might also be more likely to explore the comparison of rates among different lenders. This being true, it is important for the lender to consider not only the growth in loan amount, but also the ability to maintain the customer relationship.

Customer Retention and the Value of a Lending Relationship

A final critical item needed for calculating the lifetime value of a borrowing relationship will be the probability of retaining the customer—i.e., preventing the client from moving his or her business to a competitor. Customer retention rates should be a factor in customer lifetime value that lenders will have a large ability to influence. The dedication to serving existing customers well will require additional resources, and it will be important for lenders to assess the return on those additional investments. Moreover, a better understanding of the sensitivity of customer values to retention rates lends itself to an analysis of the tradeoff made between improving customer service for existing customers and acquiring potential new clients. The model used here is flexible enough to test the returns generated by improving customer retention rates.

Data

In order to calculate the lifetime value of an agricultural lending relationship, three key pieces of information are needed to simulate the future values of agricultural borrowers: (*a*) historical customer retention rates, (*b*) transition probabilities for the various loan amount and credit risk strata, and (*c*) the profitability of various lending relationships segmented by loan amount and credit risk stratum. Data were collected from a stratified random sample taken from the loan portfolios of six agricultural lenders. These lenders represent both commercial banks and farm credit associations in the Northeastern United States. Each of the lenders has an agricultural loan portfolio approaching or exceeding $100 million.

A stratified sampling procedure was developed to ensure adequate variance in loan amounts and risk rating. The stratification resulted in nine loan amount/risk strata combinations: small loan amounts/low risk, small loan amounts/moderate risk, small loan amounts/high risk, medium loan amounts/low risk, medium loan amounts/moderate risk, medium loan amounts/high risk, large loan amounts/low risk, large loan amounts/moderate risk, and large loan amounts/high risk.

Each of the lenders has a unique credit risk rating system, making it necessary to group the borrowers of the various institutions into homogeneous credit risk rating groups. Lenders identified to which of the three strata (low, medium, or high risk) borrowers of their unique system belonged. Low-risk borrowers are the highest quality credits with minimal risk of default. Moderate-risk borrowers are at risk of default and might require additional monitoring. High-risk loans for the purposes of this study are borrowers who are classified as substandard, doubtful, or loss (Table 1). Total loan amounts were also segmented into three groups: small (less than $100,000), medium ($100,000 to $400,000), and large (more than $400,000). The two segments were merged to create the nine loan amount/risk strata identified above.

Next, a random sample was selected from within each amount/risk stratum for a total of 1,001 relationships considered. Outliers with unusually large loan amounts and those relationships with fewer than three years of credit risk data were eliminated, leaving 884 borrowers in the sample considered here. The number of borrowing relationships, the percentage of total borrowers, and the average total loan amounts for each amount/risk stratum are reported in Table 2. It should be noted that just 11 loan relationships exist in the large loan amount/high-risk stratum. These 11 relationships represent 84% of the population, i.e., there were only 13 loans in this population, and the data on the remaining two were too inadequate for inclusion. In general, there simply are very few loan relationships in this category and it is difficult to obtain accurate data on them. Nevertheless, the data on these 11 borrowers are accurate, despite the small number of this type of loan in our sample.

Table 1. Credit Risk Rating Descriptions

Credit Risk Rating	Description
Low	▸ Highest quality and strong credits ▸ Strong financial statements with high, acceptable, or sufficient levels of profitability, liquidity, and repayment capacity ▸ History of timely repayment ▸ Might be monitored frequently for compliance with covenants ▸ Very low to modest likelihood of loss in the event of adverse industry financial conditions
Moderate	▸ Classified as special mention or "other assets especially mentioned" (OAEM), as well as substandard and doubtful loans that are still accruing ▸ Highly leveraged and the financial statements reveal several weaknesses that threaten repayment ▸ Require substantial attention ▸ Uncorrected weaknesses may seriously threaten repayment capacity ▸ Currently experiencing adverse economic conditions, or if such conditions are experienced repayment could be jeopardized ▸ Collateral securing the loan may be questionable ▸ Although possible, default is not imminent
High	▸ Classified substandard, doubtful, or loss ▸ Inadequately covered by collateral and repayment capacity ▸ The likelihood of loss of interest and principal is high or the lender must go to great lengths to protect its position ▸ All loans for which interest and principal are in excess of 90 days past due or classified as non-accrual ▸ Repayment likely depends upon collateral

Table 2. Relationships in Sample by Loan Amount and Credit Risk (N = 884)

		Total Outstanding Relationship Balances		
Risk Level	**Variable**	**Small (< $100k)**	**Medium ($100k–$400k)**	**Large (> $400k)**
Low	Number of Borrowers	158	142	143
	Sampling %	3.29%	6.65%	23.68%
	Average Loan Amount	$55,758	$222,332	$1,068,649
Moderate	Number of Borrowers	120	113	98
	Sampling %	19.74%	28.46%	75.97%
	Average Loan Amount	$66,170	$253,246	$1,494,967
High	Number of Borrowers	67	32	11
	Sampling %	52.34%	82.05%	84.62%
	Average Loan Amount	$65,709	$236,666	$848,657

Data regarding loan balances, credit ratings, types and terms of loan products, interest paid by the borrower, and other financial services fees earned were collected from the loan files. Furthermore, the loan officer assigned to the borrower completed a questionnaire that inquired about the amount of time spent by various personnel with the borrower over the last 12 months—a critical component of the costs associated with servicing and monitoring the borrower.

While the data used in this study are of shorter duration than in other studies of credit risk migration, the data are also very unique. Unlike other studies in which 10 years of credit risk data have been used (e.g., Barry, Escalante, and Ellinger, 2002), this study considers actual lender data and lender-assigned credit ratings. Lender data are sensitive and carefully guarded, elevating the costs of collecting this information. Considering a shorter time period might allay some of the difficulty associated with obtaining lender data. For example, a recent article by Featherstone, Roessler, and Barry (2006) uses lender credit ratings, but it also uses data from a shorter than 10-year period (1995–2002). Perhaps more importantly, none of the earlier studies examining 10-year periods include data on the profits generated by serving borrowers. Consequently, the data considered here are richer than most studies in other dimensions. Finally, previous research has found that the value of using data beyond two to three years in credit rating studies declines rapidly (Novak and LaDue, 1999).

Transition Probabilities

Loan files were examined in order to identify the borrowers' current and five-years-previous loan amounts as well as the credit rating assigned to the borrower in 2001, 2000, 1999, and 1998. The data on loan amounts were used to calculate a growth rate for each relationship. The growth rate was then applied to the beginning loan amount to estimate the outstanding loan amount in subsequent years. Recently established customer relationships did not have ratings available for all years. As a result, only the available data were included.

To calculate changes in loan amounts, the current loan amount and the loan amount five years ago were used to estimate the amount of dollars lent in each of the intermediate years. Specifically, a growth rate was calculated for each relationship by using the following equation:

$$(1) \qquad \sqrt[5]{\frac{A_{2000}}{A_{1995}}} - 1.$$

This calculation is used to estimate the loan amount for the four years between 1995 and 2000, and will provide an indication of if and when a borrower transitioned between loan amount strata. While this is only an approximation representing the lower bounds of the transition probabilities, lenders will be able to precisely identify when loan amount and risk transitions occur.

By combining the risk-rating data and the loan amount for each year, four observations on loan amount and risk-level data were developed for each borrower. Thus, each farm could have three possible changes in its amount/risk stratum. These three years of change data were used to develop the probabilities of changing to another amount/risk stratum from any given stratum. Next, the data were combined with the customer retention rates to determine the probabilities that a farm will move to each strata or exit in that year.

A transition matrix was created by combining these historical transitions in loan amount and credit risk rating with customer retention rates. Two important points must be noted regarding terminology. First, this is not a typical risk transition matrix because the data are used to consider loan amount and credit risk transitions simultaneously. Typical transition matrices consider only credit risk. In addition, the term "customer retention rate" here refers to the likelihood that a lender will continue to maintain a relationship with a borrower into the next year; it does not refer to a borrower maintaining his or her credit risk rating.

Lenders were asked to supply a five-year retention rate for borrowers in each of the nine loan amount/risk categories. The median value of these retention rates for each loan amount/risk stratum was used as an estimate of the retention rates. From this information, an annual retention rate was then estimated (Table 3).[1] For example, 96.8% of all borrowers in the medium loan amount/moderate credit risk stratum continued to do business with their existing lender the following year, while 3.2% moved the majority of their debt to an alternative lender. This resulted in the loan amount/risk transition matrix (Table 4) used to simulate a customer's life cycle over the 10-year period.

Clearly, most of the borrowers in a particular stratum are likely to remain in that stratum in any given year, with the exception of those in the high-risk strata who are most likely to no longer be a part of the lending portfolio. Furthermore, the most likely transitions among the low- and moderate-risk strata tend to be incremental in either loan amount or credit risk, but typically not both.

For example, those borrowers starting with medium loan amounts and low risk ratings maintain their credit risk rating, but decrease loan amount 5.62% of the time and increase loan amount 8.86% of the time. Moreover, nearly 2% of the time they maintain their medium loan amounts, but move to moderate risk. The transitions across both loan amount and credit risk are unlikely (less than 0.5%), and a large jump in credit risk rating is highly unlikely (just 0.15%).

[1] This was acceptable for all of the six low and moderate risk strata. Many of the lenders stated that all loss borrowers would exit by year five, making it impossible to estimate annual retention rates for the high-risk strata. As a result, the customer retention rates for loss borrowers were developed after additional data and input were gathered from the lenders.

Table 3. Customer Retention and Exit Rates by Loan Amount and Risk

Loan Amount/ Risk Level	Retention Rate [a] (%)	Exit Rate (%)
Small/Low	95.6	4.4
Small/Moderate	94.6	5.4
Small/High	40.0 [b]	60.0
Medium/Low	98.0	2.0
Medium/Moderate	96.8	3.2
Medium/High	45.0 [b]	55.0
Large/Low	98.8	1.2
Large/Moderate	95.4	4.6
Large/High	50.0 [b]	50.0

[a] Median of values provided by lenders.
[b] Estimated from values provided by lenders. Data supplied were five-year retentions, many of which were zero, with some added data on when borrowers actually exited the lender.

Customer Profitability

The final piece of the model of relationship lifetime value is the one-period profits associated with each of the strata. The following equation was used to calculate one-period relationship profitability:

$$(2) \qquad \pi = A \times M + F - W + S - C,$$

where π is relationship profit, A is loan amount, M is interest rate margin, F is loan fees collected, W is the amount of write-offs incurred, S is income generated from other financial services, and C is the direct costs associated with the relationship such as loan officer, credit analyst, and loan committee time. This calculation gives us an estimate of the profitability excluding overhead costs.

Summary statistics by loan amount and credit risk stratum regarding relationship profit are presented in Table 5. It is clear that in a one-period framework, loan relationships with moderate credit risk ratings earn more on average than their low-risk counterparts. This is to be expected because in one period the moderate-risk relationships will earn higher interest rates on their loan amounts.

Table 4. Distribution of Borrowers in Next Year After Being in Current Strata

Moving from (current strata): Amount/Risk Strata	Moving to (next year strata): 1	2	3	4	5	6	7	8	9	Exit
	<----				(%)					---->
1 Small/Low	84.16	0.87	0.26	9.77	0.15	0.00	0.38	0.01	0.00	4.40
2 Small/Moderate	1.03	83.02	0.36	0.29	9.73	0.00	0.00	0.17	0.00	5.40
3 Small/High	6.80	1.06	31.26	0.00	0.00	0.76	0.00	0.00	0.12	60.00
4 Medium/Low	5.62	0.13	0.00	81.01	1.95	0.15	8.86	0.28	0.00	2.00
5 Medium/Moderate	0.00	3.75	0.00	6.55	78.66	0.00	0.62	7.22	0.00	3.20
6 Medium/High	0.00	0.00	2.92	6.27	1.40	34.41	0.00	0.00	0.00	55.00
7 Large/Low	0.00	0.00	0.00	1.43	0.00	0.00	94.36	2.83	0.18	1.20
8 Large/Moderate	0.00	0.00	0.00	0.00	2.42	0.00	0.00	92.21	0.77	4.60
9 Large/High	0.00	0.00	0.00	0.00	0.00	0.00	5.05	0.00	44.95	50.00

Table 5. One-Period Profitability by Loan Amount and Credit Risk Stratum

Amount/Risk Strata	Mean ($)	Standard Deviation ($)	Coefficient of Variation	Percent Negative Profitability (%)
Small/Low	1,145.53	1,649.23	1.44	9.15
Small/Moderate	1,526.68	1,546.33	1.01	9.17
Small/High	-793.53	4,683.04	5.90	43.86
Medium/Low	3,618.52	4,116.06	1.14	13.67
Medium/Moderate	4,482.90	5,023.40	1.12	12.39
Medium/High	1,473.25	11,491.93	7.80	25.00
Large/Low	16,138.78	17,503.42	1.08	9.15
Large/Moderate	22,999.86	36,568.29	1.59	4.21
Large/High	-68,832.01	148,380.20	2.16	57.14

Additionally, the low- and moderate-risk relationships with smaller loan amounts generate on average less profit than their medium and large loan amount peers.

Notably, large, high-risk loans can have a substantial detrimental impact on the profitability of the lending institution. On average, these borrowers create a loss of more than $68,000 in annual profit, so it should be no surprise that these types of relationships occur infrequently. Typically, it would take more than 86 small, high-risk relationships to total the negative profits caused by one large, high-risk relationship—confirming the notion that a large amount of default risk is concentrated as loan amounts are increasing.

Lifetime Value of Lending Relationships

In order to estimate the lifetime value of the lending relationships, we combine the three elements of retention rates, transition probabilities, and one-period profitability within a simulation model (Figure 1). This will provide an indication of the value of borrowers in different strata, and should suggest to lenders where resources could be directed to improve the long-term profitability and viability of the entire loan portfolio. The simulation model works in three steps:

- Step 1 assigns a loan amount and credit risk rating stratum (or potentially not a customer) for borrowers during each period for 10 periods;

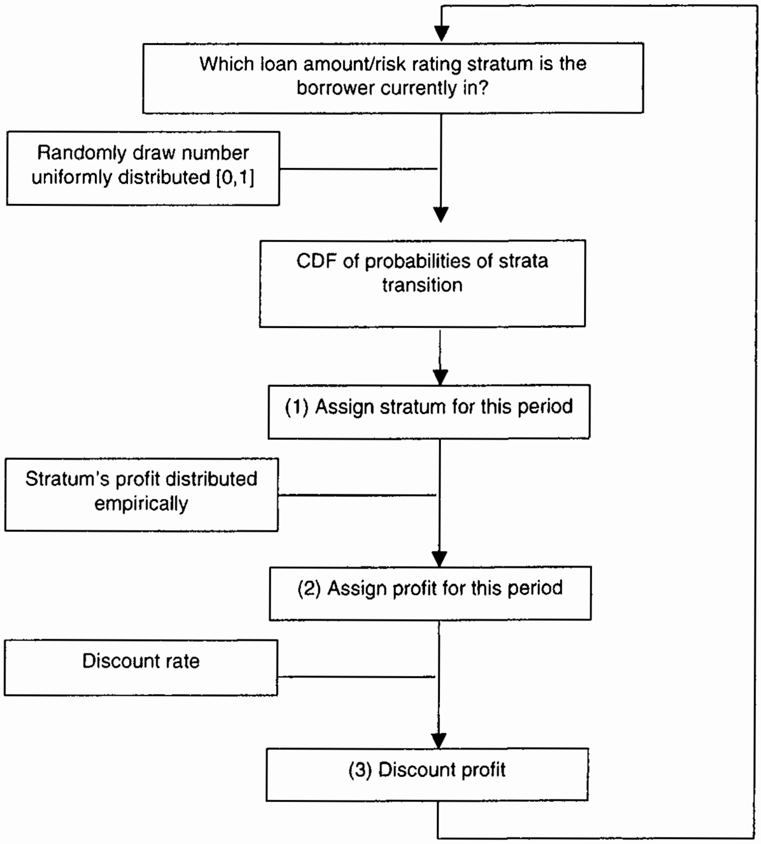

Figure 1. Customer Lifetime Value Simulation Model

- Step 2 assigns the profitability based upon that assigned stratum; and
- Step 3 discounts and sums the assigned profits.

After identifying the initial stratum of the borrower, the model begins by drawing a random number between 0 and 1. The random number drawn is then compared to the cumulative density function of the transition matrices, and the model assigns the new stratum for the borrower. This process is repeated for 10 periods, assigning the transitions in each period based upon the transition probabilities associated with the updated stratum.

The second step of the model is to assign a profit for that period based upon the assigned stratum. The model identifies in which stratum the borrower is located and chooses a random profit determined from the empirical distribution of the profits associated with that particular stratum. Each profit is randomly drawn for each period, i.e., the profits will be different for every period even if the borrower remains in the same stratum throughout the simulation.

The final step is to discount these values based on the cost of funds for the lender and sum them over the 10 time periods. The average cost of funds is an appropriate discount rate, as it represents the opportunity cost of the funds for other uses. The model is simulated for 10,000 iterations using the @Risk® add-on for Microsoft Excel®, and the analysis is drawn from these results. Results from this model can be used to assess the level of credit risk premiums currently being charged by agricultural lenders.

Table 6. Lifetime Value by Loan Amount and Credit Risk Stratum

Amount/Risk Strata	Mean ($)	Standard Deviation ($)	Coefficient of Variation	Percent Negative Lifetime Value (%)
Small/Low	21,020.41	27,870.11	1.33	1.20
Small/Moderate	23,238.32	34,085.90	1.47	1.16
Small/High	810.93	13,277.21	16.37	40.96
Medium/Low	51,756.00	47,278.09	0.91	1.04
Medium/Moderate	57,119.75	62,070.50	1.09	1.37
Medium/High	7,426.42	24,243.66	3.26	23.56
Large/Low	122,256.78	60,645.44	0.50	0.92
Large/Moderate	136,947.49	107,104.25	0.78	2.00
Large/High	-105,976.56	186,721.46	-1.76	66.79

Furthermore, as loan amounts become increasingly larger, this procedure should help lenders understand the pitfalls of concentrating risk among few, large borrowers.

Results

Based on the results of the simulation, current risk premiums adequately compensate the lenders for probability of default increases associated with higher risk borrowers. This section highlights the effects of changes in loan amount, credit risk, and retention rates on customer lifetime value. The fact that lenders earn larger amounts of lifetime value on their moderate credit risk borrowers (relative to low-risk peers within loan amount strata) suggests the additional likelihood of default is being captured in pricing. The results indicate the concentration of risk which occurs with larger borrowers also earns a premium. Finally, the impact of a change in the retention rate of one stratum has important influences within and across other strata.

Loan Amount and Lifetime Value

Generally, relationships with larger loan amounts generate greater amounts of lifetime value (Table 6). Loan relationships with loan amounts between $100,000 and $400,000 generate more than double the amount of lifetime value than do relationships with loan amounts less than $100,000 among risk peers. Large loan relationships generate nearly six times the amount of lifetime value created by their small peers of the same risk stratum. Also of note is that these medium and large relationships generate lifetime value with less variability relative to their mean lifetime value. While lenders are increasingly concentrating risk among fewer, large borrowers, it appears they are doing so in a way that limits negative lifetime value by these relationships.

Despite the larger amounts of lifetime value generated by larger loan amounts, it has been found that per dollar of loan amount, loan relationships with small amounts can be more profitable than their larger counterparts in a one-period framework (Gloy, Gunderson, and LaDue, 2005). If one divides the mean lifetime values generated over this 10-year period by the mean average daily balances by loan amount stratum, then these results suggest that even in a multi-period framework, the value per dollar of loan amount can be greater for small loan amount relationships (Table 7). For loan relationships with small volumes, these per dollar lifetime values are more than 60% larger than medium-volume peers with low risk, and about 55% greater for peers with moderate risk.

Table 7. Lifetime Value per Dollar of Loan Amount

Amount/Risk Strata	Mean Lifetime Value ($)	Mean Loan Amount ($)	Lifetime Value per Dollar of Loan Amount ($)
Small/Low	21,020.41	55,758.00	0.377
Small/Moderate	23,238.32	66,170.00	0.351
Small/High	810.93	65,709.00	0.012
Medium/Low	51,756.00	222,332.00	0.233
Medium/Moderate	57,119.75	253,246.00	0.226
Medium/High	7,426.42	236,666.00	0.031
Large/Low	122,256.78	1,068,649.00	0.114
Large/Moderate	136,947.49	1,494,967.00	0.092
Large/High	-105,976.56	848,657.00	-0.125

The results of this analysis appear to send mixed signals regarding loan amount and profitability. While the lender stands to earn large amounts of lifetime value from a single large loan relationship, it might be at the expense of reaping high "per dollar of loan amount" values from several small-volume relationships. Admittedly, the lender will have limited opportunities to serve the larger relationships, and therefore might choose to serve them to add diversity to the overall loan portfolio.

Credit Rating and Lifetime Value

For each of the loan amount strata, moderate-risk borrowers generate greater customer lifetime values (CLVs) than do their low-risk counterparts (Table 6). There is roughly a 10% premium in lifetime value for the moderate-risk borrowers in the small ($23,238 CLV for moderate risk versus $21,020 CLV for low risk) and medium ($57,120 CLV for moderate risk versus $51,756 CLV for low risk) loan amount strata, and about a 12% premium in the large loan amount stratum ($136,947 CLV for moderate risk versus $122,257 CLV for low risk). This additional revenue generated by large loan amount relationships might reflect a premium earned for the additional concentration in risk.

The results also show that the moderate-risk loans have greater absolute variability as well as greater variability relative to the mean lifetime value. For example, the small loan amounts with moderate risk have a standard deviation which is 22% larger than their low-risk peers. Interestingly, the percentage of simulated relationships with negative lifetime values is less for the moderate-risk borrowers in this small loan amount stratum compared to the low-risk borrowers. For the large loan amount strata, the opposite is true; i.e., a larger percentage of simulated moderate-risk borrowers had negative values than did the same volume of peers with low risk. Senior managers can use this information if they are working to limit the number of relationships generating negative long-term profitability.

When assessing lifetime value and credit risk transitions, lenders should consider incorporating transitions from a larger time frame than used here. Moreover, it would be wise for agricultural lenders to examine time periods of instability in production agriculture caused by macroeconomic variables. The time period considered here (1998 to 2001) likely does not fully reflect the cyclical nature of agriculture.

Retention Rates and Lifetime Value

The CLV simulation model is useful for agricultural lenders as they consider allocating their resources. By choosing the

Table 8. Sensitivity to Large Loan Amount, Low-Risk Retention Rate

	Customer Lifetime Value ($) Generated by Strata When Large Loan Amount/Low-Risk Retention Rate Is:				
Amount/Risk Strata	**90%**	**92.5%**	**95%**	**97.5%**	**100%**
Small/Low	14,367	17,426	20,552	23,828	28,460
Small/Moderate	16,383	18,807	22,047	25,752	30,350
Small/High	398	577	801	1,082	1,438
Medium/Low	30,788	36,370	43,811	53,147	65,178
Medium/Moderate	36,371	41,239	46,288	51,384	65,012
Medium/High	3,627	3,914	4,555	5,042	5,623
Large/Low	63,186	80,272	96,419	105,545	146,808
Large/Moderate	104,181	115,200	128,271	143,906	162,773
Large/High	-118,870	-113,455	-112,906	-109,524	-105,791

types of borrowers who are most valuable for the lender and working to improve the lifetime value generated by less profitable groups, the lender can enhance the overall profitability of the loan portfolio. Therefore, it will be important for lenders to focus attention on the resources spent to maintain and serve existing relationships. One means of evaluating this issue is to identify the retention rates of different customer groups.

Running the model for different levels of retention rates for each of the customer groups can help lenders identify the greatest return on retention activities. It is important to note that changes in a particular stratum's retention rate will impact not only the stratum under investigation, but also other strata whose members might transition into that stratum. Therefore, it is critical to evaluate the changes in lifetime value across all of the strata, rather than just the stratum whose retention rate is under consideration.

As an example, the model was run an additional five times, varying the retention rate for borrowers with low risk and large loan amounts each time. The retention rate used in the initial model was 98.8%, and we varied the rate from 90% to 100%. As anticipated, there is a large impact on the lifetime value of large/low-risk relationships and large/moderate-risk relationships (Table 8 and Figure 2). If the lender were to maintain its relationship with 100% of the large/low-risk borrowers, lifetime values could be expected to increase by about $24,550 per relationship, or about 16%. Alternatively, if the lender were to let retention within this stratum slide to 90%, it would lose about 48% of the average lifetime value (about $59,000).

Included in Figure 2 is the impact the change in retention rates has on medium loan amount borrowers (relationships with small loan amount borrowers are also impacted, but to a much lesser degree). It is notable that the medium loan amount/low-risk borrowers more frequently transition to become large loan amount/low-risk borrowers than do their moderate-risk peers. Consequently, improvements in retention of large/low-risk borrowers actually accelerate the gain in average lifetime value among these medium loan amount/low-risk borrowers as well. Therefore, lenders might allocate additional resources to retain low-risk borrowers rather than moderate-risk borrowers, assuming the cost of improving retention rates is equal across strata.

Conclusions

The objective of this research was to promote a better understanding of the impacts of credit risk and loan amount on the lifetime value of agricultural borrowers.

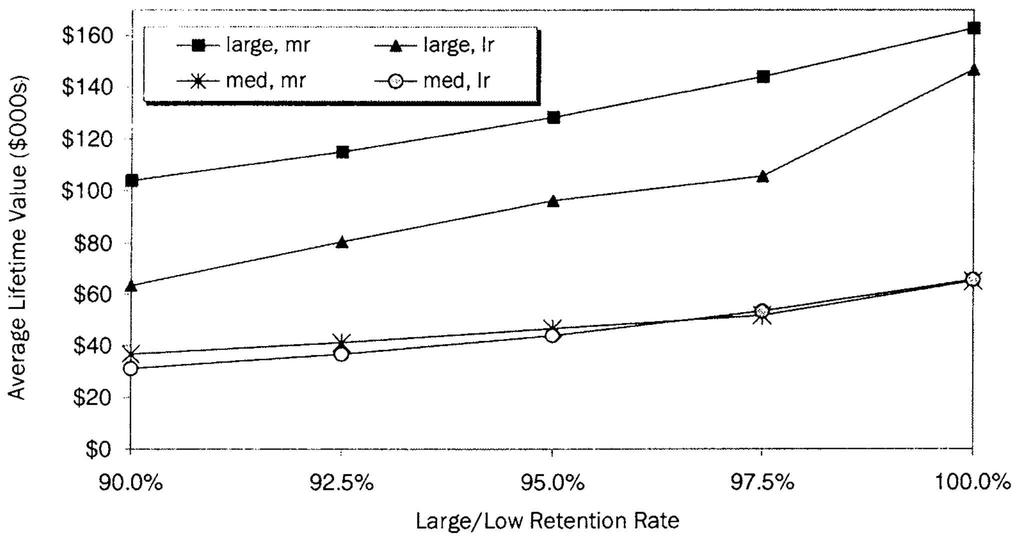

Figure 2. Sensitivity to Large Loan Amount, Low-Risk Retention Rate

Using historical transition data on loan amount and credit risk migrations, a simulation model was constructed to calculate a 10-year lifetime value for customers of different loan amounts and credit risk ratings. The results imply lenders are doing a satisfactory job of pricing for the increased potential of default among moderate-risk borrowers compared to their low-risk peers. Additionally, large loan amount relationships generate more dollars of lifetime value, but fewer dollars of lifetime value per dollar of loan amount among risk peers.

Lenders are competing in an increasingly consolidated production agriculture market. The modeling tool presented here should help them when considering their resource allocation in establishing and maintaining loan relationships with borrowers. It should also provide some insight into assessing risk for long-term success. Lenders should have greater access to credit risk and loan amount transitions over more refined credit risk rating strata and a larger time frame. These additional data should improve the accuracy and usefulness of the results for individual lenders.

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A Crop Profitability Analysis for Long-Term Crop Investments

Clark Seavert, Herbert Hinman, and Karen Klonsky

Abstract

The Crop Profitability Analysis (CPA) computer program is designed to help agricultural producers make long-run cropping decisions. CPA uses previously generated enterprise budgets to establish a base from which producers can analyze the potential profitability of perennial crops with establishment periods, such as orchard, berry, and vineyard crops, or the feasibility of long-term crop rotations. CPA permits up to a 20-year planning horizon and uses the economic concepts of net present value, annual equivalence, and internal rate of return to analyze the potential profitability of a given enterprise. CPA also analyzes the financial feasibility of potential investments by generating annual net cash flows.

Key words: crop profitability analysis, financial feasibility, investments, net present value, perennial crops

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Producers of perennial crops, such as orchard, berry, and vineyard crops, often put in large up-front investments in hopes of gaining sufficient returns in the future to cover their establishment costs and make a reasonable return off their investment. Producers who misjudge the costs and potential returns of such an investment may find themselves in serious financial difficulty.

The Crop Profitability Analysis (CPA) computer program is designed to help agricultural producers in making long-run cropping decisions. CPA uses previously generated enterprise budgets to establish a base from which producers can analyze the potential profitability of perennial crops with establishment periods, such as orchard, berry, and vineyard crops, or the feasibility of long-term crop rotations.

All assumptions as to prices received, yields obtained, or input items, amounts, and costs can be readily changed in the preexisting budgets so the producer can develop a situation that best fits his or her needs. Under the derived situation, the producer can estimate what prices and yields must be obtained over the years to have a profitable investment.

The producer can also compare the profitability implications of two different investments at the same time. CPA uses the economic concepts of net present value, annual equivalence, and internal rate of return (IRR) to analyze the potential profitability of a given enterprise. CPA also analyzes the financial feasibility of the potential investments by generating annual net cash flows.

Budget Editor and CPA

CPA uses previously stored enterprise budget files to analyze the economic consequences of alternative crop enterprises. The budget material used to develop CPA budgets comes from existing published university budgets or budgets developed from scratch by previous CPA users. University enterprise budgets are constructed in cooperation with a committee of better managers within the industry, along with extension and research faculty. These enterprise budgets are stored in separate budget files with respect to returns, variable harvest costs, variable non-harvest costs, and capital investments to meet CPA budget format requirements using a separate computer program (**Budget Editor**) developed specifically for storing and editing budgets to be used by CPA.

The data for each of the yearly enterprise budgets, for a given situation, can be as detailed as desired by the person putting the budget(s) together. In using CPA to project possible future outcomes, the budget data must be presented in such a way as to portray what the actual cash flow may be throughout the life of the investment. Therefore, what might be treated as a "fixed cost" in a traditional budget is treated as an annual cash capital investment in a CPA budget. For instance, what might be considered as machine depreciation in a traditional budget is treated as annual cash payment for machinery replacement in a CPA budget. Whenever a new machine is needed to be purchased in a given year, its cost becomes part of the machinery cash capital investment cost for that particular year.

Land and/or orchard (vineyard) costs are entered as an up-front investment with both a beginning investment value and an ending investment value. Budget Editor allows the user to edit, add, or delete information from these budgets and save the modified budgets as originals or as separate budget files. If a desired budget is not listed, the user may modify an existing budget and store it under a new name or generate and store a new budget altogether.

All budget data are in current dollars, and any increase in value over the years is due to improvements in or maturity of the enterprise. The effects on future costs and returns due to inflation, as well as lost returns from alternative investments, and the uncertainty associated with the investment are taken into account when establishing the discount rate.

The CPA computer program uses the budget files developed by Budget Editor to construct investment scenarios to be analyzed. CPA has a maximum of a 20-year life for the investments being considered. The types of investment problems that may be analyzed using CPA include: (*a*) estimating the profitability and cash flow implication of a proposed investment under different yield and price assumptions, (*b*) comparing the profitability and cash flow implications of two different proposed investments, and (*c*) comparing a proposed investment with a current investment (i.e., should an old orchard block be replaced at this time?).

The purpose of this paper is to demonstrate the analytical features of CPA by presenting a detailed example of a producer considering long-term crop investments.

An Example

For our illustrative example, a producer is contemplating the establishment of a cherry orchard of 272 free-standing trees per acre as well as a high-density Fuji apple orchard (745 trees) using a V-trellis. The CPA analysis procedure for determining which orchard plan to choose is laid out in the subsections below.

Budget Files

The budget files currently stored for a 272 trees per acre cherry orchard (although actually much more detailed than shown) are summarized in Table 1.

Table 1. Stored Per Acre Budget Files for Cherry Orchard

Year	Yield (tons)	Price per Ton ($)	Returns ($)	Harvest Costs ($)	Non-Harvest Costs ($)	Capital Investment Costs ($)	Net Returns ($)
UFI[a]	—	—	—	—	1,923.25	3,500.00	-5,423.25
1	—	—	—	—	3,137.24	204.85	-3,342.09
2	—	—	—	—	1,826.82	189.68	-2,016.50
3	—	—	—	—	2,184.15	1,815.56	-3,999.71
4	3.0	1,500	4,500	1,103.76	2,564.38	1,015.97	-184.11
5	5.5	1,500	8,250	2,023.71	2,456.22	330.34	3,439.73
6	7.5	1,500	11,250	2,759.44	2,467.60	355.66	5,667.30
Mature	9.0	1,500	13,500	3,313.66	2,671.82	406.72	7,107.80
Last Year	9.0	1,500	13,500	3,313.66	2,671.82	(10,406.72)[b]	17,107.80

[a] UFI is up-front investment.
[b] Sell cherry orchard for $10,000/acre at the end of 20 years.

Table 2. Stored Per Acre Budget Files for Fuji Apple Orchard

Year	Yield (bins)	Price per Bin ($)	Returns ($)	Harvest Costs ($)	Non-Harvest Costs ($)	Capital Investment Costs ($)	Net Returns ($)
UFI[a]	—	—	—	—	3,152.00	3,500.00	-6,652.00
1	—	—	—	—	3,137.24	204.85	-3,342.09
2	5.0	200	1,000	148.94	1,736.30	235.99	-1,121.23
3	15.0	200	3,000	474.25	1,665.19	2,640.73	-1,780.17
4	25.0	200	5,000	814.78	2,002.44	362.23	1,820.55
5	35.0	200	7,000	1,140.70	2,001.53	366.66	3,491.11
Mature	45.0	200	9,000	1,459.76	2,143.82	381.05	5,015.38
Last Year	45.0	200	9,000	1,459.76	2,143.82	(7,381.05)[b]	12,015.38

[a] UFI is up-front investment.
[b] Sell Fuji apple orchard for $7,000/acre at the end of 20 years.

If there are items the producer would like to change in any of these original budget files, this may be done by using Budget Editor and restoring the budget file under the original name or a new name. Assuming that the current budgets are to the producer's satisfaction, the data for the up-front investment and years 1 through 6 will be entered from the respective budget files as shown in Table 1. The data for years 7 through 20 will be as shown in the mature year file. In addition, it is assumed that the bare land on which this orchard is being established is currently worth $3,500 per acre, and in 20 years will be worth $10,000 per acre (in current dollars), including the trees. The yield and price estimates are for "field-run" cherries which include the culls. Furthermore, the producer desires a minimum return of 12% on the investment (discount rate).

The budget files currently stored for a high-density Fuji apple orchard using a V-trellis are summarized in Table 2. Assuming the individual performing this analysis is satisfied that the information in these budget files is representative of what

Table 3. Percent Change Table for Example Analysis

BASE PLAN: Cherry Orchard					COMPARISON PLAN: Fuji Apple Orchard			
Year	**Yield**	**Price**	**Harvest Costs**		**Year**	**Yield**	**Price**	**Harvest Costs**
UFI					UFI			
1					1			
2					2			
3					3			
4	-100		-100		4	-50		-50
5					5			
6		-5			6		-5	
7		-5			7		-5	
8		-5			8		-5	
9	-100	-5	-100		9	-50	-5	-50
10		-5			10		-5	
11		-10			11		-10	
12		-10			12		-10	
13	-3	-10	-3		13	-3	-10	-3
14	-100	-10	-100		14	-51.5	-10	-51.5
15	-6	-10	-6		15	-6	-10	-6
16	-6	-15	-6		16	-6	-15	-6
17	-9	-15	-9		17	-9	-15	-9
18	-9	-15	-9		18	-9	-15	-9
19	-100	-15	-100		19	-56	-15	-56
20	-12	-15	-12		20	-12	-15	-12

may occur in the future with regard to an investment in a Fuji apple orchard, these budget files may be used to initially establish the analysis for the Fuji apple orchard over a 20-year period. Thus, in setting up the analysis for the Fuji apple orchard, the data for the up-front investment and years 1 through 5 will be entered from the respective budget files as shown in Table 2. The data for years 6 through 20 will be as shown in the mature year file. In addition, it is assumed that the bare land on which this orchard is being established is currently worth $3,500 per acre, and will be worth $7,000 per acre (in current dollars), including trees, at the end of 20 years. As with the cherry investment, the yield and price estimates are for field-run fruit and the producer desires a minimum return of 12% on the investment (discount rate).

The Percent Change Table

In this example analysis, a producer is comparing the potential profitability of planting a sweet cherry orchard with the profitability of planting a Fuji apple orchard. In most cases, budgets which are developed using Budget Editor and stored for producer use make the assumption that nothing will go wrong. In reality, however, things do go wrong, and prices and yields change. To help account for some of this variation, a percent change table (see Table 3) has been developed whereby annual adjustments to yield, price, and harvest costs over the life of an investment can be made.

In the given example the following assumptions are made: (*a*) the cherry crop will freeze out at least once every five years, beginning in year 4; (*b*) during these

Table 4. Net Returns and Present Value by Year

	Base Plan: Cherry Orchard (discount rate = 12%)*		Comparison Plan: Fuji Apple Orchard (discount rate = 12%)*	
Year	**Net Returns ($)**	**Present Value ($)**	**Net Returns ($)**	**Present Value ($)**
UFI	(5,423.25)	(5,423.25)	(6,652.00)	(6,652.00)
1	(3,342.09)	(2,984.01)	(7,676.59)	(6,854.10)
2	(2,016.50)	(1,607.54)	(1,121.23)	(893.84)
3	(3,999.71)	(2,846.91)	(1,780.17)	(1,267.09)
4	(3,580.35)	(2,275.38)	(272.06)	(172.90)
5	3,439.73	1,951.80	3,491.11	1,980.95
6	5,104.80	2,586.25	4,565.37	2,312.96
7	6,432.80	2,909.87	4,565.37	2,065.14
8	6,432.80	2,598.10	4,565.37	1,843.88
9	(3,078.54)	(1,110.15)	1,020.25	367.91
10	6,432.80	2,071.19	4,565.37	1,469.93
11	5,757.80	1,655.23	4,115.37	1,183.07
12	5,757.80	1,477.88	4,115.37	1,056.31
13	5,492.71	1,258.79	3,916.17	897.48
14	(3,078.54)	(629.93)	695.65	142.34
15	5,227.62	955.07	3,716.96	679.07
16	4,593.12	749.24	3,293.96	537.32
17	4,348.28	633.30	3,108.25	452.70
18	4,348.28	565.45	3,108.25	404.20
19	(3,078.54)	(357.44)	198.84	23.09
20	14,103.44	1,462.06	9,922.55	1,028.64
Total:	49,874.46	3,639.61	41,462.20	605.08
Annual Equivalent:		487.27		81.01

Comparison Summary:

	Base Plan	**Comparison Plan**	**Base minus Comparison**
Total Returns	$49,874.46	$41,462.20	$8,412.27
Net Present Value	$3,639.61	$605.08	$3,034.54
Annual Equivalent	$487.27	$81.01	$406.26

* Percent Change Table is in use.

same years, the Fuji apple crop yield will decrease 50%; (*c*) prices for both cherries and apples will decrease by 5% every five years; and (*d*) after year 12, yields for both cherries and apples will decrease by 3% every two years. Thus, the percent change table used in the analysis would look similar to the example given in Table 3. Once the data for the analysis are complete, the information may be saved in an analysis file for later recovery.

Interpreting the Analysis

The CPA program can easily compare the economics of these two alternatives and help the producer decide which alternative to pursue. Furthermore, after these two alternatives are compared under the given cost, yield, and price assumptions, it is a simple matter to change the assumptions in the CPA analysis and perform a thorough sensitivity analysis.

After entering, editing, and storing the data for the two alternatives, the following comparisons between the two alternatives can be made. (It should be noted that an analysis of a single alternative can also be done in its entirety.)

Net Returns and Present Value by Year Comparisons

Table 4 compares the annual net returns and their present values (using a 12%

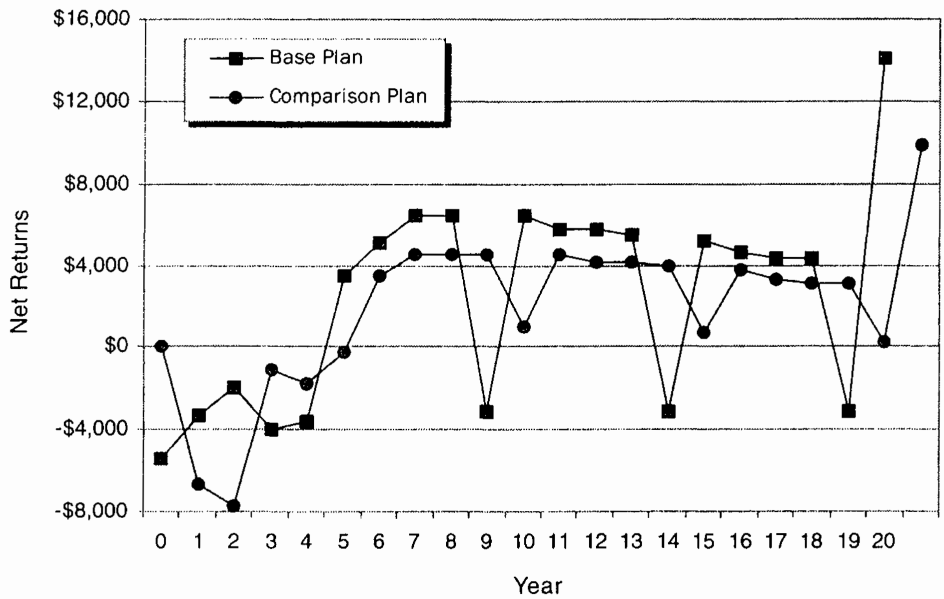

Figure 1. Net Annual Returns for Base and Comparison Plans

discount rate in this example) on an annual basis. As can be seen by the results from this table, the cherry orchard (base plan) returns more over the 20-year period in both current and discounted dollars than does the Fuji apple orchard (comparison plan). Specifically, under the given assumptions and a 12% discount, over the 20-year period, the cherry orchard will return $3,035 per acre more in today's dollars compared to the Fuji apple orchard. Note that the up-front investment costs represent the cost of the orchard land in combination with the cost of preparing the land for establishing the orchards. These up-front values are not discounted in the present value analysis. It should also be noted that in year 20, the remaining orchard values for both alternatives are included in the net returns.

The investment with the highest net present value (the sum of all present values) is the desirable choice when both investments have the same investment life. However, if the investments have different life spans (for example, if one has a 15-year life and the other a 20-year life), one must use the "annual equivalent" figures rather than the net present value figures in making comparisons.

Figure 1 presents a graph generated by CPA of the net annual returns for both the cherry alternative (base plan) and the Fuji apple alternative (comparison plan).

Accumulated Returns

A CPA-generated graph of the annual and accumulated net returns for the base plan (cherries) is presented in Figure 2. Similarly, Figure 3 provides a graph of the annual and accumulated net returns for the comparison plan (Fuji apples).

Table 5 reports the returns, costs, net returns, and the accumulated net returns on an annual basis for both alternatives. As shown by the cash flow implications, during the first year, the costs of establishing the Fuji apple orchard are considerably higher ($14,329) than the first year of establishment for the cherry orchard ($8,765). However, it is predicted the Fuji apples will begin producing in the second year, and by the end of year 4 a per acre net cost of $17,502 will have accumulated.

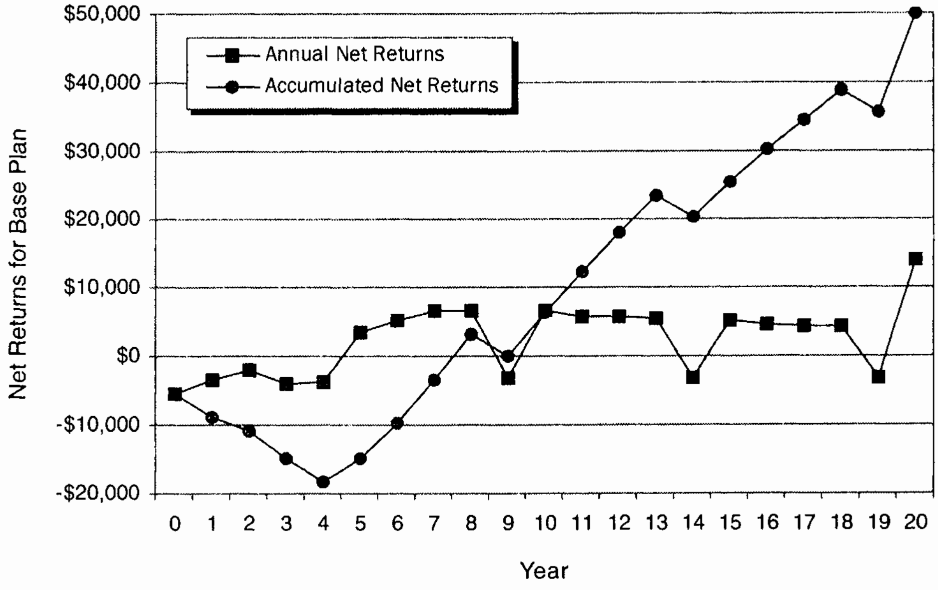

Figure 2. Annual and Accumulated Net Returns for Base Plan (Cherries)

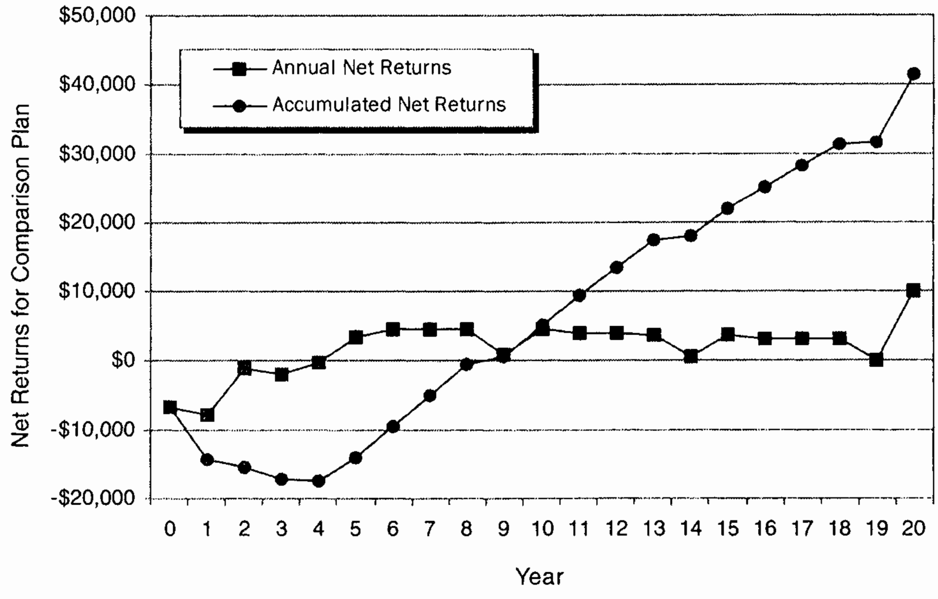

Figure 3. Annual and Accumulated Net Returns for Comparison Plan (Fuji Apples)

Table 5. Accumulated Net Returns

	Base Plan:* Cherry Orchard			
Year	**Annual Returns ($)**	**Annual Cost ($)**	**Net Annual Returns ($)**	**Accumulated Net Returns ($)**
UFI	0.00	5,423.25	(5,423.25)	(5,423.25)
1	0.00	3,342.09	(3,342.09)	(8,765.34)
2	0.00	2,016.50	(2,016.50)	(10,781.83)
3	0.00	3,999.71	(3,999.71)	(14,781.54)
4	0.00	3,580.35	(3,580.35)	(18,361.89)
5	8,250.00	4,810.27	3,439.73	(14,922.16)
6	10,687.50	5,582.70	5,104.80	(9,817.36)
7	12,825.00	6,392.20	6,432.80	(3,384.56)
8	12,825.00	6,392.20	6,432.80	3,048.24
9	0.00	3,078.54	(3,078.54)	(30.30)
10	12,825.00	6,392.20	6,432.80	6,402.50
11	12,150.00	6,392.20	5,757.80	12,160.30
12	12,150.00	6,392.20	5,757.80	17,918.10
13	11,785.50	6,292.79	5,492.71	23,410.81
14	0.00	3,078.54	(3,078.54)	20,332.27
15	11,421.00	6,193.38	5,227.62	25,559.89
16	10,786.50	6,193.38	4,593.12	30,153.01
17	10,442.25	6,093.97	4,348.28	34,501.29
18	10,442.25	6,093.97	4,348.28	38,849.57
19	0.00	3,078.54	(3,078.54)	35,771.03
20	20,098.00	5,994.56	14,103.44	49,874.46

(extended . . .)

Summary:	**Base Plan**	**Comparison Plan**
Year returns are greater than annual costs	5	5
Year returns are greater than total costs of all previous years	8	9
Total cash costs to establish orchard	$18,361.89	$17,502.06

* Percent Change Table is in use.

In contrast, sweet cherries do not begin producing until year 5, at which time a per acre net cost of $14,922 will have accumulated. For both alternatives, year 5 is the year that returns are predicted to be greater than expenses.

It is also predicted that by the end of year 8 the cherry orchard will have recovered all establishment costs and be approximately $3,000 per acre to the positive. Fuji apples, on the other hand, are predicted to take until year 9 before recovering all establishment costs, and at that time be approximately $705 per acre to the positive. If money must be borrowed to establish the orchard, the producer will need to borrow approximately $800 more per acre to establish the cherry orchard; however, the ability to pay back the loan in a shorter period of time is much more likely than if the producer established Fuji apples.

Net Present Value Profile

CPA-generated graphs of the net present value profile and the annual equivalent profile are presented in Figures 4 and 5, respectively, followed by Table 6 which reports the net present value and the annual equivalent for the base (cherries) and comparison (Fuji apples) plans at discount rates ranging from 0% to 40%.

Table 5. Extended

	Comparison Plan:* Fuji Apple Orchard			
Year	**Annual Returns ($)**	**Annual Cost ($)**	**Net Annual Returns ($)**	**Accumulated Net Returns ($)**
UFI	0.00	6,652.00	(6,652.00)	(6,652.00)
1	0.00	7,676.59	(7,676.59)	(14,328.59)
2	1,000.00	2,121.23	(1,121.23)	(15,449.83)
3	3,000.00	4,780.17	(1,780.17)	(17,230.00)
4	2,500.00	2,772.06	(272.06)	(17,502.06)
5	7,000.00	3,508.89	3,491.11	(14,010.94)
6	8,550.00	3,984.63	4,565.38	(9,445.57)
7	8,550.00	3,984.63	4,565.38	(4,880.19)
8	8,550.00	3,984.63	4,565.38	(314.82)
9	4,275.00	3,254.75	1,020.25	705.44
10	8,550.00	3,984.63	4,565.38	5,270.81
11	8,100.00	3,984.63	4,115.38	9,386.19
12	8,100.00	3,984.63	4,115.38	13,501.56
13	7,857.00	3,940.83	3,916.17	17,417.73
14	3,928.50	3,232.85	695.65	18,113.38
15	7,614.00	3,897.04	3,716.96	21,830.34
16	7,191.00	3,897.04	3,293.96	25,124.30
17	6,961.50	3,853.25	3,108.25	28,232.56
18	6,961.50	3,853.25	3,108.25	31,340.81
19	3,366.00	3,167.16	198.84	31,539.65
20	13,732.00	3,809.45	9,922.55	41,462.20

In this example, at all discount rates the base plan has a higher net present value and annual equivalent. This table also shows that the internal rate of return for the base plan is 14.93% and 12.46% for the comparison plan. However, since the annual net returns value for the base plan changes signs more than once (as shown in Figure 2 and Table 5), the IRR displayed for the base plan may be misleading. Nevertheless, as illustrated in the net present value profile graph in Figure 4 and the annual equivalent profile graph in Figure 5, 14.93% IRR for the basic plan appears to be correct. Furthermore, by going back and setting the discount rate to 14.93% in the analysis, the net present value of the base plan becomes zero.

Summary of Example Analysis

Under the given assumptions of the example analysis between sweet cherries (the base plan) and Fuji apples (the comparison plan), the CPA analysis reveals the sweet cherries scenario would be more profitable. The main factor determining which plan to choose is how vulnerable the decision maker thinks sweet cherries are going to be to adverse weather as compared to the vulnerability of Fuji apples.

In the example analysis, it was assumed sweet cherries would completely freeze out every five years, and Fuji apples would lose 50% of their production potential every five years. Given these and the other assumptions that went into this analysis, when using a 12% discount rate, the base plan (sweet cherries) displays a higher per acre net present value ($3,640) and annual equivalent ($487) than does the Fuji apple comparison plan ($605 and $81, respectively). Furthermore, an internal rate of return of 14.93% is found for sweet cherries as compared to 12.46% for Fuji apples.

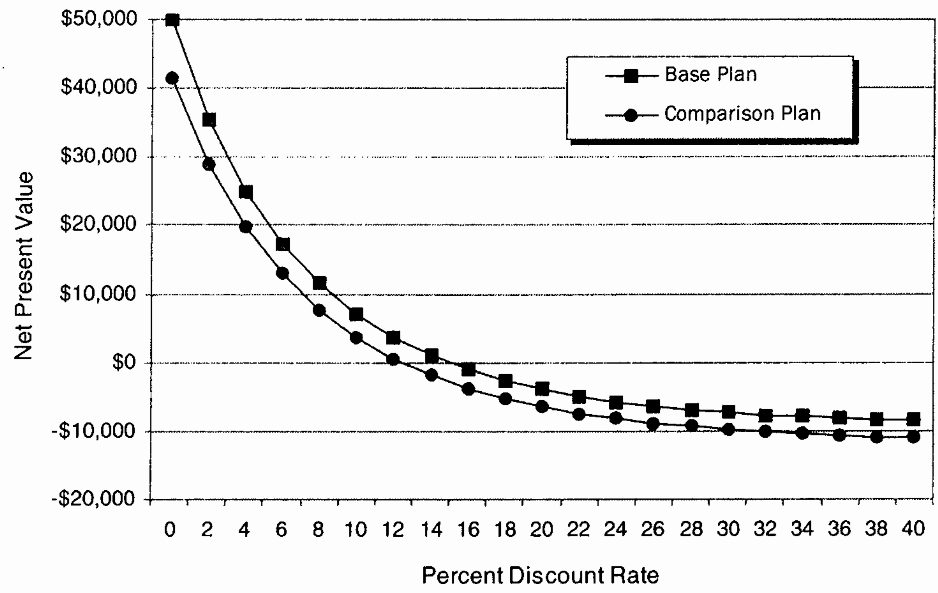

Figure 4. Net Present Value Profile Graph

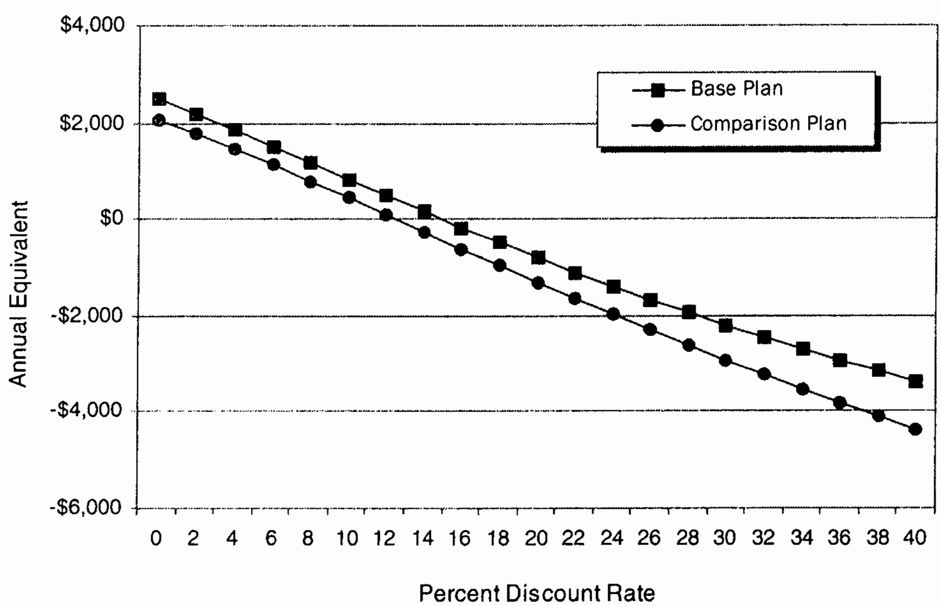

Figure 5. Annual Equivalent Profile Graph

Table 6. Net Present Value Profile

Discount Rate (%)	Net Present Value: Base:* Cherries ($)	Net Present Value: Comparison:* Fuji Apples ($)	Annual Equivalent: Base:* Cherries ($)	Annual Equivalent: Comparison:* Fuji Apples ($)
0	49,874.46	41,462.20	2,493.72	2,073.11
2	35,566.88	28,981.88	2,175.15	1,772.44
4	25,082.45	19,771.50	1,845.61	1,454.82
6	17,303.78	12,886.19	1,508.62	1,123.48
8	11,465.07	7,676.16	1,167.74	781.83
10	7,034.82	3,688.84	826.31	433.29
12	3,639.61	605.08	487.27	81.01
14	1,013.92	(1,802.94)	153.09	(272.22)
16	(1,033.28)	(3,699.76)	(174.28)	(624.03)
18	(2,641.01)	(5,205.61)	(493.39)	(972.51)
20	(3,911.52)	(6,409.36)	(803.26)	(1,316.20)
22	(4,920.84)	(7,377.35)	(1,103.26)	(1,654.02)
24	(5,726.09)	(8,159.68)	(1,393.12)	(1,985.20)
26	(6,370.60)	(8,794.54)	(1,672.80)	(2,309.28)
28	(6,887.52)	(9,311.32)	(1,942.44)	(2,626.01)
30	(7,302.48)	(9,732.85)	(2,202.33)	(2,935.30)
32	(7,635.43)	(10,077.02)	(2,452.85)	(3,237.20)
34	(7,902.04)	(10,357.96)	(2,694.43)	(3,531.84)
36	(8,114.71)	(10,586.93)	(2,927.54)	(3,819.45)
38	(8,283.30)	(10,772.95)	(3,152.68)	(4,100.25)
40	(8,415.75)	(10,923.31)	(3,370.33)	(4,374.55)

Internal Rate of Return (IRR):

	Base Plan*	Comparison Plan*
Beginning Investment Value	$3,500.00	$3,500.00
Ending Investment Value	$10,000.00	$7,000.00
Internal Rate of Return	14.93% [a]	12.46%

* Percent Change Table is in use.

[a] Caution: The IRR displayed for the Base Plan may be misleading. This is because net returns change signs more than once over the years in the plan.

In terms of cash flow, over a five-year period, approximately $800 more per acre will be required to establish the cherry orchard compared to the Fuji apple orchard. However, due to predicted higher future returns, the cherry orchard will likely be able to pay off the establishment costs about a year earlier than its Fuji apple orchard counterpart.

A Final Note

A copy of the CPA and Budget Editor programs can be obtained by going to the CPA website at http://oregonstate.edu/dept/mcarec/decision_tools/. At this website a potential user can download the CPA computer program, the Budget Editor program, the user manual, and all currently stored budget and analysis files. This website will be continually updated with respect to changes to the CPA and Budget Editor programs, as well as new and updated budget and analysis files. Any one of the three authors may also be contacted if problems arise when attempting to download from the web.

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