Crop Insurance in the Midsouth

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CONTENTS

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EXECUTIVE SUMMARY

An analysis of crop insurance participation, loss experience, and premium rates is presented for cotton and soybeans in the Midsouth states of Arkansas, Louisiana, and Mississippi. Growers in the region purchase significantly less buy-up, multiple-peril crop insurance (MPCI) than growers in other regions of the U.S.

The Midsouth's low MPCI participation is partly due to premium rates, which are higher than those found in many other regions. A whole-farm simulation model reveals that for growers in the Midsouth, buy-up MPCI purchasing may actually increase the probability of eventual insolvency. Current high premium rates are the result of past loss experience. Contract design flaws, moral hazard, and adverse selection have all contributed to a history of large losses in the region. Recent program changes have been designed to address many of these problems. To the extent that these program changes have addressed historical problems, premium rates based on historical losses may overestimate current loss risks.

A non-parametric simulation model was used to generate unit-level, break-even MPCI premium rates. The simulated premium rates are significantly lower than current MPCI premium rates. This suggests that premium rates could be reduced if recent program changes have adequately addressed historical problems. However, due to various model restrictions and data limitations, these findings should be interpreted as preliminary. Needs for future research are presented.

INTRODUCTION

The Federal Crop Insurance Program (FCIP) provides a variety of yield and revenue insurance products to U.S. crop growers. Some of these products provide insurance protection against yield losses while others provide protection against revenue (the product of yield and price) losses.

The FCIP is a public-private partnership between the federal government and private-sector insurance companies. Traditionally, the Risk Management Agency (RMA) of the U.S. Department of Agriculture (USDA) developed all FCIP products and established premium rates. Recently, private insurance companies have developed and rated some new FCIP products. Insurance revenues are shared between the RMA and private insurance companies as is the liability for paying any insurance claims. Private insurance companies are wholly responsible for all sales and loss adjustment activities. RMA subsidizes the premiums charged to growers, provides reinsurance for the loss risk exposure assumed by private insurance companies, and reimburses private insurance companies for administrative and operating expenses.

While revenue insurance products have recently become available in the Midsouth, this report will focus on the FCIP's traditional crop yield insurance product, known as Multiple-Peril Crop Insurance (MPCI). This is the product most widely used by Midsouth growers. However, it should be noted that many of the issues raised here with regard to MPCI are also relevant for Crop Revenue Coverage (CRC), the revenue insurance product most widely available in the region. This is because the yield risk portion of CRC premium rates is based on MPCI premium rates.

An MPCI policyholder establishes an actual production history (APH) yield based on the grower's actual verifiable production records for the most recent 10 years on the insured unit. If the grower does not have 10 years of production records, an APH yield can be based on as little as 4 years of yield data. Growers who cannot provide at least 4 years of actual production records are penalized by receiving less insurance protection per premium dollar. The APH yield is extremely important since it is used to determine the dollar amount of protection being purchased, as well as the yield threshold below which an indemnity will be paid to the policyholder.

Growers of eligible crops can obtain a catastrophic (CAT) MPCI policy by paying an administrative fee of $60 per crop per county. The federal government fully subsidizes the insurance premium on CAT policies. The CAT policy pays indemnities equal to 55% of the expected market price on yield losses greater than 50% of expected yield. While the policy provides very minimal insurance protection – only 27.5% of the expected crop value would be covered in the event of a complete crop loss – the cost to growers is also very low.

Growers may also choose to "buy-up" to higher levels of insurance protection. While CAT policies cover only 50% of the expected yield, buy-up policies are available that will cover up to 75% of the expected yield. Coverage levels up to 85% are available in some regions but not in the Midsouth. CAT policies indemnify covered losses at 55% of expected market price but buy-up policies will indemnify covered losses at up to 100% of expected market price.

CAT policies are based on "basic" units that allow for the production of a given crop in a given county to be insured separately according to share-partners. Each share-rent partner constitutes a different basic unit. Owned land and cash-rented land together constitute a basic unit. Buy-up policyholders can further divide their production of a given crop in a given county into subdivisions of basic units known as optional units. The criteria for establishing optional units vary across crops and geographic areas but typically require that parcels have separate USDA Farm Service Agency (FSA) serial numbers and/or be located in different sections.

Policies on optional units are more likely to be indemnified than policies on basic units. As production is aggregated into larger and larger units, the law of large numbers ensures that there will be less variation in yield around the expected value. For this reason, buy-up policyholders who take advantage of optional units forego a premium discount available to those who are willing to insure their production at the basic unit level.

RESEARCH OBJECTIVES

This bulletin will later show that crop growers in the Midsouth purchase very little buy-up MPCI. This is paradoxical since premiums are heavily subsidized by the federal government. Further, MPCI has historically paid out more in indemnities to farmers than has been received in farmer premiums and federal premium subsidies. So, in the aggregate, those who have purchased MPCI have actually found it profitable – something that cannot be said for any other type of insurance. *So why do so few growers purchase an insurance policy that costs far less than what the policy has historically paid in indemnities?* This is the motivating question for this research effort, which includes five specific objectives:

1. Describe historical FCIP experience in the Midsouth.
2. Assess the efficacy of crop insurance purchasing as a risk management strategy for farms in the Midsouth.
3. Collect and analyze anecdotal information about the historical evolution of the crop insurance market in the Midsouth.
4. Develop statistical models to calculate non-parametric, simulation-based premium rates for cotton and soybean MPCI in the Midsouth.
5. Compare simulated premium rates with current RMA experience-based premium rates.

MIDSOUTH FCIP EXPERIENCE

Midsouth crop growers purchase less buy-up MPCI than growers in other states. Figure 1 shows 1998 net buy-up acres insured relative to planted acreage for cotton and soybeans in the U.S. as a whole and in the Midsouth states of Arkansas, Louisiana, and Mississippi. In general, Midsouth growers are more likely to insure soybeans than cotton. Mississippi growers purchase more insurance than Louisiana growers, who purchase more insurance than Arkansas growers. However, the percentage of eligible cotton and soybean acreage insured in all three Midsouth states is less than national averages. In 1998, only 1% of eligible Arkansas cotton acreage was insured above the CAT level. Only 4% of eligible Louisiana cotton acreage was insured above the CAT level.

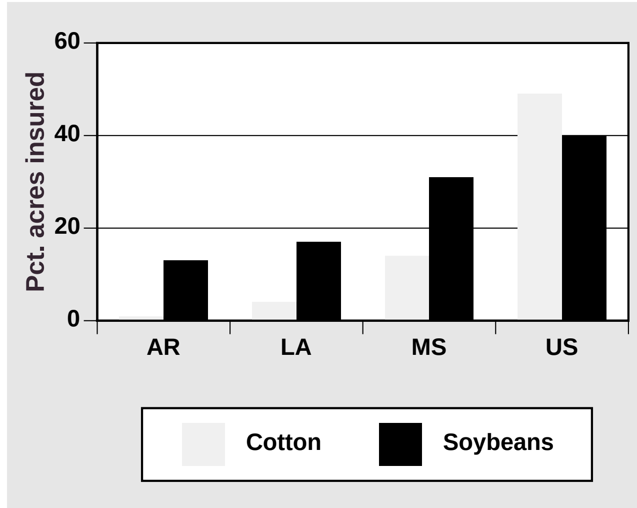


Figure 1. 1998 MPCI Buy-up Participation

Loss Ratio and Loss Costs

Related to the issue of low participation is the historically poor actuarial performance of crop insurance in the region. Figures 2-7 compare the loss ratio in each of the three states to national averages for cotton and soybean buy-up MPCI. A loss ratio is equal to indemnities divided by premiums (including government subsidies). Thus, a loss ratio of 1.00 indicates that the insurer "broke even" for the period. A loss ratio greater than 1.00 signifies underwriting losses (indemnities greater than premiums). A loss ratio less than 1.00 signifies underwriting gains (indemnities less than premiums). On average since 1981, buy-up MPCI loss ratios for cotton in Arkansas and Louisiana have been higher than for cotton in the U.S. as a whole (Figure 8). Mississippi cotton loss ratios have been slightly less than national averages. For most years, loss ratios in the region have been greater than 1.00, indicating underwriting losses on cotton buy-up MPCI business.

Figure 2. Arkansas and U.S. Cotton Buy-up Insurance Loss Ratios

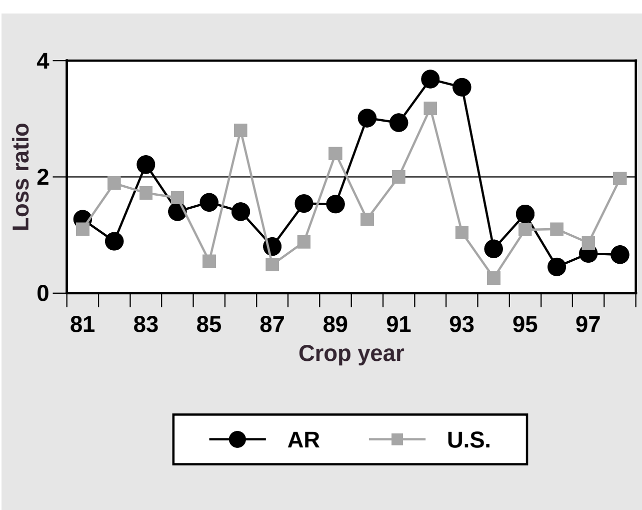
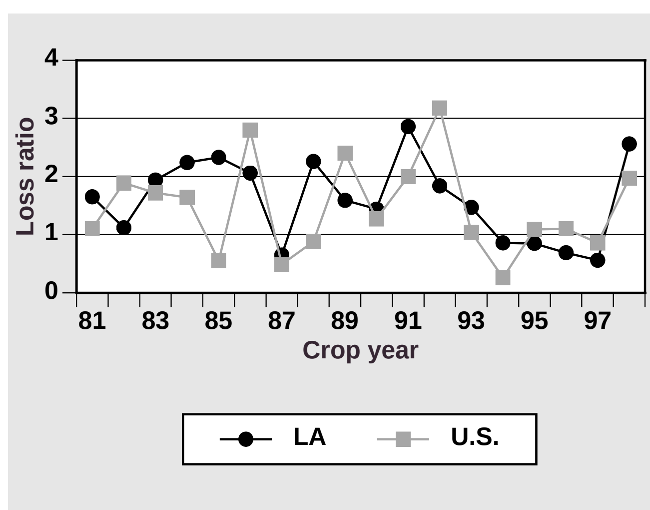


Figure 3. Louisiana and U.S. Cotton Buy-up Insurance Loss Ratios



Since 1981, soybean loss ratios in all three Midsouth states have been well above national averages. The annual average loss ratio for Louisiana and Mississippi soybeans is approximately 2.00 (Figure 9). This indicates that since 1981 soybean buy-up MPCI policies sold in these states have paid out twice as much in indemnities as has been received in premiums. The annual average loss ratio for Arkansas is slightly less at approximately 1.70.

Figures 10-15 compare the loss cost for cotton and soybean buy-up MPCI in each of the three states to national averages. Loss cost is equal to indemnities divided by the dollar amount of insurance protection outstanding (liability). It indicates what percentage of the insurer's loss exposure was actually paid in indemnities during a given period. On average since 1981, buy-up MPCI loss costs for cotton in Arkansas and Louisiana have been slightly higher than for cotton in the U.S. as a whole (Figure 16). Mississippi cotton loss cost has been well below national averages. For soybeans, Louisiana has had the highest loss cost, but all three states have experienced loss costs that are approximately three times national averages (Figure 17).

Figure 4. Mississippi and U.S. Cotton Buy-up Insurance Loss Ratios

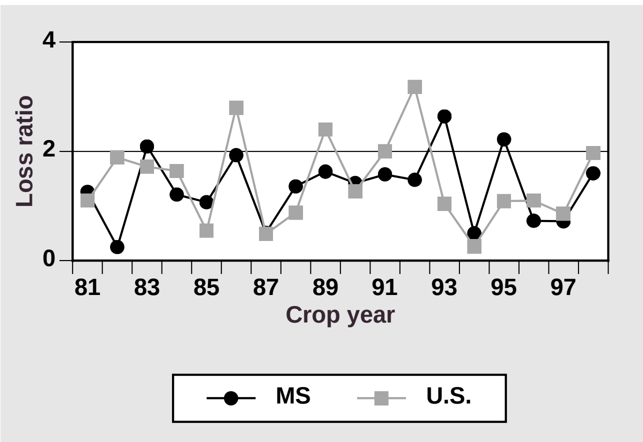


Figure 5. Arkansas and U.S. Soybean Buy-up Insurance Loss Ratios

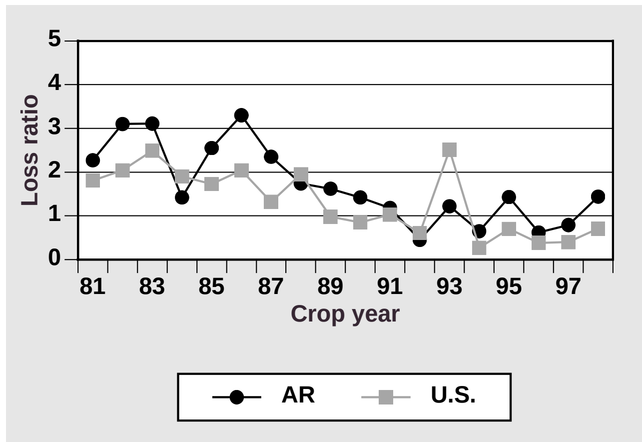


Figure 6. Louisiana and U.S. Soybean Buy-up Insurance Loss Ratios

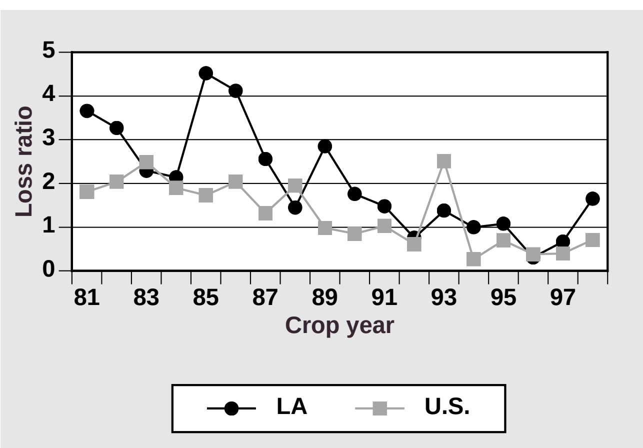


Figure 7. Mississippi and U.S. Soybean Buy-up Insurance Loss Ratios

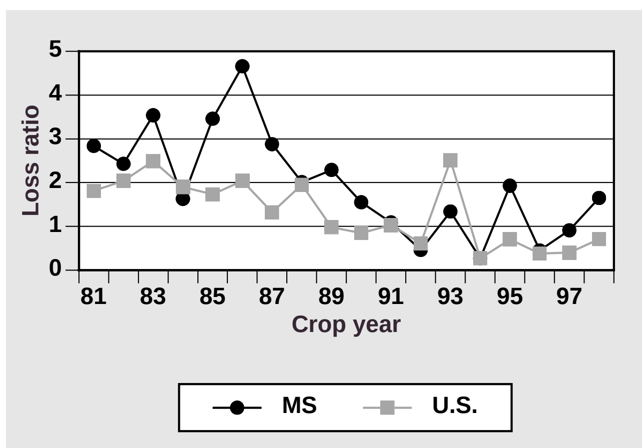


Figure 8. 1981-1998 Annual Average Cotton Loss Ratio

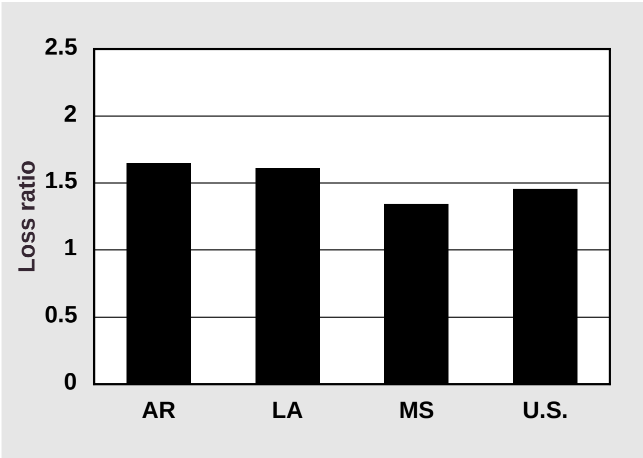


Figure 9. 1981-1998 Annual Average Soybean Loss Ratio

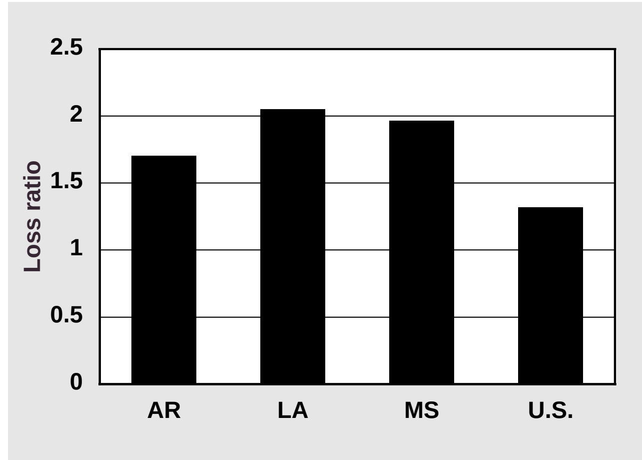


Figure 10. Arkansas and U.S. Cotton Buy-up Insurance Loss Costs

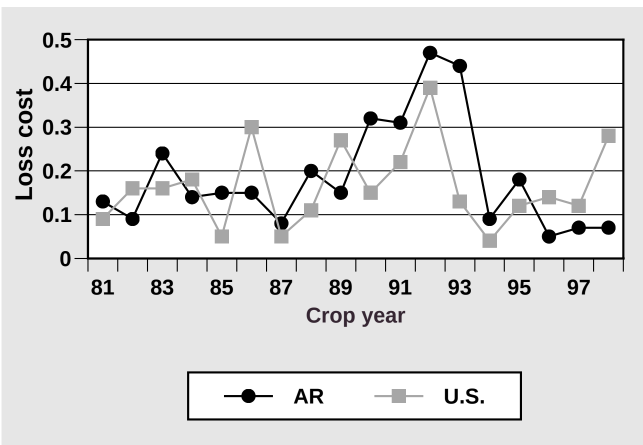


Figure 11. Louisiana and U.S. Cotton Buy-up Insurance Loss Costs

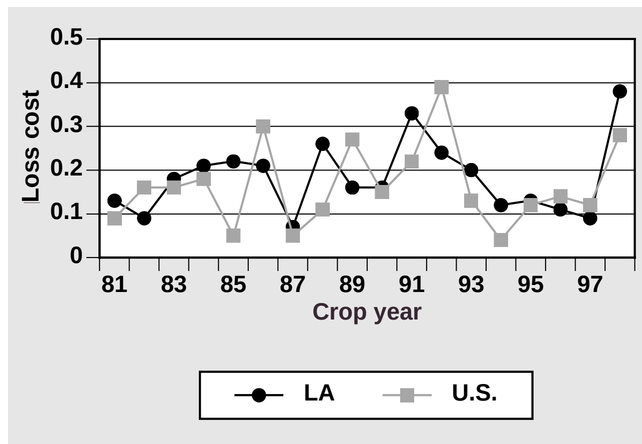


Figure 12. Mississippi and U.S. Cotton Buy-up Insurance Loss Costs

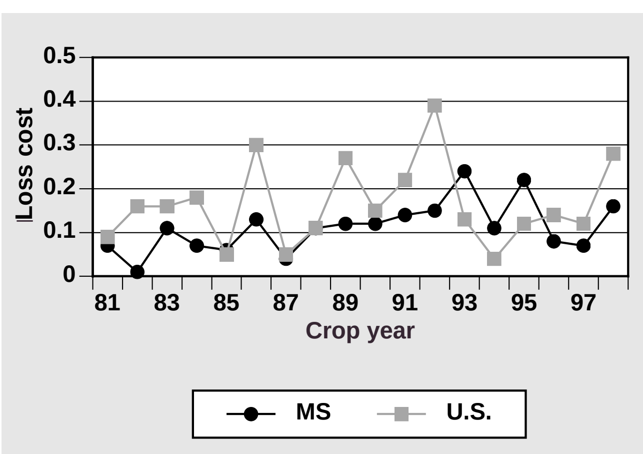


Figure 13. Arkansas and U.S. Soybean Buy-up Insurance Loss Costs

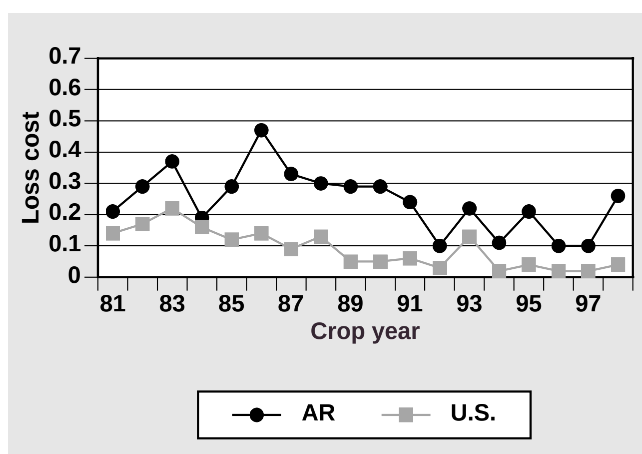


Figure 14. Louisiana and U.S. Soybean Buy-up Insurance Loss Costs

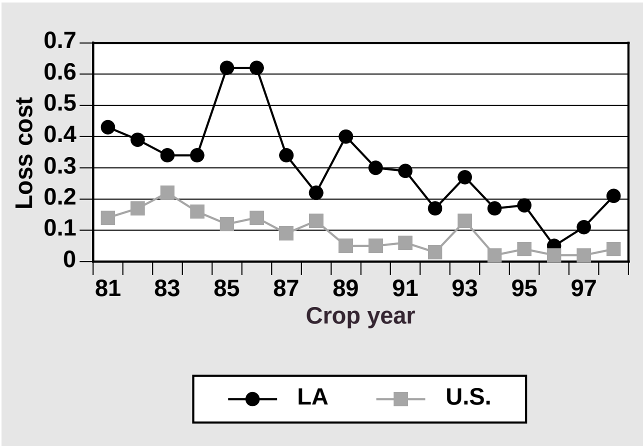


Figure 15. Mississippi and U.S. Soybean Buy-up Insurance Loss Costs

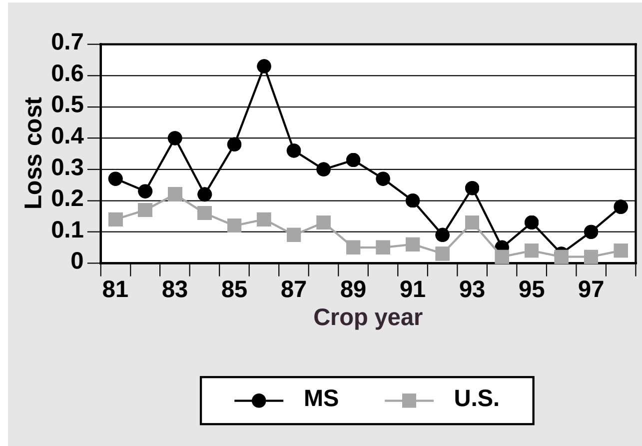


Figure 16. 1981-1998 Annual Average Cotton Loss Cost

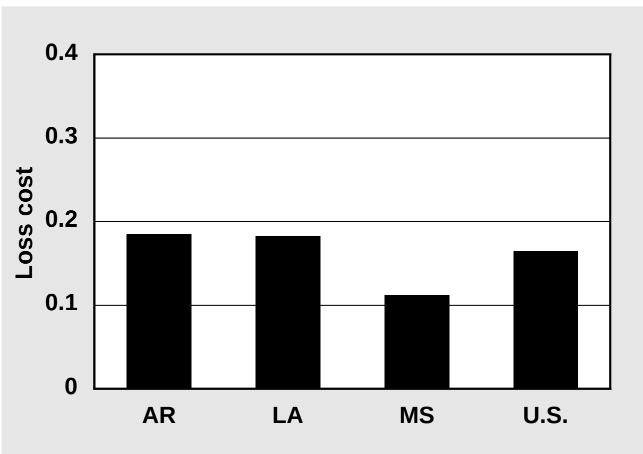
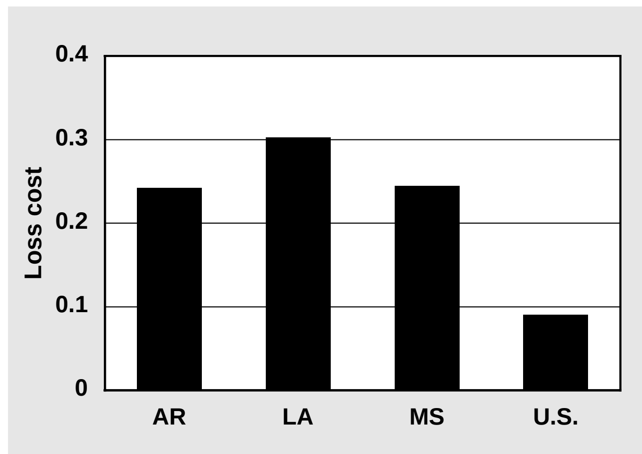


Figure 17. 1981-1998 Annual Average Soybean Loss Cost

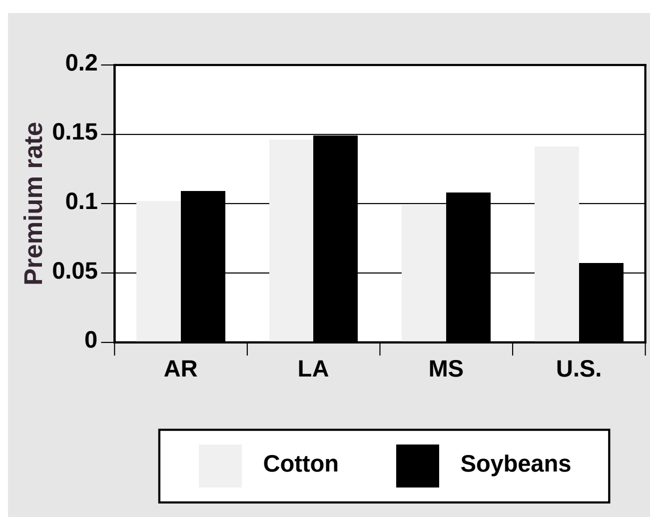


Premium Rates

A premium rate is the price of the insurance product (the premium) divided by the dollar amount of protection purchased. For example, if a grower pays $4 in premium for every $100 of crop insurance protection, the premium rate is 4%.

Figure 18 presents 1998 average buy-up premium rates, weighted by liability, for the three Midsouth states and the U.S. as a whole. Assuming comparable buy-up coverage levels across regions, cotton premium rates in Arkansas and Mississippi are lower than the national average, while cotton premium rates in Louisiana are slightly higher than the national average. However, Midsouth cotton producers would argue that this comparison is misleading. A large proportion of U.S. cotton is produced in the high plains of Texas. Due to the large annual variability in rainfall in that region, cotton pro-

Figure 18. 1998 MPCI Buy-up Weighted Average Premium Rate



duction in the Texas high plains is generally considered to be much riskier than cotton production in the Midsouth. Cotton growers in Texas also purchase much more buy-up MPCI than do growers in the Midsouth. Thus, the national weighted average premium rate for cotton is likely inflated due to high-risk Texas producers being disproportionately represented. Midsouth cotton producers argue that their cotton buy-up MPCI premium rates should be even lower relative to the national average.

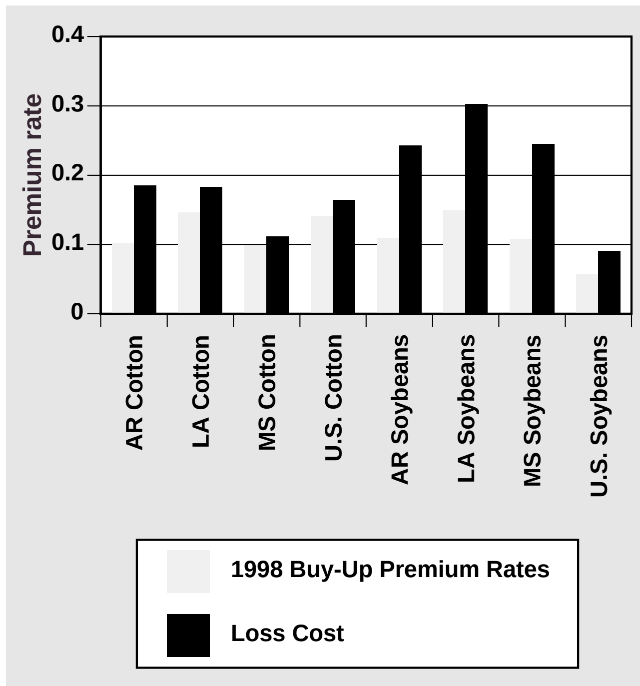
Soybean buy-up MPCI premium rates in Arkansas and Mississippi are approximately double the national average. Soybean buy-up premium rates in Louisiana are approximately triple the national average.

Comparing Premium Rates to Loss Costs

Growers in the Midsouth contend that participation in buy-up MPCI is low because the premium rates are exorbitant. An insurer who desired to break even (loss ratio = 1) over the long run would establish a premium rate equal to the expected loss cost. But Figure 19 demonstrates that the average loss cost since 1981 is greater than the weighted average buy-up premium rate for 1998. Said differently, since 1981 insurance purchasers in the region have, on average, received more indemnity dollars per year on buy-up MPCI than the premium cost for 1998. While this is true for both cotton and soybeans in all three Midsouth states, the comparison for soybeans is particularly striking. While soybean buy-up MPCI premium rates in the Midsouth are two to three times the national average, the 1981-98 annual average loss costs for soybeans in the Midsouth are four to five times the national average.

Simply put, premium rates are high in the Midsouth because historical losses have been high. Further, growers do not pay the full premium cost. Buy-up MPCI policies are heavily subsidized by the federal government. We are back to the paradox that motivates this research. *Why do so few growers purchase an insurance policy that costs far less than what the policy has historically paid in indemnities?* The remainder of this report is directed toward answering that question.

Figure 19. 1998 MPCI Buy-up Weighted Average Premium Rate and 1981-98 Annual Average Loss Cost



WHOLE-FARM FINANCIAL SIMULATION

To better understand why so few Midsouth growers purchase buy-up MPCI, a whole-farm financial simulation model was used to estimate probability distributions of ending net worth under four different insurance alternatives, as well as the base case of no insurance. The financial simulation model produces annual financial information for a 10-year period. Nonstochastic variables include acres of each crop, costs of production, government program characteristics, and other items. Prices and yields are modeled as stochastic variables.

The representative farm contained 1,545 acres and was located in the Delta area of Mississippi. Planted acreage included 380 acres of nonirrigated cotton, 240 acres of irrigated cotton, 650 acres of nonirrigated soybeans, 120 acres of irrigated soybeans, and 155 acres of fallow. The grower was assumed to own 730 acres and rent 815 acres. Beginning assets were equal to $1,266,450. Beginning liabilities were $189,593.

Historical yield and price data were used to fit parametric distributions for cotton and soybean yields and prices (Tables 1 and 2). The procedures used to select appropriate parametric distributions and fit the parameters of these distributions are described in Spurlock, et al. In addition, correlation coefficients were estimated across the stochastic variables (Table 3). The simulation model was built as an Excel spreadsheet with the add-in program @Risk used to generate observations on the stochastic variables. The model was run assuming various levels of MPCI coverage across three scenarios: insurance purchased on cotton only, insurance purchased on soybeans only, and insurance purchased on both cotton and soybeans.

Table 1. Estimated parameters of probability density functions for cotton and soybean yields.

Crop	Distribution	Mean	Std. dev.
Nonirrigated cotton (lb/A)	Normal	811	207
Irrigated cotton (lb/A)	Normal	1,048	214
Nonirrigated soybean (bu/A)	Gamma	25.0	9.3
Irrigated soybean (bu/A)	Gamma	32.8	6.2

Table 2. Estimated parameters of probability density functions for cotton and soybean prices.

Price	Distribution	Mean	Std. dev.
Cotton lint ($/lb)	Lognormal	0.613	0.071
Cotton seed ($/ton)	Lognormal	96.25	28.84
Soybeans ($/bu)	Lognormal	6.28	0.76

Table 3. Rank correlation matrix for cotton and soybean prices and yields.

Variable	ISBY	NISBY	ICLY	NICLY	SBP	CLP	CSP
Irrigated soybean yield (ISBY)	1						
Nonirrigated soybean yield (NISBY)	0.721	1					
Irrigated cotton lint yield (ICLY)	0.018	-0.164	1				
Nonirrigated cotton lint yield (NICLY)	0.248	0.103	0.733	1			
Soybean price (SBP)	-0.236	-0.176	-0.261	-0.309	1		
Cotton lint price (CLP)	0.079	-0.042	-0.127	0.430	0.212	1	
Cotton seed price (CSP)	-0.139	-0.091	-0.552	-0.382	0.794	0.406	1

For all three scenarios, the mean value of ending net worth for CAT coverage was higher than that for no insurance. Yet the mean value of ending net worth for any level of buy-up coverage was lower than that for CAT (Tables 4, 5, and 6). When insuring soybeans only, higher levels of buy-up coverage reduced the probability of eventual insolvency (Table 4). *When insuring either cotton only or cotton and soybeans, purchasing any coverage beyond the CAT level actually increased the probability of insolvency* (Tables 5 and 6). This rather counterintuitive result occurred because buy-up MPCI reduced expected ending net worth without greatly reducing the standard deviation of ending net worth. To the extent that these results can be generalized, the model implies that farmers in the region are making a rational economic decision by not purchasing MPCI beyond the CAT level. The small percentage of farmers who actually purchase buy-up MPCI may do so because they face more yield risk than that assumed in the model. Alternatively, lenders may be requiring buy-up MPCI to collatoralize loans – and unwittingly may be increasing the probability of default.

Table 4. Ending net worth with MPCI insurance for soybeans only.

Coverage levels	Mean net worth ($)	Std. dev. of net worth ($)	Prob. (net worth < 0)
No insurance	1,059,781	1,155,729	.19090
CAT	1,064,732	1,149,237	.19088
50/100	1,041,842	1,148,483	.19309
65/100	1,020,816	1,147,273	.18817
75/100	958,293	1,150,227	.18784

Table 5. Ending net worth with MPCI insurance for cotton only.

Coverage levels	Mean net worth ($)	Std. dev. of net worth ($)	Prob. (net worth < 0)
No insurance	1,059,781	1,155,729	.19090
CAT	1,064,439	1,145,061	.19090
50/100	1,015,032	1,144,899	.19533
65/100	957,926	1,118,217	.19369
75/100	821,117	1,090,209	.21369

Table 6. Ending net worth with MPCI insurance for cotton and soybeans.

Coverage levels	Mean net worth ($)	Std. dev. of net worth ($)	Prob. (net worth < 0)
No Insurance	1,059,781	1,155,729	.19090
CAT	1,069,390	1,138,488	.19088
50/100	996,991	1,137,481	.19752
65/100	917,744	1,108,288	.19487
75/100	712,359	1,082,953	.25664

POSSIBLE EXPLANATIONS

The financial simulation model lends credence to a common sentiment among Midsouth crop growers. *Many current Midsouth crop growers do not believe that historical loss experience accurately represents what they can expect to receive in indemnities on buy-up MPCI policies.* There are at least three possible explanations for why historical loss experience might deviate from current expectations: program design flaws, moral hazard, and adverse selection. In this section each is discussed in turn, with examples drawn from MPCI experience in the region.

Program Design Flaws

The Crop Insurance Improvement Act of 1980 was designed to greatly increase participation in the federal crop insurance program. This was to be accomplished through premium subsidies, private-sector sales of federal crop insurance policies, as well as expansion into new crops and regions. Policymakers hoped that rapid increases in crop insurance participation would replace the need for future crop disaster payments.

Some have suggested that costly crop insurance program design flaws occurred as a result of the rapid expansion into new crops and regions during the early 1980s and the emphasis on greater participation (Skees et al.). Most commonly, program design flaws created situations where APH yields exceeded true expected yields.

Cotton FSA Program Yields

Before 1996, the FSA (earlier known as the Agricultural Stabilization and Conservation Service) generated program yields for purposes of calculating commodity program payments due to growers. There is strong evidence that these program yields were generally higher than true expected yields throughout much of the 1980s and into the early 1990s (Barnett and Skees).

Frequently during the 1980s, cotton growers were allowed to meet farm program set-aside requirements by skipping rows within a field rather than setting aside one contiguous parcel of land. A common skip-row pattern was to plant two rows and then skip one. With this skip-row pattern, each planted acre was considered equal to two-thirds of an acre of solid-planted cotton. The FSA made the necessary adjustments to planted acreage for purposes of establishing program yields. But after the acreage adjustment, skip-row yields were generally higher than solid-planted cotton since the skipped rows allowed more sunlight to penetrate below the plant canopy to lower portions of the plant. Thus, FSA program yields were inflated relative to expected yields for solid-planted cotton.

For all program crops other than cotton, the weighted average of program yields within a county was scaled to be consistent with National Agricultural Statistics Service (NASS) estimated county yields. This system of "check yields," described in Barnett and Skees, insured that program yields were consistent with historical average yields. Since check yields were not used in cotton, the average of FSA program yields within a county was often higher than the NASS yield. FSA program yields were further inflated by the fact that growers were allowed to drop years with low realized yields (GAO 1986).

When crop insurance purchasers were unable to provide a sufficient number of proven yields, adjusted FSA program yields were substituted for the missing years. The adjustment process, known as D-yields for cotton and T-yields for other crops, attempted to adjust for the inflation in FSA program yields. Yet many suspect that crop insurance "proven" yields for cotton were often well above true expected yields, increasing both the likelihood that an indemnity would be paid and the magnitude of the indemnity.

Soybean Flood Irrigation

In areas where drought is a major cause of loss, irrigated crop production should be significantly less risky than nonirrigated production. For this reason, MPCI premium rates for irrigated soybean production in the Midsouth were historically set lower than those for nonirrigated production. Growers who irrigated also received higher T-yields (or D-yields) than growers who did not.

In the Midsouth, it is common to irrigate soybeans by building levies around fields and then flooding the fields much like rice paddies. Soybeans irrigated in this manner sometimes turn yellow, wilt, and then die – a condition known locally as "scalding." As indicated by the name, it is commonly believed that this condition is due to excessive heat. Local lore suggests that scalding results from sunlight reflecting off the water, from steam, or from sunlight overheating the irrigation water. The real cause of scalding is depleted oxygen in the root zone due to the soil being completely saturated with water.

Throughout the 1980s, the federal crop insurance program paid large indemnities on flood-irrigated soybeans. Frequently, when hot, dry weather occurred, policyholders were reluctant to flood irrigate the crop due to the mistaken belief that hot weather would cause scalding. As a result, indemnities were paid on many irrigated soybean policies with the cause of loss being listed as "drought." Between 1984 and 1986, more than $18 million in crop insurance indemnities were paid on irrigated soybeans due to "drought."

Large indemnities were also paid on soybeans that were flood irrigated and subsequently scalded. The cause of loss was most frequently listed as "excess heat." In reality, most of these losses were probably the result of poor irrigation management.

Accurately measuring acreage was another problem with flood irrigation. Typically, growers did not build levies until it became obvious that irrigation would be required. Then, a levy-building implement was pulled through the field, destroying part of the crop in the process. When filing claims, growers were frequently allowed to calculate realized yields based on the full size of the field, not adjusted for the levies. This lowered realized yields, thus increasing the magnitude of any indemnity.

Any program design flaw may increase the probability of paying an indemnity and/or increase the magnitude of an indemnity. When, as a result, loss costs exceed premium rates, the insurer responds by raising premium rates. In recent years, the RMA has taken actions to address many of these program design problems. For example, there is currently no difference between irrigated and nonirrigated premium rates for soybeans in the Midsouth. Nor is there any difference between irrigated and nonirrigated T-yields. In addition, the RMA no longer allows flood irrigation as an acceptable irrigation practice for soybeans. Even if these changes rectify earlier program design flaws, the historical loss cost experience will continue to influence premium rates for many years.

Moral Hazard

Moral hazard occurs when, as a result of purchasing insurance, policyholders make production decisions that significantly increase the probability of loss and/or the magnitude of loss. Fraud is an extreme example of moral hazard. But moral hazard need not imply illegal or unethical behavior. It may be simply a subtle change in farming practices as a result of having purchased insurance – for example, choosing to forego an expensive prophylactic pesticide treatment when it is uncertain whether the pest will pose a problem during the current growing season. As with program design flaws, moral hazard can cause loss costs to exceed premium rates. And given that current premium rates are based on historical loss costs, moral hazard problems that occur at any given time will affect premium rates well into the future.

Fraud

While crop growers around the nation express concern about fraud in the federal crop insurance program, those in the Midsouth seem convinced that fraud is rampant (Coble et al., September 1999). In the past, problems occurred because there was no mechanism for tracking a grower's loss history and sharing that information across insurance companies. A grower who experienced a poor yield and received an insurance indemnity would have a lower APH yield for the subsequent year. A grower could avoid this problem by switching insurance companies in the subsequent year and filing a false realized yield for the previous year. The new company would not know that the grower had actually filed a claim for a low realized yield in the previous year. Anecdotal information indicates that independent insurance agents, who write policies for more than one insurance company, actually assisted growers in implementing this "company switching" fraud. In recent years, the FCIC has implemented a data base system that tracks insurance policies by Social Security number. This precaution should greatly reduce the potential for company switching fraud.

The availability of "optional units" facilitates a scheme currently used for committing fraud. This occurs when growers shift production across optional units. For example, suppose a grower experiences a yield loss of 20% on each optional unit. While a 20% aggregate yield loss may create financial difficulties for the grower, it will not trigger an insurance indemnity if the loss is spread evenly across all optional units. The grower may be tempted to claim that production from one optional unit was actually produced on another. By switching production across optional units a grower can claim losses on a given optional unit (or units) in excess of the deductible and thus receive an indemnity. Growers in the Midsouth have claimed for years that "production switching" across optional units is rampant. They also claim that some insurance loss adjusters knowingly participate in such complicities.

As indicated earlier, not all moral hazard problems are the result of fraud. Moral hazard can occur when growers simply respond to existing incentives in a manner that is both rational and ethical. Some Midsouth examples are described in the following material.

Cotton Stage Coverage

Unlike many crops, inputs are applied throughout the cotton growing season. Before 1988, cotton crop insurance indemnities were adjusted based on the crop's stage of production. If the crop was declared a total loss early in the growing season, when the grower had borne only a small portion of the expected variable input cost, the indemnity would be adjusted downward accordingly. In 1988, this practice was discontinued such that indemnities are no longer adjusted for the stage of production. Now, if a cotton crop is declared a disaster early in the growing season, the farmer can collect a full insurance indemnity. Excess moisture frequently causes poor stands of cotton in the delta regions of Arkansas, Louisiana, and Mississippi. Many have noted that when this type of loss occurs, uninsured farmers are busy trying to replant, while insured farmers are often waiting until they can collect an insurance indemnity and then replant the acreage to soybeans.

Irrigated Soybeans

To qualify for irrigated production, growers must simply certify that they have irrigation equipment available. Growers are not necessarily required to use the irrigation equipment on the insured crop.

In the Midsouth, many crop growers produce both cotton and soybeans. Cotton is a high-value crop that requires extensive inputs. Mississippi State University planning budgets for cotton indicate per-acre variable costs of production in the state well in excess of $400 per acre. By comparison, soybeans are a low-value, low-input crop. Mississippi State University planning budgets for soybeans indicate per-acre variable costs of production that are generally less than $125 per acre. A grower with irrigation equipment can insure both cotton and soybeans with an irrigated practice designation. But in times of drought, a rational grower will first irrigate the high-value cotton crop. Soybeans are a residual crop that will receive irrigation only after the irrigation requirements of the cotton crop have been satisfied. Thus, crop insurance program regulations for certifying an irrigated practice create opportunities and incentives for moral hazard.

Various reports on the crop insurance program have suggested that insurance agents and loss adjusters representing private insurance companies do not have sufficient incentives to control fraud and moral hazard (GAO 1992; Office of the Inspector General). These reports suggest that since private companies cannot compete on price, they compete on "service." A company with agents and/or loss adjusters known to be "grower-friendly" will have a competitive advantage. The reinsurance agreements negotiated between the RMA and private insurance companies in 1992 and 1997 were designed to increase the amount of loss risk retained by the private companies. The RMA hoped that by doing so, the companies would have greater incentives to control fraud and moral hazard problems.

Adverse Selection

Adverse selection occurs when the insurer cannot accurately classify potential policyholders according to their level of risk exposure. The insurer assumes that the potential insurance purchasers are relatively homogeneous, when the level of risk exposure actually varies widely within the group. The insurer offers to sell a policy at a given premium rate that reflects the expected risk exposure of the group. High-risk individuals will be inclined to purchase the insurance, but low-risk individuals will not. The insurer is left with a pool of insurance purchasers who are actually riskier than had been assumed when premium rates were established. As a result, indemnities are likely to exceed premiums (i.e., the loss ratio will be greater than one).

Assuming that the high loss ratio is evidence that premium rates are too low, the insurer will likely respond by raising premium rates. But this further exacerbates the problem, leading to an even more adversely selected group of insurance purchasers. The problem can only be addressed through better classification procedures that effectively differentiate high-risk growers from low-risk growers. In an adversely selected insurance market, participation may be low even when historical loss costs are well above current premium rates. Historical loss costs reflect expected loss cost only for the high-risk pool of individuals who purchase insurance. Lower risk growers, who perceive that they have a much lower expected loss cost, find current premium rates excessive and choose not to purchase insurance. This scenario would seem to describe the current market for MPCI in the Midsouth.

In 1984, FCIC indemnified 70% of soybean policies in Jackson County, Arkansas. Yet, the average county soybean yield in Jackson County for 1984 was higher than any experienced from 1975 to 1989. The average yield for Jackson County was 24 bushels per acre. The average yield for crop insurance policyholders was 13 bushels per acre. Interestingly, indemnities of $821,000 were paid for losses attributed to drought. At the same time, indemnities of $842,000 were paid for losses attributed to excess precipitation.

Consider another example. In 1988, more than 50% of soybean policyholders in Avoyelles Parish, Louisiana, were indemnified. Yet, 1988 generated the second highest average soybean yield on record for the parish. The average soybean APH yield among policyholders was just over 15 bushels per acre. The average yield for the parish was more than 30 bushels per acre, yet indemnities of more than $250,000 were paid for losses attributed to drought.

In 1985, 100% of soybean policyholders in Claiborne County, Mississippi, were indemnified. The county average yield was the second highest on record at 26 bushels per acre. The average APH yield for policyholders was just under 20 bushels per acre, and the average realized yield for policyholders was 7 bushels per acre. Excess precipitation and drought were listed as the major causes of loss.

Were these outcomes the result of fraud, moral hazard, adverse selection or some combination thereof? After the fact, and without additional information, it is difficult to determine the primary factors in these situations. Nor are these problems unrelated. For example, a history of fraud can create a severely adversely selected pool of policyholders. As losses due to fraud increase over time, premium rates will increase to cover these losses. At some point, premiums will become so high that only growers who intend to defraud the program can afford to buy insurance. This is what growers mean when they say that the only people who purchase crop insurance are those who are “farming the crop insurance program.”

ANALYSIS OF RATE STRUCTURE

In Illinois, a typical MPCI premium rate at the 65% coverage level for corn or soybeans would be approximately 4% to 5%. In Arkansas, Louisiana, and Mississippi, a typical MPCI premium rate at the 65% coverage level for cotton, soybeans, or corn would be between 10% and 15%. Compared with the low MPCI participation in the Midsouth, more than 70% of the corn acreage and almost 60% of the soybean acreage in Illinois is covered under buy-up MPCI.

It is not surprising that MPCI premium rates in the Midsouth are higher than in the Midwest. For various reasons, including soil quality and insect and disease pressure, crop production in Arkansas, Louisiana, and Mississippi is riskier than corn or soybean production in Illinois. The question is, “How much riskier?” Do the higher premium rates in the Midsouth reflect only the higher yield risk in the region? Or do the higher premium rates also reflect a history of high loss costs resulting from the contract design flaws, moral hazard, and adverse selection described in the previous section?

The analysis described in this section attempts to answer these questions by estimating unit-level, break-even MPCI premium rates. The procedures used are similar to, but not identical to, those used by Atwood, Baquet, and Watts (ABW) in rating the Income Protection revenue insurance product. Specifically, bootstrapping (random sampling with replacement) procedures are employed to simulate a large number of unit-level yield observations. The data used in the bootstrapping process are short series of unit-level yield data and longer series of county-level yield data. A non-parametric simulation model is then used to generate an expected loss cost for various crop-county combinations at three insurance coverage levels. The model is non-parametric in that no distributional assumptions are imposed on yields. As indicated earlier, expected loss costs can be thought of as break-even premium rates. A technical discussion of the simulation model is contained in the appendix.

In contrast to traditional insurance rate-making procedures based on historical realized loss costs, a simulation framework allows for the development of premium rates based solely on the variability in the underlying random variable (e.g., yield). Thus, previous problems related to contract design flaws and/or moral hazard should not affect simulated premium rates. Since the simulation model uses yield data reported by MPCI purchasers, estimated premium rates may still be affected to some degree by adverse selection problems.

Data were obtained from two sources. National Agricultural Statistical Service (NASS) county-level yield data were obtained for the years 1956-1997. Unit-level yields reported by MPCI purchasers were obtained from RMA for the years 1987-1996. Only cotton and soybean data for Arkansas, Louisiana, and Mississippi were included in the analysis.

The RMA data are for basic and optional units depending on the selection of the purchaser. Each unit may have yields reported for up to 10 years (1987-1996), but most have significantly fewer reported yields. In order to be included in the analysis, each unit was required to have at least 6 years of reported yields. In order to be included in the analysis, each crop-county combination was required to have at least 50 units that met the prior condition. Figure 20 shows the cotton counties (parishes) included in the analysis. These counties account for 76% of Arkansas cotton, 90% of Louisiana cotton, and 67% of Mississippi cotton. Figure 21 shows the soybean counties (parishes) included in the analysis. These counties account for 84% of Arkansas soybeans, 68% of Louisiana soybeans, and 77% of Mississippi soybeans.

Figure 20. Counties (Parishes) Included in Cotton Premium Rate Analysis

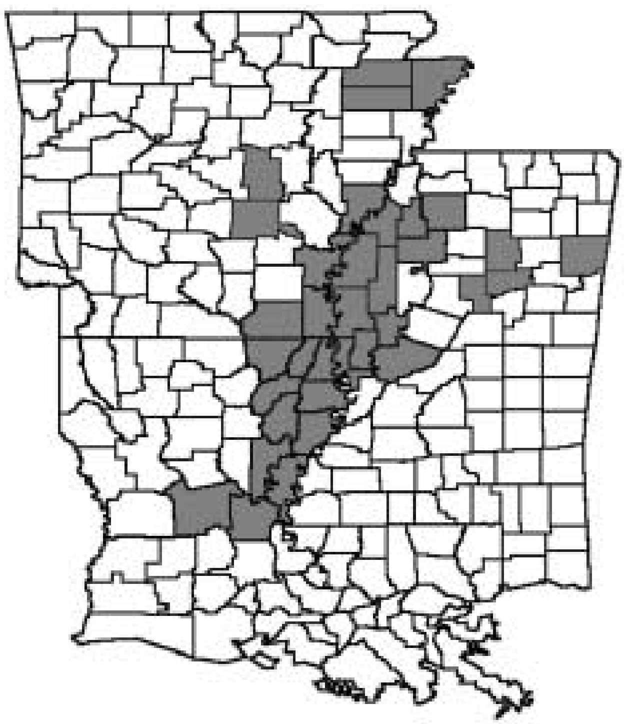
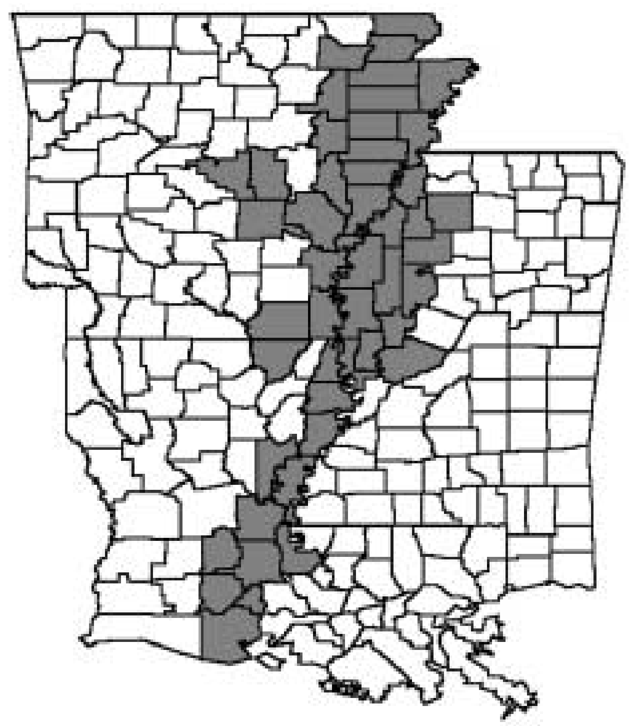


Figure 21. Counties (Parishes) Included in Soybean Premium Rate Analysis



The simulated break-even premium rates are divided by 0.88 in accordance with the standard RMA procedure for reserve loading. Tables 7-12 compare the resulting simulated break-even premium rates with 1998 unsubsidized RMA premium rates at the 75%, 65%, and 50% coverage levels. The RMA premium rates are for nonirrigated production where the APH yield is assumed equal to the predicted unit-level yield (PF_{1998}) from the simulation model.

Simulated premium rates were uniformly lower than RMA premium rates for every coverage level and every crop-county combination analyzed. Further, the mean simulated premium rates at each coverage level had much less variability across states than the mean RMA premium rates. Louisiana soybeans had the highest mean RMA premium rates. Mississippi cotton had the lowest mean RMA premium rates. Arkansas soybeans, Arkansas cotton, Mississippi soybeans, and Louisiana cotton had similar mean RMA premium rates. In comparison, mean simulated premium rates for cotton were uniformly lower than those for soybeans in each state at all three coverage levels.

For cotton, mean RMA premium rates for Louisiana are higher than those for Arkansas, which, in turn, are higher than those in Mississippi. Mean simulated premium rates had just the opposite ordering for the 75% and 65% coverage levels with Mississippi rates being highest, followed by Arkansas and Louisiana. There was no appreciable difference in mean premium rates at the 50% coverage level.

For soybeans, mean RMA premium rates for Louisiana are higher than those for Mississippi, which are higher than those in Arkansas. Mean simulated premium rates for all coverage levels were highest for Mississippi, followed by Louisiana and Arkansas.

Tables 7-12 also contain the ratio of the RMA premium rate divided by the simulated premium rate for each coverage level (*ratio*). Since RMA premium rates are uniformly greater than simulated premium rates, *ratio* is always greater than one. Cotton *ratio* at the 50% coverage level is generally larger than for higher coverage levels. Further, the variability in *ratio* is lower for higher coverage levels and higher for lower coverage levels. This increased variability may result from the nonparametric nature of the simulation model. Relative to higher coverage levels, there are far fewer simulated unit-level yields (y^s) that would trigger a loss at the 50% coverage level.

For soybeans, *ratio* is higher at the 50% coverage level only for Mississippi. Soybeans demonstrate a similar increase in the variability of *ratio* as coverage level decreases, but the increased variability is not as pronounced as in cotton.

Table 7. Comparing RMA premium rates with simulated premium rates for Arkansas cotton.

County	PF_{1998}	RMA 75% rate	Simulated 75% rate	RMA 75% rate ÷ simulated 75% rate	RMA 65% rate	Simulated 65% rate	RMA 65% rate ÷ simulated 65% rate	RMA 50% rate	Simulated 50% rate	RMA 50% rate ÷ simulated 50% rate
Ashley	999.9	0.220	0.053	4.12	0.143	0.032	4.49	0.104	0.014	7.63
Chicot	893.8	0.275	0.053	5.15	0.180	0.033	5.46	0.134	0.017	7.86
Craighead	991.6	0.173	0.080	2.17	0.112	0.056	2.01	0.081	0.031	2.64
Desha	1118.5	0.217	0.044	4.90	0.141	0.025	5.64	0.102	0.010	9.97
Jefferson	909.5	0.236	0.072	3.30	0.153	0.045	3.37	0.111	0.017	6.51
Lonoke	1069.7	0.190	0.048	3.98	0.123	0.030	4.16	0.089	0.013	7.12
Mississippi	876.2	0.152	0.091	1.67	0.099	0.067	1.48	0.072	0.043	1.67
Phillips	866.2	0.166	0.078	2.12	0.108	0.057	1.90	0.079	0.035	2.24
Poinsett	823.1	0.185	0.091	2.04	0.121	0.064	1.90	0.088	0.034	2.58
Simple Mean	949.8	0.202	0.068	2.97	0.131	0.045	2.89	0.096	0.024	4.04

Table 8. Comparing RMA premium rates with simulated premium rates for Louisiana cotton.

County	PF_{1998}	RMA 75% rate	Simulated 75% rate	RMA 75% rate ÷ simulated 75% rate	RMA 65% rate	Simulated 65% rate	RMA 65% rate ÷ simulated 65% rate	RMA 50% rate	Simulated 50% rate	RMA 50% rate ÷ simulated 50% rate
Avoyelles	955.2	0.237	0.043	5.49	0.155	0.023	6.82	0.111	0.009	12.21
Catahoula	852.9	0.228	0.078	2.91	0.149	0.057	2.62	0.107	0.034	3.14
Concordia	996.0	0.190	0.063	3.04	0.123	0.043	2.85	0.089	0.026	3.41
East Carroll	793.0	0.231	0.058	3.99	0.150	0.039	3.88	0.108	0.020	5.28
Franklin	694.5	0.212	0.058	3.66	0.138	0.034	4.05	0.100	0.015	6.77
Madison	817.6	0.301	0.053	5.64	0.196	0.036	5.39	0.141	0.025	5.64
Morehouse	874.7	0.247	0.044	5.57	0.160	0.025	6.40	0.116	0.010	11.34
Rapides	916.6	0.166	0.035	4.71	0.108	0.019	5.59	0.079	0.007	11.59
Richland	652.3	0.223	0.084	2.65	0.145	0.058	2.50	0.105	0.031	3.42
Tensas	868.1	0.201	0.078	2.56	0.131	0.063	2.10	0.095	0.049	1.94
West Carroll	563.2	0.294	0.122	2.42	0.191	0.091	2.10	0.138	0.052	2.64
Simple Mean	816.7	0.230	0.065	3.53	0.150	0.044	3.38	0.108	0.025	4.27

Table 9. Comparing RMA premium rates with simulated premium rates for Mississippi cotton.

County	PF_{1998}	RMA 75% rate	Simulated 75% rate	RMA 75% rate ÷ simulated 75% rate	RMA 65% rate	Simulated 65% rate	RMA 65% rate ÷ simulated 65% rate	RMA 50% rate	Simulated 50% rate	RMA 50% rate ÷ simulated 50% rate
Bolivar	804.6	0.152	0.088	1.74	0.099	0.059	1.68	0.072	0.028	2.53
Calhoun	704.9	0.169	0.089	1.91	0.110	0.059	1.86	0.080	0.030	2.71
Coahoma	811.7	0.155	0.083	1.87	0.101	0.059	1.71	0.073	0.035	2.07
Humphreys	928.0	0.123	0.068	1.80	0.080	0.043	1.85	0.057	0.020	2.79
Issaquena	869.9	0.190	0.052	3.63	0.124	0.032	3.90	0.089	0.015	6.02
Monroe	690.0	0.179	0.100	1.79	0.116	0.070	1.65	0.084	0.040	2.11
Montgomery	726.7	0.151	0.064	2.37	0.098	0.041	2.40	0.071	0.020	3.47
Panola	724.8	0.132	0.049	2.70	0.086	0.027	3.15	0.062	0.011	5.46
Quitman	744.0	0.151	0.081	1.87	0.098	0.052	1.87	0.071	0.024	2.98
Sharkey	998.9	0.140	0.039	3.62	0.091	0.020	4.45	0.066	0.008	8.30
Sunflower	792.6	0.157	0.092	1.71	0.102	0.066	1.55	0.074	0.038	1.97
Tallahatchie	764.3	0.170	0.063	2.72	0.110	0.039	2.85	0.080	0.016	5.03
Washington	891.6	0.176	0.069	2.54	0.114	0.048	2.39	0.082	0.028	2.89
Webster	639.4	0.198	0.078	2.53	0.129	0.057	2.27	0.093	0.033	2.82
Yazoo	904.5	0.130	0.060	2.16	0.084	0.035	2.38	0.061	0.014	4.47
Simple Mean	799.7	0.158	0.072	2.21	0.103	0.047	2.18	0.074	0.024	3.10

Table 10. Comparing RMA premium rates with simulated premium rates for Arkansas soybeans.

County	PF_{1998}	RMA 75% rate	Simulated 75% rate	RMA 75% rate ÷ simulated 75% rate	RMA 65% rate	Simulated 65% rate	RMA 65% rate ÷ simulated 65% rate	RMA 50% rate	Simulated 50% rate	RMA 50% rate ÷ simulated 50% rate
Arkansas	42.8	0.167	0.034	4.90	0.109	0.022	5.05	0.079	0.011	6.95
Ashley	25.0	0.191	0.133	1.44	0.124	0.107	1.16	0.090	0.074	1.22
Chicot	26.2	0.220	0.142	1.55	0.143	0.116	1.23	0.104	0.082	1.27
Clay	34.6	0.155	0.092	1.68	0.101	0.065	1.56	0.072	0.033	2.18
Craighead	35.4	0.162	0.069	2.34	0.105	0.050	2.10	0.077	0.027	2.82
Crittenden	26.8	0.234	0.118	1.98	0.152	0.095	1.59	0.110	0.066	1.67
Cross	38.2	0.175	0.040	4.40	0.114	0.024	4.78	0.083	0.013	6.64
Desha	31.1	0.177	0.094	1.88	0.115	0.069	1.66	0.084	0.043	1.95
Greene	34.5	0.155	0.083	1.87	0.101	0.058	1.74	0.072	0.031	2.35
Jackson	27.2	0.196	0.090	2.18	0.128	0.067	1.91	0.092	0.041	2.25
Jefferson	29.6	0.243	0.158	1.54	0.159	0.131	1.22	0.114	0.094	1.21
Lawrence	29.7	0.160	0.073	2.20	0.104	0.050	2.08	0.075	0.026	2.87
Lee	27.1	0.234	0.135	1.73	0.152	0.116	1.31	0.110	0.089	1.24
Lonoke	32.8	0.206	0.084	2.45	0.134	0.061	2.18	0.097	0.039	2.51
Mississippi	36.2	0.162	0.082	1.98	0.105	0.059	1.78	0.077	0.033	2.34
Monroe	29.9	0.216	0.078	2.75	0.140	0.057	2.46	0.103	0.035	2.92
Phillips	28.7	0.223	0.147	1.52	0.145	0.126	1.15	0.105	0.095	1.10
Poinsett	34.7	0.152	0.058	2.62	0.099	0.040	2.49	0.071	0.023	3.12
Pulaski	27.4	0.208	0.156	1.34	0.135	0.126	1.07	0.098	0.086	1.13
St. Francis	28.2	0.202	0.101	2.00	0.132	0.077	1.71	0.095	0.050	1.90
Woodruff	28.9	0.212	0.073	2.92	0.138	0.053	2.58	0.100	0.034	2.93
Simple Mean	31.2	0.193	0.097	1.99	0.125	0.075	1.68	0.091	0.049	1.86

Table 11. Comparing RMA premium rates with simulated premium rates for Louisiana soybeans.

County	PF_{1998}	RMA 75% rate	Simulated 75% rate	RMA 75% rate ÷ simulated 75% rate	RMA 65% rate	Simulated 65% rate	RMA 65% rate ÷ simulated 65% rate	RMA 50% rate	Simulated 50% rate	RMA 50% rate ÷ simulated 50% rate
Acadia	28.4	0.240	0.088	2.74	0.156	0.069	2.25	0.112	0.048	2.33
Avoyelles	30.8	0.287	0.081	3.56	0.187	0.061	3.05	0.134	0.042	3.19
Catahoula	25.2	0.283	0.084	3.37	0.184	0.058	3.17	0.133	0.028	4.68
Concordia	26.6	0.360	0.107	3.37	0.233	0.086	2.70	0.169	0.061	2.75
East Carroll	26.7	0.258	0.122	2.12	0.167	0.095	1.75	0.121	0.064	1.90
Evangeline	27.3	0.307	0.100	3.07	0.200	0.075	2.67	0.144	0.048	3.02
Lafayette	31.5	0.235	0.080	2.95	0.153	0.057	2.69	0.110	0.039	2.85
Madison	26.2	0.280	0.142	1.97	0.182	0.115	1.59	0.132	0.080	1.66
Morehouse	25.5	0.235	0.136	1.72	0.153	0.110	1.39	0.110	0.077	1.42
Pointe Coupee	41.5	0.208	0.051	4.07	0.135	0.032	4.24	0.098	0.016	6.16
St. Landry	32.0	0.292	0.084	3.47	0.190	0.066	2.88	0.137	0.047	2.94
Tensas	26.8	0.285	0.135	2.11	0.185	0.106	1.75	0.134	0.070	1.90
Vermilion	29.8	0.222	0.140	1.59	0.144	0.106	1.36	0.105	0.063	1.68
Simple Mean	29.1	0.269	0.104	2.59	0.175	0.080	2.19	0.126	0.052	2.40

Table 12. Comparing RMA premium rates with simulated premium rates for Mississippi soybeans.

County	PF_{1998}	RMA 75% rate	Simulated 75% rate	RMA 75% rate ÷ simulated 75% rate	RMA 65% rate	Simulated 65% rate	RMA 65% rate ÷ simulated 65% rate	RMA 50% rate	Simulated 50% rate	RMA 50% rate ÷ simulated 50% rate
Bolivar	28.4	0.186	0.133	1.40	0.120	0.109	1.10	0.088	0.078	1.12
Coahoma	30.8	0.176	0.111	1.58	0.114	0.085	1.34	0.083	0.055	1.52
Humphreys	25.2	0.158	0.106	1.50	0.102	0.076	1.34	0.074	0.044	1.67
Issaquena	26.6	0.282	0.110	2.56	0.184	0.086	2.13	0.133	0.059	2.25
Leflore	26.7	0.181	0.105	1.73	0.117	0.074	1.58	0.085	0.040	2.14
Panola	27.3	0.224	0.136	1.64	0.146	0.108	1.35	0.106	0.068	1.55
Quitman	31.5	0.232	0.135	1.72	0.150	0.108	1.39	0.109	0.073	1.50
Sharkey	26.2	0.214	0.102	2.09	0.139	0.076	1.83	0.101	0.048	2.12
Sunflower	25.5	0.218	0.106	2.06	0.142	0.080	1.79	0.103	0.050	2.06
Tallahatchie	41.5	0.243	0.106	2.30	0.158	0.078	2.02	0.114	0.045	2.51
Tunica	32.0	0.186	0.069	2.68	0.120	0.044	2.71	0.088	0.023	3.87
Washington	26.8	0.190	0.119	1.59	0.123	0.094	1.30	0.089	0.061	1.45
Yazoo	29.8	0.237	0.095	2.48	0.155	0.069	2.24	0.110	0.040	2.77
Simple Mean	29.1	0.210	0.110	1.90	0.136	0.084	1.63	0.099	0.053	2.40

Caveats

There are several caveats that are important when comparing these simulated premium rates with RMA premium rates. First, in the Midsouth, replant payments are a major cause of loss for soybeans. Since they cannot account for replant payments, simulated premium rates will contain a significant and systematic downward bias. For both cotton and soybeans, the simulated premium rates also cannot account for losses due to prevented planting.

A further problem exists with quality adjustments. When determining indemnities, MPCI adjusts realized yields for quality losses. To the extent that the APH yield histories reflect years when the unit was insured under MPCI, these quality adjustments should be reflected in the reported yields. However, many Midsouth MPCI purchasers only began purchasing insurance in recent years. Thus, the yields reported in the APH yield histories likely have not been adjusted for quality losses.

A third problem relates to the nature of the APH yield data used in the simulation. While the RMA premium rates in Tables 7-12 are at the optional unit level, the APH yield data used in the simulation are at the basic and optional-unit levels, depending on the choices of the policyholders.

All of these factors would cause simulated premium rates to be systematically biased downward. Estimating the magnitude of this bias would require much further research. However, it seems unlikely to fully account for the large differences between RMA premium rates and simulated premium rates reported in this bulletin.

Nonparametric procedures, similar to those described here, are increasingly being used for purposes of rating agricultural insurance (Skees, Black, and Barnett; Atwood, Baquet, and Watts; Coble et al.). Still, much remains to be learned about the sensitivity of these models to alternative assumptions.

While existing nonparametric rating models are conceptually similar, they have been developed independently and are not identical. Future research should test the robustness of simulated premium rates across alternative underlying assumptions. For example, this study employed different yield trend estimators than those used by ABW. This study also estimated yield trend at the county-level as opposed to the higher levels of aggregation used by ABW.

Even when different researchers have employed identical underlying assumptions, it is not clear how sensitive the results are to the imposed underlying assumptions. For example, this study followed ABW by including in the analysis only those APH units with at least six reported yields. We also followed ABW by estimating premium rates only for those crop-county combinations with at least 50 units that met the prior condition. Do these data requirements significantly affect the resulting premium rates? We do not know.

Finally, we follow ABW by implicitly assuming that $\beta = 1$ (Miranda), where

$$\beta = \frac{\operatorname{cov}(y_t^f, C_T)}{\operatorname{var}(C_T)}.$$

Future research could address whether it is possible to improve rating procedures by empirically estimating β for each unit, *f*, over the short time-series of data available (see appendix for definitions of variables).

RMA indicated that cotton premium rates in Arkansas, Louisiana, and Mississippi would be reduced for the 2000 crop year. The new premium rates will be based in part on a nonparametric rating model. A similar model is already being used to rate the Income Protection revenue insurance product. As RMA makes increased use of nonparametric rating models, further research will be needed to assess the out-of-sample properties of these models. In particular, it will be necessary to see if these models provide unbiased and efficient predictions of realized loss cost. If out-of-sample testing reveals that the models are not well-calibrated, model modifications, premium loads, or other revisions may be necessary.

CONCLUSION

This report has analyzed crop insurance participation, loss experience, and premium rates for cotton and soybeans grown in the Midsouth states of Arkansas, Louisiana, and Mississippi. Growers in the region purchase significantly less buy-up MPCI than growers in other regions. To some extent, this lower purchase rate is likely caused by the fact that premium rates in the region are generally higher than national averages.

A whole-farm simulation model indicated that buy-up MPCI purchasing may actually increase the probability of eventual insolvency for growers in the region. This finding occurred because the cost of buy-up MPCI reduced the expected ending net worth relatively more than it reduced the standard deviation of ending net worth. The model results imply that growers in the region who forego purchasing buy-up MPCI at current premium rates may be making a rational economic decision.

Current premium rates are high due to a history of high loss costs. While the Midsouth is faced with significant yield risk due to pests, disease, and adverse weather conditions, other factors have also influenced loss experience in the region. Contract design flaws, moral hazard, and adverse selection have all contributed to the history of high loss costs.

A nonparametric simulation model was employed to generate unit-level, break-even MPCI premium rates. A simulation model allows for the development of premium rates that reflect only yield variability (not contract design problems or moral hazard). The results of the simulation model must be interpreted with caution since there are various causes of loss (replant payments, prevented planting, quality adjustments) that cannot be captured within the simulation framework. However, the results indicate that current MPCI premium rates are significantly higher than the simulated loss cost.

Simulation-based rating holds potential for replacing loss-cost-based rating in areas that have experienced severe problems caused by contract design flaws, moral hazard, and/or adverse selection. Still, further research is required to test the robustness of simulated premium rates across alternative underlying assumptions. Additional research is also required to assess the out-of-sample properties of simulation-based rating models.

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APPENDIX

For each crop-county combination, there exists T continuous annual observations on NASS county-level yield, C_T. For most crop-county combinations, NASS data are available for the years 1956-1998 so that T = 43. We create a variable, TAC_T, that corresponds to C_T but contains NASS county yields that have been trend-adjusted to 1998 technology using a one-knot spline function. For each crop-county combination, PC_{1998} is the predicted county-level yield for 1998. Thus, PC_{1998} is the mean of TAC_T and $TAC_T = PC_{1998} + \varepsilon_T$, where ε_T is a random error term.

In the APH database there exists t continuous annual observations on unit-level yields, y_t^f, for units f = 1, 2, . . . F. For each unit, f, the APH data series contains a maximum of 10 observations on y_t^f, corresponding to the years 1987-1996. Following Atwood, Baquet, and Watts (ABW), we eliminate any unit, f, for which $t \leq 6$ with the six observations corresponding to the most recent years. Thus, for any unit, f, that is included in the simulation, $10 \geq t \geq 6$, with the minimum value corresponding to the years 1991-1996. Higher values of t indicate that the APH data series for the unit also contains continuous observations for years before 1991. Also following ABW, we conduct the simulation only for those counties where there are at least 50 units that meet the criteria described above. In cases where the county does not have at least 50 units that meet the criteria, ABW aggregate the units into larger regional areas. Given the limited number of APH units that meet the required criteria for some regions of Arkansas, Louisiana, and Mississippi, the larger regional areas would contain highly diverse geographical areas. For this reason, we simply eliminate from the analysis any crop-county combinations that do not meet the required criteria.

The APH units included in the analysis include both irrigated and nonirrigated production. This is consistent with ABW and is based on an assumption that irrigated production has a higher mean yield than nonirrigated production but a similar standard deviation. For purposes of comparison, the analysis was also conducted using only nonirrigated APH units with no appreciable difference in results.

For each crop-county combination we calculate the percentage deviation of the realized unit-level yield relative to the corresponding NASS county-level yield as

$$\boldsymbol{d}_t^f \frac{(y_t^f - C_T)}{C_T}$$

for all $t = T$.

Following Atwood, Baquet, and Watts, for each crop-county combination we combine the observations on d_t^f across units, f, and time, t, into one vector $\mathbf{d}$. Thus, there are $\sum_f \sum_t \boldsymbol{d}_t^f$ elements in the vector $\mathbf{d}$.

We take the mean of $\mathbf{d}$ as

$$\bar{\mathbf{d}} = \frac{\sum_f \sum_t \boldsymbol{d}_t^f}{f\,t}.$$

For each crop-county combination, the predicted unit-level yield, PF_{1998}, is calculated by making an adjustment to the predicted county-level yield, PC_{1998}, as follows

$$PF_{1998} = PC_{1998} \text{ x } (1 + \bar{\mathbf{d}}).$$

This adjustment accounts for any differences in expected yield between those growers included in the pool of APH data and the county as a whole.

By combining across time, T, we convert the county-level, trend-adjusted yields into vector notation as **TAC**. For each crop-county combination, unit-level yields, y^s, are simulated as

$$y^s = \mathbf{TAC} + (1 + \mathbf{d})$$

by randomly sampling with replacement from **TAC** and randomly sampling with replacement for **d**.

A crop insurance loss cost, LC, is calculated as

$$LC = \frac{y^s - \gamma\, PC_{1998}}{\gamma\, PC_{1998}}$$

where loss cost is measured in percentage terms and γ is a variable representing different coverage levels. Conceptually, γ can be a continuous variable bounded between 0% and 100%. For this analysis, γ is set at three discrete levels: 50%, 65%, and 75%. These levels correspond to the most commonly selected MPCI coverage levels. For each crop-county combination the bootstrapping procedure simulates 10,000 iterations of y^s. The simulated values for y^s are then used to generate 10,000 iterations of *LC* for each coverage level. For each coverage level, γ, the break-even premium rate is calculated as the average loss cost over the 10,000 iterations.