Crop Insurance Reconsidered

Joseph W. Glauber

During the late 1980s and early 1990s, there was much debate over how to fix what were perceived as the "failures" of the Federal crop insurance program. The Federal Crop Insurance Improvement Act of 1980 made crop insurance the primary form of disaster protection for agricultural producers, replacing a standing disaster assistance program with subsidized crop insurance. To encourage sales, private companies were enlisted to deliver the product and significantly share in the underwriting risks. Almost overnight, the crop insurance program was converted from a pilot program offering limited coverage to a limited number of crops nationwide, to a nationwide program covering most major field crops in most major growing regions.[1]

The perceived failures of crop insurance were many. At the time of passage of the 1980 Act, Congress envisioned a participation rate approaching 50% of eligible acres by the end of the decade. Despite premium subsidies and expanded coverage, crop insurance participation grew very slowly. When a major drought struck the Midwest in 1988, only 25% of eligible acreage was enrolled in the program nationwide and participation was even less in states such as Illinois and Indiana (Chite). Widespread crop losses and poor participation in the insurance program prompted Congress to pass supplemental disaster legislation throughout the decade including almost $5 billion in disaster assistance to cover crop losses in 1988 and 1989 alone (Glauber and Collins).

In addition to its failure to replace disaster assistance, the actuarial performance of the crop insurance program was dismal throughout the 1980s and early 1990s. The aggregate loss ratio, that is, total indemnities divided by total premiums (including premium subsidies), exceeded 150% over 1981–93. Poor actuarial performance was blamed on expansion of coverage into new areas without having adequate data to rate risks which contributed to adverse selection problems and the difficulty in monitoring producer behavior which contributed to moral hazard issues (U.S. General Accounting Office 1993).

Finally, despite large actuarial losses, companies shared little of the underwriting risks. Over 1981–90, total indemnities exceeded total premiums (including premium subsidies) by $2.3 billion. Over the same period, companies recorded net underwritings "gains" of $102 million (Glauber and Collins). This prompted repeated criticism from the U.S. General Accounting Office (1981, 1987, 1992) that companies were not adequately sharing in risks.

Within ten years of the 1980 Act, poor performance of the crop insurance program prompted the Bush Administration to propose eliminating the crop insurance program and replacing it with a standing disaster program (Gardner 1994). The proposal received little interest in Congress, but the criticism of the crop insurance program remained unabated.

Widespread crop losses due to the 1993 floods in the Midwest prompted yet another disaster bill. This time, however, Congress and the Clinton Administration agreed on the Crop Insurance Reform Act of 1994, which authorized additional premium subsidies to increase participation. Yet, despite increases in participation, Congress passed ad hoc disaster legislation covering losses in 1998, 1999, and 2000. In 2000, Congress passed the Agricultural Risk Protection Act, which provided further subsidies to encourage crop insurance purchases.

Now, fifteen years and two reform bills later, the crop insurance program boasts an 80% participation rate with over 215 million acres enrolled and a total liability estimated in excess of $46 billion for 2004 (Davidson). Over

---

Waugh Lecture.

Joseph W. Glauber is deputy chief economist, U.S. Department of Agriculture.

The author acknowledges the helpful comments of Keith Coble, Keith Collins, Robert Dismukes, Jim Hrubovcak, Jerry Skees, Vince Smith, and Tom Worth. The views expressed are the author's and do not reflect those of USDA or the Federal Crop Insurance Corporation.

This article was presented as the Waugh Memorial Lecture at the Annual Meeting of the American Agricultural Economics Association in Denver, Colorado, August 2004.

[1] For a more detailed history of the Federal crop insurance program, see Kramer, Gardner (1994), Goodwin and Smith (1995), and Glauber and Collins.

Copyright 2004 American Agricultural Economics Association

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

57% of participating acres are enrolled at coverage levels in excess of 65%. The loss performance of the crop insurance program has improved as well. Over 1994–2003, the aggregate loss ratio for the program was 98%, which prompted the Secretary of Agriculture to conclude, "the program on a national scale is financially sound, properly rated, and effectively managed" (Glickman). And, new reinsurance agreements negotiated between the private companies and the government have resulted in companies retaining more risk and facing larger possible underwriting losses in event of widespread crop losses.

Yet, have the program reforms since 1994 really addressed the fundamental failures raised fifteen years ago? Despite large gains in participation, Congress continues to pass ad hoc disaster legislation; two years after passage of the Agricultural Risk Protection Act, Congress passed supplemental disaster assistance to cover 2002 crop losses. The costs of the program have risen dramatically as well. Expected annual costs of the program are over $3 billion—compared with less than one-third of that cost fifteen years ago. Increased subsidies have, in turn, raised concerns about the distorting effects of crop insurance on production. While the aggregate actuarial performance has improved, large regional disparities exist. Finally, as private companies have taken on more risks, they have come under increasing criticism for the large underwriting gains they earn from the program.

In the following sections, the paper reconsiders the crop insurance program and the problems of agricultural insurance more generally. It draws on the large literature that has emerged on crop insurance, particularly over the past ten years. Economic research on crop insurance can be traced at least as far back as Valgren's 1922 study of private insurance markets.[2] However, the amount of research on crop insurance has increased dramatically over the past ten years, paralleling the growth in the program itself. For example, over 1981–93, ten journal articles were published in the *American Journal of Agricultural Economics*. Since 1994, fifty-one articles have been published, including over twenty in 2003 and 2004 alone.

The paper is organized as follows. The next section examines the demand for crop insurance and why participation in the crop insurance program has depended on large subsidies. The following section examines the problems of rating agricultural production risks and how subsidies mask actuarial performance. The section "Private Companies and Risk Sharing" examines the role of the private sector in program delivery and risk sharing. The unintended effects of subsidized crop insurance on production are considered in section "Effects of Crop Insurance on Production." The section "Alternative Crop Insurance Plans" examines alternatives means to manage production risks, including area yield options and weather derivatives. Summary and conclusions are offered in the final section.

The Demand for Crop Insurance

Table 1 shows the growth of the crop insurance program since 1981. Participation in the program grew slowly in the 1980s, reaching only 55.6 million acres in 1988, about 25% of eligible acreage. Participation reached 40% in 1989 and 1990, largely because of disaster legislation that required recipients of disaster payment in 1988 and 1989 to buy crop insurance in the subsequent crop year. By 1993, participation had fallen to 32% of eligible area (Glauber and Collins).

Over the period 1981–93, participating producers received, on average, about $2 in indemnity payments for every $1 of premium paid. Why then did participation rates in the program remain so low throughout the 1980s and early 1990s? The most often cited reason is adverse selection (see, e.g., Miranda). Adverse selection problems arise when risks vary across insurance buyers and buyers know more about the risks they face than does the insurer who sets the rates (Hirshleifer and Riley). Thus, producers whose expected indemnities exceed the premiums costs are more likely to purchase insurance; those whose costs exceed their expected indemnities are less likely to purchase. Second, studies show that farmers and ranchers use a variety of risk-management strategies to mitigate the risks that they face (Harwood et al., U.S. GAO 1999). Empirical studies of crop insurance participation during this period confirmed that many of these practices had negative effects on participation (see Knight and Coble 1997).

By the end of the 1980s, it was clear to policy makers that the subsidy levels provided under the 1980 Act were not sufficient to achieve 50% participation without either making insurance

[2] See Gardner and Kramer for a review of the early crop insurance literature.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Table 1. Selected Indicators of the Federal Crop Insurance Program

Year	Policies (thousand)	Acres (mil)	Liability ($ mil)	Premium ($ mil)	Subsidy ($ mil)	Producer Premium ($ mil)	Indemnity ($ mil)	Total Loss Ratio[a]	Producer Ratio[b]
1981	416.8	45.0	5981.2	376.8	47.0	329.8	407.3	1.08	1.23
1982	386.0	42.7	6124.9	396.1	91.3	304.8	529.1	1.34	1.74
1983	310.0	27.9	4369.9	285.8	63.7	222.1	583.7	2.04	2.63
1984	389.8	42.7	6619.6	433.9	98.3	335.6	638.4	1.47	1.90
1985	414.6	48.6	7159.9	439.8	100.1	339.7	683.1	1.55	2.01
1986	406.9	48.7	6230.0	379.7	88.1	291.6	615.7	1.62	2.11
1987	433.9	49.1	6094.9	365.1	87.6	277.5	369.8	1.01	1.33
1988	461.0	55.6	6964.7	436.4	108.0	328.4	1067.6	2.45	3.25
1989	949.7	101.7	13620.7	819.4	206.3	613.1	1215.3	1.48	1.98
1990	893.7	101.3	12818.2	835.5	215.1	620.5	1033.6	1.24	1.67
1991	706.8	82.4	11216.0	737.0	190.5	546.5	955.3	1.30	1.75
1992	663.4	83.1	11334.1	758.8	196.8	562.0	918.2	1.21	1.63
1993	679.2	83.7	11353.4	755.7	200.1	555.6	1655.5	2.19	2.98
1994	800.9	99.6	13608.4	949.4	255.3	694.1	601.1	0.63	0.87
1995	2034.3	220.5	23728.5	1543.3	889.5	653.8	1567.7	1.02	2.40
1996	1615.2	204.9	26876.8	1838.6	982.1	856.4	1492.7	0.81	1.74
1997	1319.8	182.2	25459.0	1775.4	903.1	872.3	993.6	0.56	1.14
1998	1242.7	181.8	27921.4	1875.9	947.6	928.4	1677.5	0.89	1.81
1999	1288.8	196.9	30939.5	2310.1	1394.0	916.2	2434.7	1.05	2.66
2000	1323.2	206.5	34443.8	2540.2	1365.8	1174.3	2594.8	1.02	2.21
2001	1297.9	211.3	36732.8	2961.9	1771.8	1190.1	2959.8	1.00	2.49
2002	1259.5	214.9	37311.3	2915.9	1741.5	1174.4	4066.1	1.39	3.46
2003	1241.1	217.4	40643.6	3430.6	2041.7	1389.0	3226.5	0.94	2.32
1981–93 average	547.1	62.5	8452.9	540.0	130.2	409.8	821.0	1.52	2.00
1994–03 average	1342.3	193.6	29766.5	2214.1	1229.2	984.9	2161.5	0.98	2.19

[a]Indemnity divided by total premium.
[b]Indemnity divided by producer premium.
Source: U.S. Department of Agriculture, Risk Management Agency.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Table 2. Premium Subsidy Rates for APH (Crop Yield) Insurance

Coverage Level (%)	Federal Crop Insurance Act of 1980	Federal Crop Insurance Reform Act of 1994	Agricultural Risk Protection Act of 2000
55	30.0	46.1	64.0
65	30.0	41.7	59.0
75	16.9	23.5	55.0
85	–	13.0	38.0

purchases compulsory or increasing the level of the subsidy. In their analysis of the U.S. crop insurance program, Gardner and Kramer concluded that premiums would have to be subsidized as much as 50% to achieve 50% participation. Similar conclusions were reached by Wright and Hewitt and Goodwin and Smith (1995).

Congress responded by both making insurance compulsory and increasing premium subsidies. Under the Crop Insurance Reform Act of 1994, producers of insurable crops were eligible to receive a basic level of coverage, catastrophic risk protection (CAT), which initially covered 50% of a producer's approved yield at 60% of the expected market price.[3] CAT coverage was required for producers who participated in the commodity price support and production adjustment programs, farm credit, or other farm programs. While the premium cost of CAT coverage was fully subsidized by the government, producers were required to pay a sign-up fee equal to $50 per crop per county. In addition, the 1994 Act provided additional subsidies for coverage levels greater than 50% (buy-up levels). Over 220 million acres were enrolled in the program in 1995, over 80% of eligible acres (excluding hay), with over half of these at the CAT level. Responding to producer criticism, Congress eliminated the compulsory provisions for CAT coverage in 1996 causing enrollment in CAT to decline. However, enrollment in buy-up coverage continued to increase, reaching 120 million acres in 1998 (Glauber and Collins).

To encourage further enrollment in higher coverage levels, Congress provided supplemental premium subsidies in the 1999 and 2000 crop years and in 2000 passed the Agricultural Risk Protection Act, which increased subsidy levels for most buy-up levels (table 2). Enrollment in the crop insurance program rose from 182 million acres insured in 1998 to over 217 million in 2003, almost a 20% increase. Where less than 8% of insured acres were enrolled at coverage levels greater than 65% in 1998, over 53% were enrolled in 2003. Because of increased enrollment and enrollment at higher coverage levels, total liability was $40.6 billion in 2003, a 46% increase over 1998 levels.

The experience of the past twenty-five years suggests that with adequate subsidies, producers will buy crop insurance, but the marginal costs are large. Because the demand for crop insurance is generally inelastic with respect to premium (Goodwin, Coble and Knight), the marginal per acre costs of enrolling additional acres into the program are high. Figure 1 shows premium subsidies plotted against buy-up acres over 1981–2003. It shows how the marginal costs of enrolling additional buy-up acres have increased as subsidy levels have increased under successive crop insurance reform legislation. Because subsidies are applied to all participating acres, it becomes more and more expensive to coax in acreage at the margin. Estimated at the mean buy-up acreage over the period, the marginal cost per acre (in $2000) during 1981–94 was $3.31 per acre, compared to an average per acre subsidy of $2.73. During 1995–98, the marginal subsidy cost per acre was $10.51 compared with an average per acre subsidy of $4.99. From 1999 to 2003, the marginal subsidy costs are estimated at $25.99, compared with an average per acre subsidy of $7.76. These costs include premium subsidy costs only. Delivery costs would bring per acre marginal subsidy costs to as high as $30 per acre—about twice the average per acre premium cost.

Over 1981–2003, total federal costs of crop insurance and disaster assistance have totaled $45 billion, an average of almost $2 billion per year (table 3). As participation has grown, total costs have increased such that crop insurance outlays (including delivery) are in excess of $3 billion annually (USDA). And, as the last ten years have shown, higher participation

[3] This was subsequently reduced to 55% of the expected market price in 1998.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

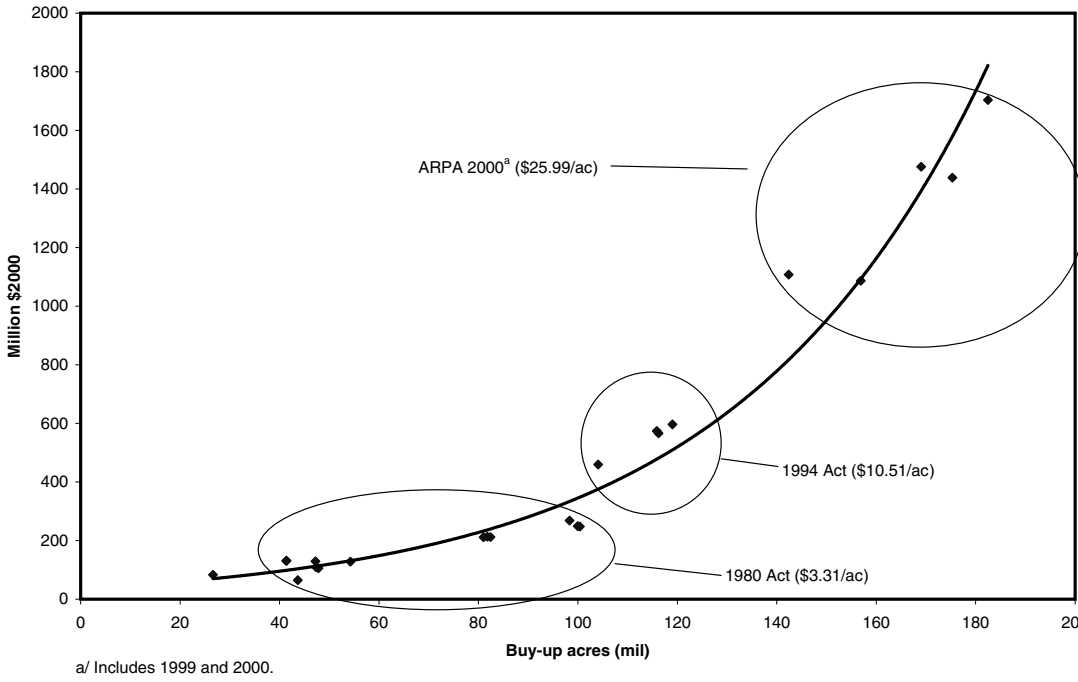


Figure 1. Increasing marginal subsidy costs of buy-up coverage

rates are no guarantee that Congress will refrain from passing supplemental legislation to provide disaster assistance to producers. Since passage of the 1980 Act, almost $19 billion has been provided to producers in the form of disaster assistance. Two years after passage of the Agricultural Risk Protection Act, with participation rates near 80%, and over 50% of acreage insured at coverage levels of 70% or higher, Congress provided $2.1 billion in supplemental disaster assistance to producers for crop losses in 2002.

Finally, there are continuous pressures from Congress, the Administration and Commodity groups to expand the crop insurance program to include new crops and expand to new regions. For example, the Risk Management Agency is considering expansion of a pilot program for rangeland to potentially include 600 million acres of public and private rangeland. Under Agricultural Risk Protection Act, insurance was expanded on a pilot basis to include livestock. While coverage to date is limited by the pilot authorities, the size of the crop insurance program could double if insurance were made available for all livestock producers.[4] In addition, there have been proposals to extend insurance to timber as well as to extend coverage to include bioterrorism risks.

Actuarial Issues

The actuarial performance of the crop insurance program has depended on two major factors: the variability of the weather and the ability of the program to control adverse selection and moral hazard problems. Adverse selection problems have long been associated with the crop insurance program, particularly because of the use of aggregate (typically county) measures to estimate individual yields and rates (Coble and Knight). Moral hazard problems arise when insured producers alter their behavior after purchasing insurance to affect their likelihood of collecting an indemnity.

Adverse Selection

The crop insurance program offers producers a myriad of choices between insurance products, coverage levels, practices, and unit determination. Corn producers in Illinois, for example, can choose between Actual Production History (APH) yield insurance, three types of revenue insurance (Crop Revenue Coverage, Revenue Assurance, Income Protection) and

[4] Costs under the livestock pilot are limited to $20 million annually.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Table 3. Crop Insurance and Crop Disaster Payments, 1981–2003

Year[a]	Indemnity	Producer Premium	Net Indemnity	Delivery Costs[b]	Total Crop Insurance Outlays	Crop Disaster Payments
1981	407	330	77	5	82	306
1982	529	305	224	26	251	115
1983	584	222	362	32	394	1
1984	638	336	303	84	387	0
1985	683	340	343	104	448	0
1986	616	292	324	111	435	556
1987	370	278	92	122	215	10
1988	1,068	328	739	130	869	3,386
1989	1,215	613	602	291	893	1,500
1990	1,034	620	413	320	734	6
1991	955	547	409	277	685	960
1992	918	562	356	263	619	872
1993	1,655	556	1,100	160	1,260	2,461
1994	601	694	−93	386	293	577
1995	1,568	654	914	508	1,422	14
1996	1,493	856	636	714	1,350	2
1997	994	872	121	790	912	0
1998	1,678	928	749	722	1,472	1,913
1999	2,435	916	1,519	771	2,290	1,452
2000	2,595	1,174	1,421	837	2,257	2,348
2001	2,960	1,190	1,770	986	2,756	0
2002	4,066	1,174	2,892	583	3,475	2,145
2003	3,227	1,389	1,838	1,121	2,959	0
1981–2003 total	32,287	15,176	17,111	9,344	26,455	18,624
1981–93 average	821	410	411	148	559	783
1994–2003 average	2,161	985	1,177	742	1,919	845

[a] Crop insurance outlays by reinsurance year. Crop disaster payments reflect fiscal year in which crops are harvested.
[b] Delivery costs to companies include administrative and operating costs reimbursements and net underwriting gains (losses). Risk Management Agency costs are not included.
Source: U.S. Department of Agriculture, Risk Management Agency, Farm Service Agency.

two plans based on area yields (Group Risk Protection and Group Risk Income Protection). Many plans offer producers the choice between several coverage levels and whether to insure by basic units, optional units, enterprise units, or whole farm units. Each choice provides the producer with multiple opportunities to adversely select the option that maximizes their net return.

In its 1989 criticism of the actuarial performance of the program, the General Accounting Office blamed the expansion of the program in the early 1980s to counties and crops where little actuarial information was available, thus resulting in adversely selected risk pools (GAO 1989). Numerous changes have been made to rating practices since the early 1980s, many made on the basis of economic research that has been subsequently published in the journal and elsewhere. Analysis of the relation between the mean and standard deviation of farm-level yields by Skees and Reed resulted in changes in rating practices at the time which assumed a constant coefficient of variation for farms within the county. In a related study of the relation between individual and county rates, Goodwin concluded that APH rating methods were flawed because they assumed the same rate for farms within a county that had the same mean yield. Research by Knight and Coble (1999) and Shaik and Atwood identified potential for adverse selection problems with the optional unit structure and, more recently, analysis by Babcock, Hart, and Hayes rejects the assumption of constant rate relativities across coverage levels.

The two most common prescriptions for mitigating adverse selection problems are by providing more accurate classification of insureds into homogenous risk pools and by requiring compulsory participation, which effectively forces all insureds into the risk pool. Much research has been given to the former, with major contributions by economic

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

researchers, some of which are cited above. Growth of the program over the past ten years has provided researchers with a vast data base with which to improve rating and risk classification methodologies.

Adverse selection problems have also been mitigated by bringing more producers into the program. While Congress rejected compulsory insurance in 1996, large subsidies have had a similar effect by encouraging producers with overrated premiums who would normally choose not to participate (Just, Calvin, and Quiggin). Take, for example, a producer who is offered a crop insurance policy at 65% coverage with an expected indemnity payment of only $0.50 for every $1.00 of premium paid. With a 59% subsidy, as offered under the Agricultural Risk Protection Act, the producer can expect an indemnity payment of $0.50 for every $0.41 of premium paid, an expected rate of return of 22%. The producer now has incentives to purchase crop insurance, and thus improve the actuarial performance of the risk pool.

Moral Hazard

Research on moral hazard has focused largely on crop insurance purchases and input use. Measurement of input use is often available only at the farm level. Thus changes in input use may reflect shifts in crop mix, rather than changes in application rates. Horowitz and Lichtenberg examined corn producers and concluded that crop insurance purchases were positively correlated with input use. These conclusions were challenged by Quiggin, Karagiannis, and Stanton, Babcock and Hennessy, Smith and Goodwin, Goodwin and Smith (2003), and more recently by Goodwin, Vandeveer, and Deal who found that input use tended to decline with crop insurance purchases.

Efforts to reduce moral hazard problems have focused primarily on monitoring. For example, the Agricultural Risk Protection Act instructed the Risk Management Agency to increase surveillance of insured producers through the Farm Service Agency and use data mining techniques to identify potential sources of fraud and abuse (Rejesus et al.).

Less attention has been given to designing contracts to combat moral hazard problems (Chambers, Rubinstein and Yaari, Crocker and Morgan, Vercammen and van Kooten). Indeed, recent program changes such as lower deductibles, the ability to drop low yields or limit declines in calculating yield guarantees, and the subsidy level itself, have likely exacerbated moral hazard problems.

Assessing Actuarial Performance

Unlike car insurance or homeowners insurance, it is difficult to assess the actuarial soundness of crop insurance without examining many years of data. This is in part due to the fact that crop yields are often highly correlated across producers within a year (Miranda and Glauber). Thus, even when aggregating across crops and regions, indemnities can vary widely from year to year. Second, because of the underlying variability of weather and its effects on crop yields, longer time series are needed to more accurately capture and weigh possible loss outcomes. For example, the crop losses that occurred in the Midwest as a result of excessive moisture in the spring and early summer of 1993 were termed by some as a 1-in-100 year event. A simple ten-year historical loss measure would thus implicitly weight the 1993 experience with a probability of 0.1, which would be ten times the appropriate probability. Unfortunately, longer time series are equally problematic because of the many changes in the crop insurance program, including rating adjustments and the growth in participation and the shift to higher coverage levels that has occurred over the past several years. Historical loss ratios may reveal little about future loss expectations.

The loss experience of the program since 1981 is presented in table 4. Separate measures are given for CAT and buy-up coverages. In addition to the loss ratio, the average premium rate (total premium as a percent of liability) and the average loss cost ratio (indemnities as a percent of liability) are also given. The loss ratio is equal to the loss cost ratio divided by the premium rate. Changes in the premium rate over time reflect rate adjustments and any changes in the underlying mix of business. The loss cost measure is far more variable, reflecting the variation in indemnities due to weather and other factors. To be able to cover indemnities over the long-run, the premium rate should equal the expected average loss cost ratio.[5]

The average loss cost for buy-up coverage over 1981–2002 was 9.2%. The loss cost ratio exceeded the long-run average in eleven of the twenty-three years, or 47.8%, including four

[5] As pointed out in the preceding section, this notion of actuarial soundness excludes delivery costs.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Table 4. Actuarial Performance

Crop Year	Loss Cost[a]			Premium Rate[b]			Loss Ratio[c]		
	Total	CAT	Buy-Up	Total	CAT	Buy-Up	Total	CAT	Buy-Up
1981	0.068	–	0.068	0.063	–	0.063	1.08	–	1.08
1982	0.086	–	0.086	0.065	–	0.065	1.34	–	1.34
1983	0.134	–	0.134	0.065	–	0.065	2.04	–	2.04
1984	0.096	–	0.096	0.066	–	0.066	1.47	–	1.47
1985	0.095	–	0.095	0.061	–	0.061	1.55	–	1.55
1986	0.099	–	0.099	0.061	–	0.061	1.62	–	1.62
1987	0.061	–	0.061	0.060	–	0.060	1.01	–	1.01
1988	0.153	–	0.153	0.063	–	0.063	2.45	–	2.45
1989	0.089	–	0.089	0.060	–	0.060	1.48	–	1.48
1990	0.081	–	0.081	0.065	–	0.065	1.24	–	1.24
1991	0.085	–	0.085	0.066	–	0.066	1.30	–	1.30
1992	0.081	–	0.081	0.067	–	0.067	1.21	–	1.21
1993	0.146	–	0.146	0.067	–	0.067	2.19	–	2.19
1994	0.044	–	0.044	0.070	–	0.070	0.63	–	0.63
1995	0.066	0.020	0.091	0.065	0.054	0.071	1.02	0.37	1.28
1996	0.056	0.020	0.070	0.068	0.057	0.073	0.81	0.35	0.95
1997	0.039	0.007	0.050	0.070	0.055	0.074	0.56	0.13	0.67
1998	0.060	0.016	0.075	0.067	0.051	0.073	0.89	0.32	1.03
1999	0.079	0.011	0.100	0.075	0.040	0.085	1.05	0.28	1.17
2000	0.075	0.009	0.093	0.074	0.037	0.083	1.02	0.25	1.11
2001	0.081	0.007	0.097	0.081	0.036	0.091	1.00	0.20	1.07
2002	0.109	0.011	0.131	0.078	0.034	0.088	1.39	0.34	1.49
2003	0.079	0.007	0.094	0.084	0.034	0.094	0.94	0.19	0.99
Average[d]	0.085	0.012	0.092	0.068	0.044	0.091	1.111	0.245	1.183

[a]Loss cost ratio = indemnities divided by liability.
[b]Premium rate = premium divided by liability.
[c]Loss ratio = indemnities divided by premium = loss cost ratio divided by premium rate.
[d]Simple average across years.

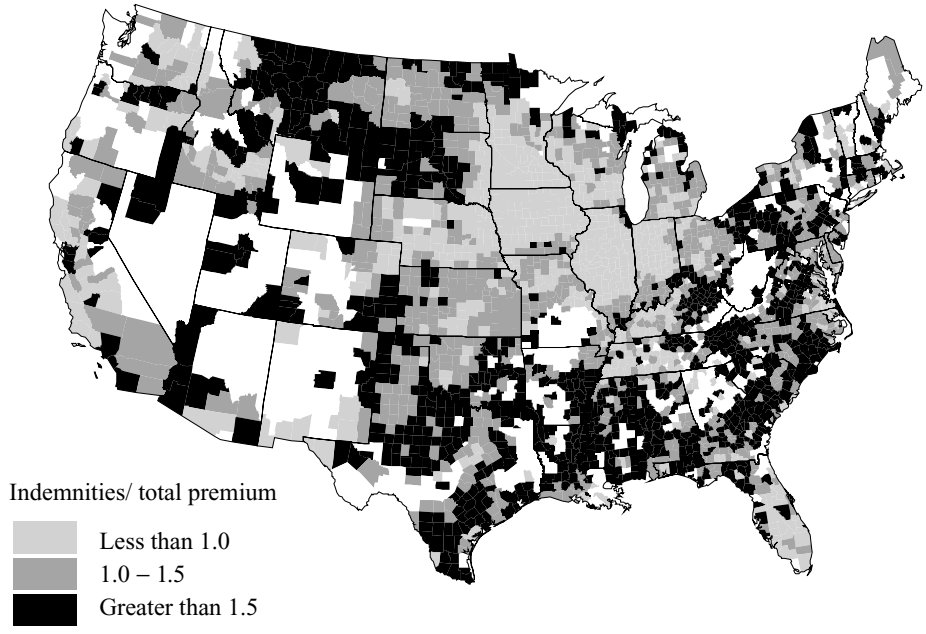
major loss years (1983, 1988, 1993, and 2002) when the aggregate loss cost ratio for buy-up exceeded 12%. By contrast, the loss cost ratio for buy-up exceeded the actual premium rate for that year in nineteen of twenty-three years, or 82.6%. This disparity suggests that premium rates were not sufficient to cover long-run loss costs, particularly during the 1980s and early 1990s when the loss cost exceeded the premium rate in every year from 1981–93.

Average premium rates for buy-up coverage began to increase in 1999 and during 2001–03 have averaged near the long-run loss cost average. Some of the increase reflects changes in the underlying premium rate structure by the Risk Management Agency to meet actuarial performance targets. However, some of the increase in average rate is reflective of the shift in participation toward higher coverage levels following implementation of the Agricultural Risk Protection Act.

Figure 2 shows that despite the improvement in the aggregate actuarial performance, there remain large regional disparities. Generally, the Midwest, California, and parts of the Northwest and Florida have had good loss performance with average loss ratios for 1981–2003 less than 1. By contrast, the Plains states and the Southeast have had generally poor performance with many counties with average loss ratios greater than 1.5. As will be shown in the following section, these disparities have implications for underwriting and risk sharing by the companies.

Finally, despite improvements, it is difficult to say whether actuarial problems of the program are "fixed." Increased participation due to subsidies have likely mitigated adverse selection problems between insured and noninsured producers, but potential for adverse selection within the program (between plans, coverage levels, etc.) remain. Better data and substantial research have improved rating methods; however, contract design changes such as lower deductibles potentially undermine gains. Moreover, with pressures to expand the program to livestock, rangeland and other areas with limited actuarial experience,

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010



Note: Excludes counties with less than $100,000 in total premium, 1981–2003.

Figure 2. Aggregate loss ratios for buy-up coverage, 1981–2003

adverse selection, and moral hazard concerns remain.

Private Companies and Risk Sharing

Private-public risk sharing has been an important and unique feature of the Federal crop insurance program since 1981. Under the 1980 Act, the Federal Crop Insurance Corporation was encouraged to privatize delivery functions "to the maximum extent practicable." Private sector involvement was seen as critical to ensuring a rapid expansion of the program. Today, the program is delivered entirely by private crop insurance companies.

Under other federally backed disaster insurance programs (e.g., the National Flood Insurance Program), the Federal government absorbs all underwriting losses and gains. A unique feature of the Federal crop insurance program is that the government shares underwriting losses and gains with companies through the Standard Reinsurance Agreement (SRA). Risk sharing was seen as an inducement to encourage companies to participate in the program by allowing them to share in underwriting gains. By requiring companies to share in underwriting losses, reinsurance encourages companies to more carefully underwrite polices and adjust claims more carefully (Bohn and Hall).

The degree of risk sharing has been a controversial aspect of the program from the outset. Under the SRA, if a private company chooses to write crop insurance policies in a state it must offer crop insurance products to any farmer in that state. Moreover, insurance companies must accept the premium rates and underwriting guidelines established by the Risk Management Agency. Thus, private crop insurance companies face a large potential risk exposure without recourse to raising rates to adequately cover costs of insuring high-risk individuals. As a consequence, companies were initially reluctant to share in much of the underwriting risks.

The degree of risk sharing between the companies and the FCIC changed significantly with the negotiation of the 1992 SRA. Under the 1992 SRA, companies were allowed to place policies in separate funds that offer varying degrees of retention and exposure. In return for taking a larger share of gains, companies agreed to take on a larger share of exposure in the event of crop losses. The 1992 SRA introduced the basic structure of the agreement that exists currently. Subsequent renegotiations of the SRA (in 1993, 1994, 1995, 1998, and 2004) have increased the exposure and potential gains to the companies.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Table 5. Loss Ratios by Fund, 1992–2003

Reinsurance Year	Reinsurance Fund		
	Commercial	Developmental	Assigned Risk
1992	1.01	1.29	1.60
1993	2.63	1.85	1.82
1994	0.39	0.62	0.84
1995	0.93	1.18	1.38
1996	0.66	1.06	1.14
1997	0.46	0.66	0.81
1998	0.74	1.18	1.54
1999	0.76	1.21	1.68
2000	0.75	1.08	1.55
2001	0.75	1.19	1.54
2002	1.16	1.61	1.79
2003	0.78	1.10	1.20

The SRA currently combines both proportional and nonproportional reinsurance features (Ker). Under the SRA, each company allocates crop insurance policies within a state to one of three reinsurance funds: Assigned Risk Fund, Developmental Fund, and Commercial Fund. The funds differ in the required level of retention and also in the shares of gains and losses from retained business under the nonproportional features of the agreement. Under the Commercial Fund, companies can retain up to 100% of the premium and associated liabilities and share in a substantial portion of gains and losses on the retained business. Under the Assigned Risk Fund, companies cede 80% of the premium to the government and share in a limited portion of the gains and losses on the retained business.[6]

Company profitability is thus directly related to how well companies are able to classify their policies by fund (Ker and McGowan, Ker and Ergün). The degree to which companies have successfully allocated their premiums is shown in table 5. The table shows average retained loss ratios by fund for 1992–2003. Loss ratios tend to be lowest in the Commercial Fund and highest in the Assigned Risk Fund, indicating the ability of companies to place the more profitable business in those funds that offer the most potential for gain. An exception was 1993 when widespread crop losses occurred in the upper Midwest—an area with a high concentration of Commercial Fund business.

Since 1992, retained premiums by the companies have grown from $466 million to almost $2.6 billion in 2003 (table 6). In part, this increase follows the rapid growth in the crop insurance program over the period, but it reflects as well the fact that companies are retaining more risk. One measure of company exposure is the maximum possible underwriting loss to companies, which is equal to the maximum net underwriting loss a company may experience in a given year.[7] The maximum possible underwriting loss rose from $228 million in 1992 to almost $2.4 billion in 2003. Loss exposure has increased over all levels of losses, not just catastrophic losses. For example, for loss ratios between 1.0 and 1.6, companies now absorb 50% of the losses, compared with 30% under the 1993 and 1995 SRAs (table 7).

As retained risk and exposure have increased, so too, have net underwriting gains to the companies. Net underwriting gains totaled over $2.3 billion over 1992–2003. Not surprising, the majority of these gains are concentrated in the Midwest where loss performance has generally been favorable (Vedenov et al.). Indeed, almost 85% of net underwriting gains over 1998–2002 were concentrated in eight states: Illinois, Minnesota, Iowa, Indiana, Missouri, Nebraska, Florida, and California. The magnitude of the gains has prompted new criticism from the GAO and others that companies are overcompensated for the risks

[6] Under the SRA, the government also subsidizes company administrative and operating (A&O) expenses at a fixed percentage rate of total premiums, depending on the type of insurance plan. On average, A&O reimbursements averaged 21.7% of premium for 1998–2003.

[7] Under the SRA, losses are capped since the government absorbs 100% of the losses for losses in excess of a loss ratio of 5.0.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Table 6. The Standard Reinsurance Agreement (Million Dollars)

Reinsurance Year	Gross Premium[a]	Retained Premium by Companies	Maximum Company Exposure[b]	Percent of Total Exposure	Net Underwriting Gain[c]	Administrative and Operating Cost Reimbursements	Total Delivery Costs
1992	694	466	228	8.2	23	240	263
1993	702	435	259	9.3	−83	243	160
1994	919	536	332	9.0	104	282	386
1995	1,270	768	493	9.7	131	378	508
1996	1,627	1,156	742	11.4	246	468	714
1997	1,688	1,262	810	12.0	353	438	790
1998	1,876	1,592	1,475	19.7	280	443	722
1999	2,310	1,837	1,645	17.8	272	499	771
2000	2,540	1,894	1,669	16.5	285	552	837
2001	2,962	2,373	2,095	17.6	351	636	986
2002	2,916	2,294	2,037	17.5	−43	626	583
2003	3,431	2,606	2,388	17.4	388	734	1,121

[a]Premiums from policies sold through private reinsured companies only. Prior to 1998, some policies were sold through the Farm Service Agency offices and through direct sales by companies that ceded all risk to the Federal Crop Insurance Corporation.
[b]Maximum possible underwriting loss to companies determined as retained underwriting loss assuming loss ratio of 5.0.
[c]Net to companies after the Standard Reinsurance Agreement.

Table 7. Company Share of Underwriting Loss in Commercial Fund

Standard Reinsurance Agreement	Company Loss Ratio			Maximum Possible Underwriting Loss[a]
	1.00–1.60	1.60–2.20	2.20–5.00	
1993	30%	20%	15%	$0.72
1995	30%	25%	15%	$0.75
1998	50%	40%	17%	$1.016
2004[b]	50%	40%	17%	$1.016

[a]Per dollar retained premium.
[b]Under quota share provisions of the 2004, company cedes 5% of net underwriting gain or loss to FCIC.

that they bear (GAO 1997, USDA Office of the Inspector General, Skees). These charges are countered by the crop insurance industry that cites the increased financial risks born by companies and increasing costs of delivery (National Crop Insurance Services).

Are delivery costs excessive? Delivery costs as a percent of total crop insurance outlays averaged between 35% and 40% from 1981 to 2003 (table 6). These costs are similar in magnitude to other property/casualty lines of insurance.[8] However, unlike other lines of insurance, crop insurance delivery costs are set by the Government and not determined in a competitive market setting.

Perhaps the more relevant policy question is whether the benefits of risk sharing exceed the costs of what many view as high underwriting gains. Critics have questioned whether the flood insurance model where companies are paid to deliver the insurance policy, but the government absorbs all underwriting risks may be more appropriate for crop insurance delivery. While there has been some research on reinsuring crop risks (see, e.g., Miranda and Glauber; Duncan and Myers; Turvey, Nayak, and Sparling; Mason, Hayes, and Lence), little empirical work has been done to analyze the benefits of risk sharing, and in particular, whether risk sharing encourages companies to reduce the incidence of moral hazard, fraud, and abuse among insured producers.[9]

[8] For example, total underwriting expenses incurred as a percent of premium earned for 1993–2002 were 35.6% for fire insurance, 35.9% for commercial multiple peril, 34.2% for earthquake, and 29.8% for commercial autoliability (A.M. Best Company).

[9] It is debatable whether elimination of the risk-sharing role of the private sector would necessarily lead to large cost savings. Rates of return vary significantly by company (Vedenov et al.) and it is likely that if risk sharing were eliminated, higher A&O rates would be negotiated.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Effects of Crop Insurance on Production

With the growth in the level of subsidies, concerns have been raised about the effects of crop insurance on production. Over the past few years there has been anecdotal evidence that suggests crop insurance has increased production of certain crops. For example, in 1999 North Dakota durum wheat producers were offered a revenue insurance policy based on a flawed pricing formula that established a revenue guarantee higher than the expected market revenue. As a result, sales of the product increased significantly and it is estimated that durum wheat increased by as much as 1 million acres over what would have been planted in absence of the policy (Glauber). Similar problems were encountered with a pilot program for watermelons which resulted in early termination of the program (RMA). More recently, Brazil has challenged the U.S. crop insurance program in the World Trade Organization for allegedly distorting cotton production (World Trade Organization).

Studies by Miller and Walter, King and Oamek, and Gardner and Kramer recognized the effects of disaster assistance on production. Disaster assistance was seen as encouraging production of riskier crops on marginal lands due to the risk reduction it provided producers and the implicit subsidy component afforded by its protection. Indeed, in debate over passage of the 1980 Act it was argued that crop insurance was preferable to disaster assistance in that it was less likely to provide production incentives (GAO 1989). However, as coverage levels and subsidies have increased, the production effects of crop insurance have also come under scrutiny.

Early theoretical work by Ahsan, Ali, and Kurian and Nelson and Loehman recognized the output-enhancing potential of crop insurance. Ramaswami pointed out that in addition to the risk-reducing and potentially output-enhancing effects there were also potential negative effects on production due to moral hazard. Chambers and Quiggin (2001) extended Ramaswami's work to include multiple-input, multiple-output technologies and concluded that the effects of insurance on output were ambiguous.

Empirical work on insurance has focused on the effects of insurance on planted area and the effects of insurance on input use. King and Oamek estimated the effects of disaster assistance on acreage decisions by Colorado wheat producers. In an analysis of Nebraska corn producers, Wu concluded that farms that purchased insurance were more likely to produce soybeans and less likely to produce forage crops. Using a simulation model with regional acreage supply equations, Young, Vandeveer, and Schnepf found that planted acreage for major field crops was only 0.4% higher due to subsidized insurance. The increased plantings of wheat and cotton accounted for about three-fourths of the increase. In a more recent econometric study, Goodwin, Vandeveer, and Deal examined Midwestern corn and soybean producers and wheat and barley producers in the Northern plains and found that a 30% decrease in premium costs were likely to increase barley acreage by about 1.1% and corn acreage by less than 0.5%. Soybean and wheat acreage showed no statistically significant impact. Cross-commodity effects are likely mitigated by the fact that insurance is now available for numerous crop alternatives.

While no studies have directly analyzed the effects of crop insurance on yield, much research has been done on the effects of crop insurance on input use. Many of these studies were cited above in the discussion on moral hazard. Most conclude that the effects of crop insurance on input use are negative suggesting that the resulting effect on yields is likely negative. Whether this effect is large enough to offset any positive effect on crop acreage remains an open question.

Alternative Crop Insurance Plans

Concern over the costs of insuring individual crop yields has prompted research into alternative insurance contracts including area yield insurance and weather-based indexed insurance. Area yield insurance dates to Halcrow and more recently, Miranda, Mahul (1999), Chambers and Quiggin (2002), and Bourgeon and Chambers. In the early 1980s, the Australian Industries Assistance Commission prompted research on the feasibility of rainfall insurance in Australia (Bardsley, Abey, and Davenport; Quiggin; Patrick). More recently, Mahul (2001) and Turvey have analyzed the effectiveness of weather-related insurance products.

Under area yield insurance, producers receive indemnity payments based on shortfalls in county yields rather than their individual yields. Because the indemnity is based on an indexed measure such as county yields or regional rainfall, moral hazard and adverse

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

selection problems are largely mitigated. However, the effectiveness of area yield or weather-indexed contracts in reducing crop risks is largely related to how well the insured's yield is correlated with the index (Smith, Chouinard, and Baquet). Area yield and weather-indexed contracts also have fewer associated administrative costs and hence are less expensive to deliver.

The recent interest in area yield insurance in the U.S. program arose in the late 1980s when the concept was touted as a potential alternative to individual-based insurance program (see, e.g., Barnaby and Skees). Congress authorized area yield insurance as a pilot program in the 1990 farm bill and FCIC began offering an area yield product, the Group Risk Plan (GRP), to soybean producers in 1993 (Skees, Black, and Barnett). In addition, an area-based revenue insurance plan, Group Revenue Insurance Plan (GRIP) was introduced in 1999.

GRP remains largely a niche market concentrated among corn and soybean producers in the Midwest Bareas where individual crop yields are more highly correlated with area yields. In recent years, acres insured under GRP have increased significantly, largely due to the expansion of GRP to rangeland and forage. Over 12.5 million acres were insured under GRP in 2003; of the total, 9.6 million acres were insured in rangeland and forage policies. An additional 262 thousand acres were insured under GRIP in 2003. Limited participation in the program among row crop producers suggests producers prefer coverage based on their individual yield outcome. This may be due to basis risk as suggested by Smith, Chouinard, and Baquet. Skees, Black, and Barnett suggest marketing efforts and knowledge by sales agents play a major role in GRP acceptability, although this seems unlikely since the program has shown only limited penetration even in areas where GRP has been available since 1993. Others have suggested that agents may have fewer incentives to sell GRP policies because the expense reimbursement rates are less than for individual-based policies (Goodwin and Smith 1995).[10]

Area yield and weather-indexed contracts have also been touted as low cost alternatives to individual-based crop insurance programs for developing countries (Skees, Hazell, and Miranda). For example, monsoon-index insurance was introduced on a pilot basis in India in 2003 (Hess). Significantly, the weather index insurance is not a self-standing insurance product, but imbedded in loan agreements with local banks. This has allowed Indian banks to expand their crop lending to nonirrigated areas where they were previously constrained by monsoon risk.

Conclusions

From a program that faced possible termination only fourteen years ago, the crop insurance program has grown into a major component of the U.S. farm safety net. Yet as the last ten years have demonstrated, high participation rates are no guarantee that Congress will refrain from passing, and the President will refrain from signing, ad hoc disaster legislation. Despite significant progress in establishing rates that more accurately reflect producer risks and thus mitigate adverse selection problems, the program continues to be susceptible to political pressures that undermine actuarial integrity. The result is a program that is costly and whose level of subsidies raises concerns over the potentially distorting effect on production.

The U.S. crop insurance program has been heralded by some as a model for other countries (e.g., Smith). This view is challenged by others (e.g., Skees, Hazell, and Miranda) who conclude that given the highly subsidized nature of the program, the U.S. program is a poor model for export. From the U.S. experience, the demand for crop insurance is likely small without large subsidies. Given the number of lower cost alternatives, crop insurance is likely a suboptimal strategy for risk management for many producers (Wright and Hewitt). This would seem particularly true for many developing countries whose producers may not be able to afford even subsidized coverage.

Because it provides producers with *ex ante* risk protection, crop insurance is clearly preferable to *ex post* forms of disaster assistance (Innes). Nonetheless, as a mechanism for providing subsidies, crop insurance subsidies are less efficient than lump sum transfers, although arguably less distorting than other subsidies tied to production such as price supports

[10] The differences in per acre A&O reimbursements are not large, at least in recent years. Under the 2004 SRA, A&O reimbursements for APH (individual yield) policies were set at 24.5% of premium, compared with 22.7% for GRP. Based on average per acre premium rates for APH and GRP corn policies in 2003, per acre A&O reimbursements were $3.19 for APH policies and $3.09 for GRP policies.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

(Gardner 1990).[11] It may be that crop insurance is, as has been suggested, a "politically palatable way of transferring income to an effective interest group" (Smith and Goodwin, p. 129).

Area yield and weather-indexed contracts may provide low cost alternatives to insuring individual risks. By minimizing adverse selection and moral hazard problems, the costs of delivering indexed contracts are lowered. However, the problems of basis risk suggest that indexed contracts are best targeted toward aggregators of risk such as grain merchants, banks, and insurance companies who then could tailor more individual-based products to producers. This suggests an alternative role for government as regulator and reinsurer of catastrophic risks rather than as a provider of individual risk protection through the sale of retail risk products.

Finally, the U.S. program has provided researchers with a valuable laboratory and rich data base, which has yielded significant insights into risk classification, rating, and contract design. In turn, the research, much of which has been supported by the Risk Management Agency, has contributed to an improved program.

References

A.M. Best Company. *Best's Aggregates and Averages*. Oldwick, New Jersey: A.M. Best, 2003.

Ahsan, S.M., A.A.G. Ali, and N.J. Kurian. "Toward a Theory of Agricultural Insurance." *American Journal of Agricultural Economics* 64(1982):520–29.

Babcock, B.A., C.E. Hart, and D.J. Hayes. "Actuarial Fairness of Crop Insurance Rates with Constant Rate Relativities." *American Journal of Agricultural Economics* 86(2004):563–75.

Babcock, B.A., and D.A. Hennessy. "Input Demand under Yield and Revenue Insurance." *American Journal of Agricultural Economics* 78(1996):416–27.

Bardsley, P., A. Abey, and S. Davenport. "The Economics of Insuring Crops Against Drought." *Australian Journal of Agricultural Economics* 28(1984):1–14.

Barnaby, G.A., and J. Skees. "A Public Policy for Catastrophic Yield Risk: An Alternative Crop Insurance Program." *Choices* 5(1990):7–9.

Bohn, J.G., and B.J. Hall. "The Moral Hazard of Insuring the Insurers." In K.A. Froot, ed. *The Financing of Catastrophe Risk*. Chicago: University of Chicago Press, 1999, pp. 363–84.

Bourgeon, J.M., and R.G. Chambers. "Optimal Area-Yield Crop Insurance Reconsidered." *American Journal of Agricultural Economics* 85(2003):590–604.

Chambers, R.G. "Insurability and Moral Hazard in Agricultural Insurance Markets." *American Journal of Agricultural Economics* 71(1989): 604–16.

Chambers, R.G., and J. Quiggin. "Decomposing Input Adjustments under Price and Production Uncertainty." *American Journal of Agricultural Economics* 83(2001):20–34.

——. "Optimal Producer Behavior in the Presence of Area-Yield Crop Insurance." *American Journal of Agricultural Economics* 84(2002): 320–34.

Chite, R.M. "A Federal Crop Insurance: Background and Current Issues." Congressional Research Service Report No. 88-739 ENR, December 1988.

Coble, K.H., and T.O. Knight. "Crop Insurance as a Tool for Price and Yield Risk Management." In R.E. Just and R.D. Pope, eds. *A Comprehensive Assessment of the Role of Risk in Agriculture*. Boston: Kluwer, 2002, pp. 445–68.

Crocker, K.J., and J. Morgan. "Is Honesty the Best Policy? Curtailing Insurance Fraud Through Optimal Incentive Contracts." *Journal of Political Economy* 106(1998):355–75.

Davidson, R.J. Jr. "Statement Before the House Agricultural Subcommittee on General Farm Commodities and Risk Management," July 21, 2004. Available at http://www.rma.usda.gov/news/testimony/2004/721davidsontestimony.pdf.

Duncan, J., and R.J. Myers. "Crop Insurance under Catastrophic Risk." *American Journal of Agricultural Economics* 82(2000):842–55.

Gardner, B.L. "A Crop Insurance in U.S. Farm Policy." In D.L Hueth and W.H. Furtan, eds. *Economics of Agricultural Crop Insurance: Theory and Evidence*. Boston: Kluwer Academic, 1994, pp. 17–44.

——. *The Economics of Agricultural Policies*. New York: McGraw-Hill, 1990.

Gardner, B.L., and R.A. Kramer. "A Experience with Crop Insurance Programs in the United States." In P. Hazell, C. Pomerada, and A. Valdez, eds. *Crop Insurance for Agricultural Development: Issues and Experience*. Baltimore: Johns Hopkins University Press, 1986, pp. 195–222.

[11] In this vein, during the 2002 farm bill debate, Senator Lugar proposed replacing crop insurance subsidies with a direct cash transfer to producers that could be applied to the purchase of a variety of risk-management instruments (U.S. Congress).

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

Glauber, J.W. "A Declaration in the U.S. District Court for the District of North Dakota, Southeastern Division Paul Wiley, et al. v. Daniel Glickman." Civil No. A3-99-32, May 18, 1999.

Glauber, J.W., and K.J. Collins. "Crop Insurance, Disaster Assistance, and the Role of the Federal Government in Providing Catastrophic Risk Protection." *Agricultural Finance Review* 69(2002):81–102.

Glickman, D. "Testimony of Dan Glickman before the House Committe on Agriculture." September 27, 2000. Available at http://www.rma.usda.gov/news/testimony/2000/house_0927.html.

Goodwin, B.K. "An Empirical Analysis of the Demand for Multiple-Peril Crop Insurance." *American Journal of Agricultural Economics* 75(1993):425–34.

Goodwin, B.K., and V.H. Smith. *The Economics of Crop Insurance and Disaster Aid*. Washington DC: The AEI Press, 1995.

——. "An *Ex Post* Evaluation of the Conservation Reserve, Federal Crop Insurance and Other Government Programs: Program Participation and Soil Erosion." *Journal of Agricultural and Resource Economics* 28(2003):201–16.

Goodwin, B.K., M.L. Vandeveer, and J. Deal. "An Empirical Analysis of Acreage Effects of Participation in the Federal Crop Insurance Program." *American Journal of Agricultural Economics* 86(2004).

Halcrow, H.G. "Actuarial Structures for Crop Insurance." *Journal of Farm Economics* 31(1949):418–43.

Harwood, J., R. Heifner, K. Coble, J. Perry, and A. Somwaru. "A Managing Risk in Farming: Concepts, Research, and Analysis." U.S. Department of Agriculture, Economic Research Service Agricultural Economic Report No. 774, March 1999.

Hess, U. "Innovative Financial Services for India: Monsoon-Indexed Lending and Insurance for Smallholders." The World Bank. Agriculture and Rural Development Working paper no. 9, August 2003.

Hirshleifer, J., and J.G. Riley. *The Analytics of Uncertainty and Information*. New York: Cambridge University Press, 1992.

Horowitz, J.K., and E. Lichtenburg. "Insurance, Moral Hazard, and Chemical Use in Agriculture." *American Journal of Agricultural Economics* 75(1993):926–35.

Innes, R. "Crop Insurance in a Political Economy: An Alternative Perspective on Agricultural Policy." *American Journal of Agricultural Economics* 85(2003):318–35.

Just, R.E., L. Calvin, and J. Quiggin. "Adverse Selection in Crop Insurance: Actuarial and Asymmetric Information Incentives." *American Journal of Agricultural Economics* 81(1999):834–49.

Ker, A.P. "Private Insurance Company Involvement in the U.S. Crop Insurance Program." *Canadian Journal of Agricultural Economics* 49(2001):557–66.

Ker, A.P., and T. Ergün. "An Empirical Analysis of the Private Insurance Companies in the U.S. Crop Insurance Program." Working paper, Dept. of Agriculture and Resource Economics, University of Arizona, March 2003.

Ker, A.P., and P. McGowan. "Weather-Based Adverse Selection and the U.S. Crop Insurance Program: The Private Insurance Company Perspective." *Journal of Agricultural and Resource Economics* 25(2000):386–410.

King, R.P., and G.E. Oamek. "Risk Management by Colorado Dryland Wheat Farmers and the Elimination of the Disaster Assistance Program." *American Journal of Agricultural Economics* 65(1983):247–55.

Knight, T.O., and K.H. Coble. "A Survey of Multiple Peril Crop Insurance Literature Since 1980." *Review of Agricultural Economics* 19(1997):128–56.

——. "Actuarial Effects of Unit Structure in the U.S. Actual Production History Crop Insurance Program." *Journal of Agricultural and Applied Economics* 31(1999):519–35.

Kramer, R.A. "Federal Crop Insurance." *Agricultural History* 97(1983):181–200.

Mahul, O. "Optimal Insurance Against Climatic Experience." *American Journal of Agricultural Economics* 83(2001):593–604.

——. "Optimum Area Yield Crop Insurance." *American Journal of Agricultural Economics* 81(1999):75–82.

Mason, C., D.J. Hayes, and S.H. Lence. "Systemic Risk in U.S. Crop Reinsurance Programs." *Agricultural Finance Review* 63(2003):23–40.

Miller, T.A., and A.S. Walter. "A Options for Improving Government Programs that Cover Crop Losses Caused by Natural Hazards." USDA Economic Research Service No. 654, March 1977.

Miranda, M.J. "A Area-Yield Crop Insurance Reconsidered." *American Journal of Agricultural Economics* 73(1991):233–42.

Miranda, M.J., and J.W. Glauber. "A Systemic Risk, Reinsurance, and the Failure of Crop Insurance Markets." *American Journal of Agricultural Economics* 79(1997):206–15.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

National Crop Insurance Services. "Federal Crop Insurance Program: Profitability and Effectiveness Analysis," March 2004. Available at www.ag-risk.org.

Nelson, C.H., and E.T. Loehman. "Further Towards a Theory of Agricultural Insurance." *American Journal of Agricultural Economics* 69(1987):523–31.

Quiggin, J. "A Note on the Viability of Rainfall Insurance." *Australian Journal of Agricultural Economics* 30(1986):63–69.

Quiggin, J., G. Karagiannis, and J. Stanton. "Crop Insurance and Crop Production: Empirical Study of Moral Hazard and Adverse Selection." *Australian Journal of Agricultural Economics* 37(1993):95–113.

Ramaswami, B. "Supply Response to Agricultural Insurance: Risk Reduction and Moral Hazard Effects." *American Journal of Agricultural Economics* 75(1993):914–25.

Rejesus, R.M., B.B. Little, A. Lovell, M. Cross, and M. Schucking. "Patterns of Collusion in the U.S. Crop Insurance Program: An Empirical Analysis." *Journal of Agricultural and Applied Economics* 36(2004):449–66.

Rubinstein, A., and M. Yaari. "Repeated Insurance Contracts and Moral Hazard." *Journal of Economic Theory* 30(1983):74–97.

Shaik, S., and J. Atwood. "Demand for Optional Units in Crop Insurance." Paper presented at the AAEA annual meeting, Montreal, Canada, 27–30 July 2003.

Skees, J.R. "The Bad Harvest." *Regulation* 24(2001):16–21.

Skees, J.R., J.R. Black, and B.J. Barnett. "A Designing and Rating an Area Yield Crop Insurance Contract." *American Journal of Agricultural Economics* 79(1997):430–38.

Skees, J.R., and M.R. Reed. "Rate-Making for Farm-Level Crop Insurance: Implications for Adverse Selection." *American Journal of Agricultural Economics* 68(1986):653–59.

Skees, JR., P. Hazell, and M. Miranda. "A New Approaches to Crop Yield Insurance in Developing Countries." International Food Policy Research Institute, EPTD Discussion Paper No. 55, November 1999.

Smith, D.R. "The Public/Private Risk Management Partnership." Paper Presented at the Agricultural Outlook Forum 2001, Washington DC, February 22, 2001.

Smith, V.H., H.H. Chouinard, and A. Baquet. "Almost Ideal Area Yield Crop Insurance Contracts." *Agricultural and Resource Economics Review* 23(1994):428–38.

Smith, V.H., and B.K. Goodwin. "Crop Insurance, Moral Hazard, and Agricultural Chemical Use." *American Journal of Agricultural Economics* 78(1996):428–38.

Turvey, C.G. "Weather Derivatives for Specific Event Risks in Agriculture." *Review of Agricultural Economics* 23(2001):333–51.

Turvey, C., G. Nayak, and D. Sparling. "Reinsuring Agricultural Risk." *Canadian Journal of Agricultural Economics* 47(1999):281–91.

U.S. Congress, Senate Committee on Agriculture, Nutrition and Forestry. Farm and Ranch Equity Act of 2001. Washington DC: 107th Cong., 1st Sess., Section 1571, 2001. Available at http://agriculture.senate.gov/Legislation/107th_Congress/farm-lug.htm.

U.S. Department of Agriculture. "FY 2005 Budget Summary." February 2004.

U.S. Department of Agriculture. Office of the Inspector General. "A Report to the Secretary on Federal Crop Insurance Reform." No. 05801-2-At, March 1999. Available at www.usda.gov/oig/auditrpt/cropsins.pdf.

U.S. Department of Agriculture, Risk Management Agency. "A USDA to Suspend Pilot Watermelon Crop Insurance Program." Press release. September 12, 1999. Available at http://www.act.fcic.usda.gov/news/pr/1999/990913.html.

U.S. General Accounting Office. "A Agriculture in Transition: Farmers Use of Risk Management Strategies." GAO/RCED-99-90, April 1999.

——. "A Crop Insurance: Overpayments of Claims by Private Companies Costs the Government Millions." GAO/RCED-88-7, May 1987a.

——. "A Crop Insurance: Federal Program Has Been Unable to Meet Objectives of 1980 Act." GAO/T-RCED-93-12, March 3, 1993.

——. "A Crop Insurance: Opportunities to Reduce Government Costs for Private-Sector Delivery." GAO/RCED-97-70, April 1997.

——. "A Crop Insurance: Program Has not Fostered Significant Risk Sharing by Insurance Companies." GAO/RCED-92-25, January 1992.

——. "A Disaster Assistance: Crop Insurance Can Provide Assistance More Effectively than Other Programs." GAO/RCED-89-211, September 1989.

——. "Analysis of Certain Operations of the Federal Crop Insurance Program." GAO/CED-81-148, July 30, 1981.

——. "Crop Insurance: Federal Crop Insurance Corporation Needs to Improve Decision-Making." GAO/RCED-87-77, July 1987b.

Valgren, V.N. "A Crop Insurance: Risks, Losses, and Principles of Protection." U.S. Department

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

of Agriculture, Bulletin No. 1043, January 23, 1922.

Vedenov, D., M. Miranda, R. Dismukes, and J. Glauber. "An Economic Analysis of the Standard Reinsurance Agreement." University of Georgia, Department of Agricultural and Applied Economics, Working paper, 2004.

Vercammen, J., and G.C. van Kooten. "Moral Hazard Cycles in Individual-Coverage Crop Insurance." *American Journal of Agricultural Economics* 76(1994):250–61.

Wright, B.D., and J.A. Hewitt. "A All-Risk Crop Insurance: Lessons from Theory and Experience." In D.L Hueth and W.H. Furtan, eds. *Economics of Agricultural Crop Insurance: Theory and Evidence*. Boston: Kluwer Academic, 1994, pp. 73–114.

World Trade Organization. Dispute Settlement Body. "United States—Subsidies on Upland Cotton (WT/DS267)." 2004. Available at http://www.wto.org/english/tratop_e/dispu_e/dispu_e.htm.

Wu, J. "Crop Insurance, Acreage Decisions, and Nonpoint-Source Pollution." *American Journal of Agricultural Economics* 81(1999):305–20.

Young, C.E., M.L. Vandeveer, and R.D. Schnepf. "Production and Price Impacts of U.S. Crop Insurance Programs." *American Journal of Agricultural Economics* 83(2001):1194–201.

Downloaded from ajae.oxfordjournals.org at University of Wisconsin-Madison on October 1, 2010

The author has requested enhancement of the downloaded file. All in-text references underlined in blue are linked to publicatio