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Drought Tolerance and Risk in the U.S. Crop Insurance Program

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Are farmers paying too much for crop insurance? It sure seems so, at least in the Corn Belt. With the exception of 2008 when a large drop in price triggered payments, Corn Belt farmers have generally paid more into the program than they have gotten out, despite Congress’s intention that farmers get at least two dollars for each dollar they pay into the program.

But answering this question is more difficult than just looking at the recent pattern of premiums paid and claims received. How crop insurance premiums are determined is quite complex. A few actuaries in USDA’s Risk Management Agency (RMA), a few actuaries outside of RMA, and a handful of university professors sort of know what is going on. However, given the growing importance of premium setting in the U.S. crop insurance program, it is important for more people to know, at least in general, how these premiums are determined.

In the public/private partnership that governs the U.S. crop insurance program, the private sector sells policies, adjusts claims, and submits data to RMA. The government’s role is to reimburse companies for their costs, provide reinsurance, and set all premiums. While most attention by the interested public has focused on companies’ large underwriting profits and agents’ extraordinary commissions in recent years, much less attention has been paid to the premium-setting part of the program. But how much the government says crop insurance companies can charge for the various insurance products plays a central role in determining how much farmers pay for their coverage and how much the overall program costs taxpayers.

Congress has instructed RMA to set premiums to achieve a target loss ratio (indemnities paid out divided by total premium charged) of 1.0. How RMA tries to achieve this target loss ratio is complicated by the fact that most farmers today buy revenue insurance, which can pay off when either market price or yield drops. But RMA determines how much companies can charge for the yield part of the coverage following fairly standard insurance guidelines for property and casualty insurance.

Insurance companies maintain large databases of historic loss data to help them determine how much they should charge for insurance. By looking back in time and across customers, companies calculate how much they have paid out in insurance claims relative to the total amount of insurance that their customers have purchased. The ratio of losses paid to coverage purchased is called the loss-cost ratio. Loss-cost ratios are used to set rates instead of just total payments made to account for variations in the amount of insurance that is purchased over time and across regions. For example, an expensive home in 1970 may have cost $200,000, whereas the comparable home today might be valued at $2 million. A $10,000 claim paid in 1970 (5 percent of the value of the home) is comparable to a $100,000 claim today. If the risk of insuring homes is no greater today, then the probability of making a 5 percent loss payment in 1970 equals the probability of making a 5 percent loss payment today. By expressing claims paid as a percentage, insurance companies can use past data to determine what they are likely to pay out in the future.

The use of past loss-cost ratios is the foundation for how RMA determines the extent to which there is yield risk. The loss-cost procedure is valid if the risk of a 30 percent loss today is the same as the risk of a 30 percent loss in the past. If it is, then RMA can simply calculate how often crop insurance companies have paid out different percentage losses to estimate the current probability of paying out losses of different magnitudes. The assumption of a constant percentage loss risk over time underlies the premium rates for all the popular crop insurance products, including Revenue Assurance, Crop Revenue Coverage, Actual Production History, Group Risk Income Protection, and the Group Risk Plan. Although this assumption is convenient for setting premium rates, there is mounting evidence that crop yields today are less susceptible to losses than in the past.

Are Crop Risks Getting Lower? Figure 1 provides the first piece of evidence that crop risk has been decreasing over time. As shown,
the overall loss ratio for the U.S. crop insurance program has indeed been declining. The average loss ratio from 1989 to 1999 was 1.12. The average from 2000 to 2008 has been 0.88. And there has not been a loss ratio above 1.0 since 2003. However, a declining loss ratio, in and of itself, is not proof that crop risk has been reduced. For example, the decline could be due to good growing-season weather. There have not been widespread losses in the Corn Belt due to drought since 1988, and Corn Belt states account for more than half of the total liability in the program. Before we can conclude that risk has been reduced, we need to account for whether the decline in loss ratios could have been caused by a string of better-than-average growing seasons that could change in the future.

Another piece of evidence that yield risk for corn is lower now than in the past is that RMA has approved substantially lower premium rates for farmers who plant biotech corn. The companies that produce this biotech corn, which expresses toxins that kill corn borers and corn rootworms, argue that their new hybrids are more vigorous and can better withstand adverse growing conditions. After seeing company data, the RMA agreed.

Because biotech corn has been planted widely now for some time, it seems reasonable to expect that evidence of lower corn yield risk should be discernable in yield data. Findings from a new research report (Yu and Babcock, 2009) support biotech company claims: corn yield losses from drought are much lower today than in the past. The report also shows that not all of the reduction in yield risk is due to increased insect control because soybean yield losses to drought have also declined. Next, we review what the report found and the implications for premiums and taxpayer cost from crop insurance.

Measuring Changes in Drought Tolerance of Corn and Soybeans

If corn and soybean yields are less susceptible to drought, then a drought of a given severity in 1980 would have resulted in larger yield losses than if the same drought had hit this year. Thus, a straightforward method for making such a determination is to compare yield losses to drought in the 1980s with more recent yield losses.

The first step is to construct a measure of drought severity. In the Corn Belt, a lack of rainfall causes the most damage if accompanied by high temperatures. A good index of drought would show severity increasing as hot and dry conditions increase (see the paper by Yu and Babcock for further details).

The second step is to construct a measure of yield loss. We accomplished this by estimating what yield would be in any year absent hot and dry conditions and then comparing what yield actually was in the years of hot and dry conditions. There are two relevant measures of yield loss. Under the lost-cost ratio method of rate making, yield loss expressed as a percentage is assumed to stay constant over time. So we are interested in calculating yield loss expressed as a percentage of what yield would have been without drought. A second measure is the number of bushels lost. If the percentage of yield loss is constant over time, and trend yields are growing over time, then the absolute number of bushels lost due to a drought of a given severity must be increasing.

The final step is to find yield data that can be matched up with the drought index data. The longest-running consistent data series on yield is published by the National Agricultural Statistics Service (NASS). Measuring how the impact of drought on yield has changed over time obviously requires observations of drought throughout the time period studied. Although the incidence of drought has decreased over time, with no major drought affecting Iowa yields since the 1980s, there have been enough droughts in certain regions of Illinois and Indiana in the 1980s and from 2000 to 2008 to allow good measurements.

Figure 2 shows how yield losses from droughts of different severities in the years 1980–1989 compare with yield losses from comparable droughts in 2000–2008 for corn and soybeans. Drought severity is indicated by the value of the drought index on the horizontal axis, and yield loss is the average loss either in bushels per acre or percentage
Thus, the data seem to support the idea that corn has become more drought tolerant over time. The evidence for soybeans is a bit mixed. Percentage yield loss due to drought is lower in 2000–2008 than in 1980–1989 for all droughts except for the most severe category, while there is no clear pattern for bushel-per-acre loss. But for both corn and soybeans, the evidence seems strong that the percentage of yield lost due to drought has declined over time.

To estimate the magnitude of these changes in drought-induced losses, we use an equation that shows how yield has changed over time because of better management and technology and how drought’s impacts on yields have changed over time. The estimated equation can also be used to determine if the increase in drought tolerance is statistically significant.

The estimated equation is available in the working paper. The hypothesis of increasing drought tolerance for corn is strongly supported by the data. For soybeans, the hypothesis of increasing drought tolerance when yield loss is measured as a percentage of yield is also strongly supported by the data. Soybean yield loss measured in bushels per acre is estimated to be practically unchanged over time. Figure 3 shows the estimated bushel-per-acre loss for corn for droughts of different severities. As shown, the estimated number of corn bushels that would be lost to drought is lower in 2008 than in 1988. The gap between drought losses in those two years widens considerably when losses are expressed as a percentage of drought-free expected yield, as shown in Figure 4. For corn, a return of a 1988 drought would reduce yields by 31 percent in 2008, which is far below the 45 percent losses from the same drought in 1988. This is a reduction in yield risk from drought of 31 percent. For soybeans, there has been less of an increase in drought tolerance than for corn. But for a 1988-style drought, estimated losses have been reduced from 28 percent of drought-free expected yields to 23 percent—a reduction in drought risk of about 18 percent.

Implications of Increased Drought Tolerance

The maintained hypothesis that underpins all premium rates for...
Both corn and soybean yields in the Corn Belt are more tolerant of drought today than they were in the past. Because drought is such an important source of yield risk, this finding implies that Corn Belt crop insurance premiums are too high. To determine the extent to which crop insurance rates may be too high, the premiums needed to cover losses due to drought from 1980 to 2008 under the assumption that percentage yield loss due to drought has been constant over time were calculated for four counties in Illinois and Indiana for each crop under the Group Risk Plan (GRP)—a county-based yield insurance program. The premiums needed to cover these losses assuming declining percentage losses as shown in Figure 4 were also calculated. The differences were then subtracted from the actual GRP rates. This results in adjusted GRP premium rates that account for increasing drought tolerance. Figure 5 shows the percentages by which current GRP rates in those counties are too high. As expected given the findings in Figure 4, the percentage over-rating for corn is generally much greater than for soybeans. The anomalous result for Spencer County corn is due to a low percentage of the GRP corn rate that is accounted for by drought. In Peoria County, the unloaded GRP premium rate for 90 percent corn coverage is 3.41 percent. Given increased drought tolerance, the premium rate should be 1.06 percent. This large difference shows the potential impact of accounting for increased drought tolerance of crops. For soybeans the difference is smaller but still significant. In Jasper County the unloaded GRP rate is 2.22 percent. Accounting for the increased drought tolerance of soybeans would drop the GRP rate to 1.52 percent.

The impact of lower premiums on farmers is straightforward: if premiums were to drop by 40 percent, then the premium that farmers would have to pay for the same level of coverage would fall by 40 percent. Consequently, farmers would greatly benefit if increased drought tolerance were accounted for in crop insurance. The amount that crop insurance companies receive as an expense reimbursement would also drop by the same percentage because expense reimbursements

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commissions. Then RMA could add in so much per policy for claims adjustment and so much per policy for salaries and other overhead.

The chances that Congress will soon embrace a cut in funding for a program that has generated 20 percent annual salary growth for crop insurance agents who reside in rural areas seems pretty remote. After all, Congress and the administration are currently borrowing money to create jobs to keep unemployment down. But eventually, borrowed money has to be paid back. And the only way to pay back money is to raise taxes or cut expenditures. But there are economic costs associated with raising tax revenue, so federal programs should be scrutinized for efficiency. In agriculture, the place to start is the crop insurance program. There is no doubt the same level of service can be provided to farmers at much lower cost.

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are calculated as a proportion of premiums. This drop in expense reimbursement could be lower if farmers responded to a premium decrease by buying more expensive coverage.

In addition, a drop in premium rates would increase loss ratios, which would decrease underwriting gains. Because taxpayers do not benefit as much from underwriting gains as they lose when there are underwriting losses, such a change would likely benefit taxpayers. Thus, taxpayers and farmers would likely be net winners from an adjustment to crop insurance premiums to account for increasing drought tolerance.

A Full Accounting
The efforts of biotechnology companies seem to have paid off in an unanticipated manner by making corn hybrids better able to withstand drought conditions. Modern, herbicide-resistant soybeans also seem, for more enigmatic reasons, to have increasing drought resistance. In addition, both crops are being managed by larger and perhaps more able managers. And better management leads to more timely field operations, which could result in increasing drought tolerance.

The large impacts of this newly evident drought tolerance in corn and soybeans may be dwarfed if seed companies are in fact successful in their targeted efforts to reduce yield losses due to drought. As new technologies become available, it is important that the crop insurance industry and Risk Management Agency alter the way they determine crop insurance rates so the system can directly reflect the lower risks.

Work Cited

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