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Economic Aspects of Revenue-Based Commodity Support

Joseph Cooper

Abstract

Interest in revenue-based commodity support is evident in the Food, Conservation and Energy Act of 2008 (the 2008 Farm Bill), which gives eligible producers the option of participating in the Average Crop Revenue Election (ACRE) program in return for reductions and eliminations of payments under more traditional programs. This report examines how the uncertainty in U.S. domestic commodity support payments for corn may differ between traditional-style approaches (defined as price-based payments plus yield-based disaster payments) to support and two revenue-based support scenarios. Variability around the total expected annual payment was found to be lower under revenue-based support, as was the probability of high payments. These results suggest potential advantages to this type of support, both in terms of lower budgetary uncertainty for the Federal Government and in better ensuring that agricultural support outlays stay below a certain ceiling. In addition, the volatility of corn revenue was found to be lower in almost all corn producing counties under the revenue-based alternatives than under the traditional price-based approaches.

Keywords: Domestic commodity support, revenue-based support, marketing loan benefits, countercyclical payments, disaster assistance, Federal crop insurance

Contents

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Summary

Traditional commodity support, in the form of countercyclical payments and marketing loan benefits, pays producers when prices fall below specified levels, but does not compensate them for yield losses. Congress historically provides disaster assistance, or compensation for shortfalls in yield, only on an *ad hoc* basis. Providing price and yield compensation in separate programs means that producers may receive support when they do not need it, or not receive support when they do need it. An alternative to separate price- and yield-based support programs would be to determine a national or regional payment rate based on shortfalls in revenue from an expected or target revenue.

What Is the Issue?

Using revenue as the basis for commodity program payments may be more efficient than a price- or yield-based program in reducing financial risk because of the inverse correlation between yields and prices. For example, a farmer who suffers a complete yield loss will not receive a payment under a price-based program. Widespread yield losses can boost prices above price program trigger levels, providing little or no assistance when producers have little product to market. Conversely, high yields, by increasing supply, can cause crop prices to fall, triggering payments to producers even though production and, potentially, revenue are high. Interest in revenue-based commodity support is evident in the Food, Conservation and Energy Act of 2008 (the 2008 Farm Bill), which offers eligible producers the option to participate in the Average Crop Revenue Election (ACRE) program.

What Did the Study Find?

To investigate the policy implications of revenue support programs, this report compares the distribution of support payments for corn under a traditional-style program scenario (price-based payments and yield-based disaster payments) versus two theoretical revenue-based program scenarios, one based on revenue shortfalls with respect to a target revenue and one based on shortfalls with respect to an expected market revenue.

Under traditional price-based programs—marketing loan benefits or counter cyclical payments—payments are triggered when market prices fall below the statutory price floor (loan rates and target prices). These prices are fixed for the life of the Farm Act legislation. The target revenue scenario extends this approach to the revenue case, i.e., the revenue floor in the target revenue program is expected yield times a fixed statutory price. In contrast, the revenue floor in the market revenue program is expected yield times the expected price at harvest time, where the expected price changes from year to year as dictated by market conditions.

For the computer simulations, commodity program parameters were chosen so that the expected value of total national payments is the same across price and revenue-based programs. Hence, from a national perspective (e.g., the taxpayer), the programs differ only in the variability (or volatility) of payments and in differing probabilities of making any particular level of payments.

Both types of revenue-based program scenarios offer the potential for less variable payment outlays from year to year (benefiting the Government) and less variability in farm revenue (benefiting the producer) than current approaches. Computer simulations also suggest that both revenue-based schemes result in a lower likelihood of high payments or overcompensation. These results suggest that revenue-based support would reduce budgetary uncertainty for the Federal Government and better ensure that agricultural support outlays stay below a predetermined ceiling, as required under some multilateral trade commitments.

In addition, the computer simulations suggest that variability of corn revenue (the coefficient of variation) was lower in almost all corn-producing counties under the revenue-based alternatives than under the traditional price-based approaches. The reduction in revenue volatility was most pronounced in the Corn Belt counties.

Finally, whether farmers prefer one type of support program over another depends on its impact on mean revenue and the variability of revenue. While revenue-based support scenarios generally reduced the downside risk of farming more than did the current-style support, farmer preferences for type of support would depend on their preferences for increasing mean returns versus decreasing the variability of returns.

How Was the Study Conducted?

To investigate the policy implications of revenue support programs, this report compares the statistical distribution of payments from hypothetical revenue-based programs to those from a suite of programs similar to the traditional set of commodity support programs. While probability-based program analysis, as used in legally required government cost estimates, summarizes the distribution of program costs into mean estimates, other summary statistics—such as the variance and skewness (shape) of the distribution—are useful too. The estimated payment distributions have implications both for government policy and for farm-level benefits. Actual program payments are sensitive to a broad array of program provisions, and seemingly small changes in these can cause large changes in payment levels. Hence, to make the support programs comparable, the study's program scenarios were designed to differ only in the fundamental program provisions.

Introduction and Overview

Most farm legislation at the Federal level is contained in "Farm Acts," which first authorized farm income support in the form of commodity payments in the 1930s (Bowers et al., 1984). Support—in the form of countercyclical payments (CCPs) and marketing loan benefits (MLBs)—makes payments to producers in response to price shortfalls. Commodity support not covered in the Farm Act includes ad hoc disaster assistance and Federal crop insurance. This report focuses on CCPs, MLBs, ad hoc disaster assistance, and a new class of revenue-based support.

While CCPs and MLBs target low prices, ad hoc disaster assistance generally targets low yields. However, farm returns per acre, as measured in terms of revenue, are price times yield. While longstanding support for program crops (corn, for example) addresses revenue, it does not do so in a coordinated fashion. In particular, government payments are typically triggered by price or yield shortfalls and, until the 2008 Farm Act, did not calculate payments based on revenue shortfalls. As a result, traditional support programs can over- or undercompensate producers relative to changes in their gross revenue.

The 2008 Farm Act, the Food, Conservation, and Energy Act of 2008 (Public Law 110-246), allows an eligible producer to receive revenue-based support in the Average Crop Revenue Election (ACRE) program. In return, the producer forgoes payments under one price-based payment program, and accedes to reduced payments under another price-based support program and to a reduction in a fixed payment (USDA/ERS, 2008; Zulauf et al., 2008).

A revenue-based support program could be more efficient than the traditional suite of uncoordinated commodity support programs and disaster assistance programs in that payments are more closely aligned to actual changes in farm revenue. If prices and yields are inversely related, the revenue-based approach may offer less variable payment outlays from year to year than the longstanding forms of support—even if mean total payments are the same between the two forms of support. In such a case, a high level of payments may also be less likely under revenue-based support.

Rather than focus specifically on the new ACRE program, which has a complex mechanism for setting payments and will not provide coverage until the 2009 crop year, this report provides an overview of revenue-based domestic commodity support alternatives in general.

Traditional Forms of Domestic Commodity Support

Direct commodity price and income support to producers under Title I of the Farm Security and Rural Investment Act of 2002 (abbreviated throughout this report as "2002 Farm Act") was primarily provided in the form of direct payments, countercyclical payments, and marketing assistance loan benefits (i.e., marketing loan gains, loan deficiency payments, and certificate exchange gains). For more detailed discussion of these programs, see USDA

(2006) and USDA/ERS (2007a). These forms of support continue with the 2008 Farm Act, but with some relatively minor changes.

Direct and countercyclical payments cover producers with base acres of feed grains (corn, sorghum, barley, and oats), wheat, oilseeds (e.g., soybeans), upland cotton, rice, peanuts, and pulse crops (only for countercyclical payments). In addition, these commodities and a number of other crops (including extra-long staple (ELS) cotton, honey, wool, and mohair) are eligible for marketing assistance loan benefits.[1] Thus, these "program" crops are those covered by standard commodity programs.[2] Commodity support in the form of subsidized crop insurance is offered under the Federal Crop Insurance Act of 1980, as amended by the Agricultural Risk Protection Act of 2000. In addition, ad hoc disaster and/or market loss assistance has been authorized by Congress for most years since 1988.

[1]For ELS cotton, the producer must repay the loan at the loan rate (plus accrued interest and other charges), and ELS cotton is not eligible for loan deficiency payments.

[2]Programs for milk and sugar, which support market prices by restricting marketable supplies, are not covered in this report.

Countercyclical Payments

The Direct and Countercyclical Payment Program (DCP), as authorized under the 2008 Farm Act, provides payments to eligible farmers and landowners on farms enrolled for the 2008−2012 crop years. Direct payments are fixed and do not vary with current crop production or price (USDA/ERS, 2007a; FSA, 2006; OMB, 2008).[3] Like direct payments, a producer's countercyclical (CCP) payments are not tied to current production, but apply whenever the effective price is less than a statutory target price (USDA/ERS, 2007a; FSA, 2006). CCPs are based on farm-level historical base acres and program yields, and so do not depend on current production. As such, they are less distorting than payments tied to actual production (USDA/ERS, 2002; pp. 27 to 28). However, since CCP payments are tied to current prices, they are more distorting than direct payments. Because they are neither price nor yield sensitive, direct payments are not included in the scenario analysis.

[3]The terminology for direct payments can be confusing. All commodity-related payments made directly to farmers are categorized as "direct payments" or "direct cash payments" in the Federal budget. The decoupled payments made to farmers are known as "Direct Payments." We capitalize this specific form of payment to distinguish it from the general category of direct cash payments.

Marketing Loan Benefits

The nonrecourse marketing assistance loan program provides income support at a per-unit price, or loan payment rate (USDA/ERS, 2007a; USDA/FSA, 2003). While CCPs use the national loan payment rates, the marketing assistance loan program uses county-level rates. The program is intended to provide financial liquidity to producers after harvest for more orderly marketing, while minimizing price distortions and the buildup of government stocks. Unlike CCPs, marketing assistance benefits require production of the specific program commodity. Farmers may request a marketing assistance loan after harvesting the program commodity, pledging the harvested commodity as collateral.

When market prices are below the loan rate plus accrued interest, farmers are allowed to repay their loan at a loan repayment rate (reflecting market prices) that is lower than the loan rate (except for extra-long staple cotton). A producer realizes a marketing loan gain if the loan is repaid at less than the loan principal. The marketing loan "gain" per unit of crop output is the amount by which the loan rate exceeds the loan repayment rate. Marketing assistance loans have a 9-month maturity and accrue interest, but if the loan repayment rate is less than the principal plus accrued interest, the interest need not be repaid (USDA/FSA, 2007). The loan is nonrecourse in that, for most program crops, the government must accept the collateral as full payment of the loan at loan maturity if a producer so chooses.

A farmer can alternatively choose to receive the marketing loan benefit as a cash payment (loan deficiency payment), or LDP, if the repayment rate is less than the loan rate. The farmer taking the LDP is free to sell the crop on the open market after receiving the LDP. Marketing loan gains and LDPs are both referred to as marketing loan benefits (MLBs).

Economic Rationale for Revenue-Based Commodity Support

The gross revenue of a producer is price times output, and so will change with changes in price or yield. Traditional commodity support, in the form of CCPs and MLBs, pays producers when prices fall below specified levels, but does not compensate them for yield losses. Traditional disaster assistance does, but in ad hoc fashion, and does not necessarily compensate for low prices. Marketing loss assistance payments, most of which occurred over 1999-2001, addressed market losses associated with low prices, but again in ad hoc fashion. Until the 2008 Farm Act, Congress provides disaster assistance only after constituent requests for aid and contingent on budget considerations. In contrast, CCPs and MLBs apply whenever market prices fall enough to trigger payments, as determined by the program parameters.

Providing price and yield compensation separately means that producers may receive support when they do not need it, or not receive support when they need it. For example, a farmer who suffers a complete yield loss will not receive a payment under a price-based program that is tied to current production (i.e., the MLB).

Revenue-Based Support Better Targets the Producer's Bottom Line

An alternative to separate price- and yield-based support programs would be to determine a national or regional payment rate based on shortfalls in market revenue from an expected or target revenue (e.g., Miranda and Glauber, 1991; Babcock and Hart, 2005; Zulauf, 2006; American Farmland Trust, 2007a; National Corn Growers Association, 2006; Cooper, 2009b).

A revenue support program may be more efficient than the longstanding suite of direct commodity support programs and ad hoc disaster assistance as it more directly targets the producer's bottom line. Revenue-based support was included in the 2007 farm bill proposals from the Administration, and in the House of Representatives and Senate-passed farm bills.[4] Under the 2008 Farm Act, producers can choose the ACRE program in lieu of the traditional suite of support payments. ACRE's revenue-based payment rates are determined by State (USDA/ERS, 2008; Zulauf et al., 2008).

The benefits of targeting revenue rather than price or yield separately hold even when price and yield move independently of each other. However, an additional advantage of revenue-based support occurs when prices are inversely correlated with national average yield (that is, market prices fall as national

[4]The House and Senate bills are titled the "Farm, Nutrition, and Bioenergy Act of 2007" and "The Food and Energy Security Act of 2007," respectively. Among other differences, the revenue program in the House bill would have used a national level payment rate, and the Senate's State level payment rate.

average yield increases).[5] This negative yield-price relationship means that a farmer's revenue is less variable from year to year than it would be otherwise. The more negative the correlation, the greater the offsetting relationship (or "natural hedge") that works to stabilize revenues.[6] For instance, a drought in a major growing region can lower aggregate yield, but the resulting price increase will compensate to some extent for the yield decrease.[7]

To the extent that this "natural hedge" exists, commodity support programs that target only price variability can systematically over- or undercompensate farmers who already have a natural hedge. For example, large yield increases nationally can reduce prices below target prices, triggering countercyclical payments. However, the higher yields offset to some extent the effect of lower prices on revenue. Countercyclical payments ignore this positive revenue factor, and can overcompensate for the revenue decline. Conversely, prices tend to rise with large yield decreases, thereby reducing countercyclical payments, which then undercompensate producers for this decline in revenue.

The offsetting price-yield relationship can make revenue-based support programs appealing from a Federal budgetary standpoint. Since revenue will tend to be less variable than price, revenue-based support programs have the potential to lower year-to-year variability in payments. However, revenue-based support is sensitive to factors like expected price and yield levels, program parameters, and general program design.

As revenue-based crop insurance has become a major part of the Federal crop insurance program (Dismukes and Coble, 2006), the rationale at play there would seem to apply to direct support as well. However, Title I support is provided free of cost to the producer, while the farmer must pay an insurance premium (albeit a subsidized one) for Federal crop insurance. Also, eligibility for crop insurance payments requires that the farmer plant or intended to plant a crop, whereas some forms of Title I support (direct payments and CCPs) do not require planting of a crop. Federal crop revenue insurance protects the farmer against decreases in revenue relative to expected revenue—as the name suggests, it is insurance. Title I support can offer price protection (in the form of CCPs and marketing loan benefits) relative to a statutory guarantee that may be above market expectations. Hence, Title I payments can raise average revenue, and not just address revenue variability.[8]

Implementation of revenue-based support might reduce or eliminate calls for ad hoc disaster assistance due to its inclusion of yield in payment calculations. However, this reduction is not a given, especially if the correlation between the revenue support payments and yield-related losses is low, or if producers believe that the program's revenue guarantee is set too low. While these last two points are not drawbacks specific to revenue-based support (they apply as well to price-based support), lowering the need for ad hoc assistance is a possible motivation for moving to revenue-based support.

Graphical Depiction of Yield and Price-Yield Correlations

The motivation for revenue-based payments based on the natural hedge (inverse price-yield relationship) can be illustrated with maps correlating county yields with national average yield and correlating county yield

[5]This situation occurs in major production regions when regional changes in production affect aggregate supply and thus commodity prices.

[6]This can be shown mathematically using the formula for the variance of the product of two non-independent variables (for example, Goodman, 1960).

[7]Note that the "natural hedge" helps to insure producers against yield drops, given that the price increase caused by the yield drop will be proportionately higher than if the price-yield correlation was zero. On the other hand, with the natural hedge, a yield increase will produce a proportionally greater decrease in price than if the price-yield correlation was zero. This dichotomy of the impact of the "natural hedge" on crop revenues was summarized by Neil Harl as "... the only thing worse for a farmer than bad weather is good weather" (quoted in Goodwin, 2000, p. 76).

[8]What is likely to be more specifically of interest to the farmer than how a support program lowers the variability of total revenue is how the program lowers downside risk in total revenue. However, variability is a convenient proxy for a measure of downside risk.

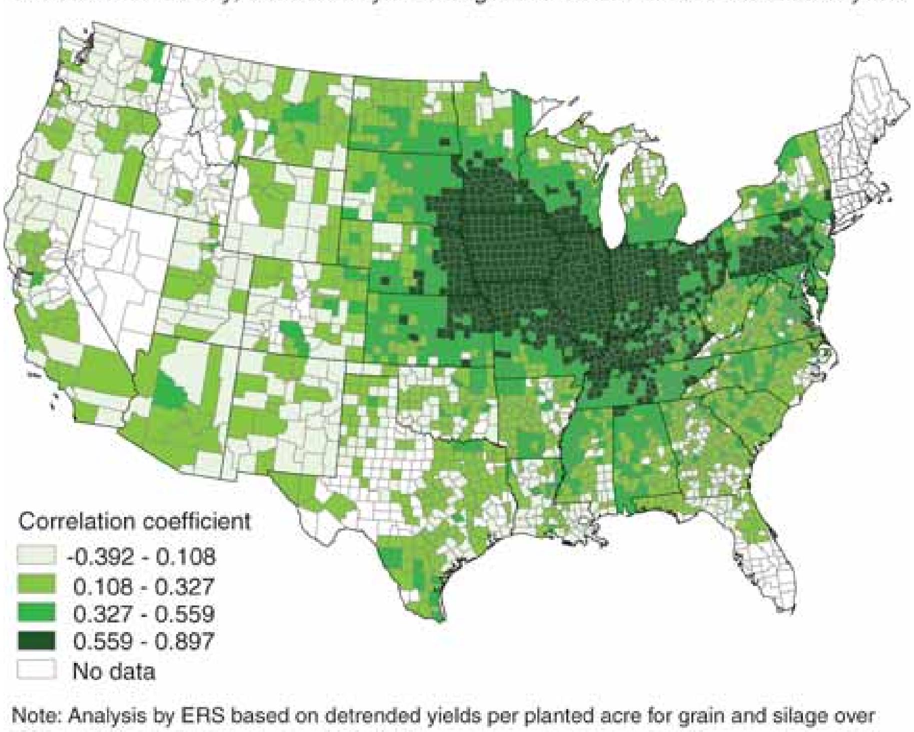
and national price.[9] Figures 1 and 2 show the correlation between county average yields and national average yield based on 1975-2005 data for corn and cotton. In both figures, the larger the (positive) correlation (shown as progressively darker shades of green), the more suggestive that the county yield moves with the national average yield. Changes in corn yield tend to be quite uniform across the Heartland (the major corn growing region, spanning Iowa and Illinois). Yields in the Heartland dominate national average yield, and most other regions are peripheral players in determining national average yield (fig. 1). For upland cotton, several regions with high correlations of county yield and national yield – for example, the Lower Mississippi region, and regions of California, Texas, and the Carolinas – are dispersed widely across the southern United States, from one coast to another (fig. 2).[10]

Figures 3 and 4 show correlation between county yield and national price for corn and upland cotton, again based on 1975-2005 data.[11] The more negative (inverse) the relationship between price and yield, the greater the natural hedge inherent in revenue. For corn (fig. 3), the negative correlation between corn price and yield in the Heartland area suggests an inherent natural hedge between price and yield in that region, with lower prices being somewhat offset by higher yields, and vice versa. Hence, for the government, the direct targeting of revenue changes with a revenue-based program may mean less variable program costs due to the lower likelihood of systemic underpayments or overpayments than with a price-based system.

Figure 1

Correlation of county corn yield with national yield

The darker the county, the more its yield changes in the same direction as national yield.



Note: Analysis by ERS based on detrended yields per planted acre for grain and silage over 1975 to 2005 for all counties for which NASS reports continuous production over the period.

Source USDA, Economic Research Service.

[9]The Pearson correlation can take on values from -1 to 1, and is a measure of the relationship between two random variables. A correlation of -1 means that the two variables move in opposite directions in a perfectly linear fashion (i.e., the movements track along a straight line). A correlation of 1 means that the two variables move in the same direction in a perfectly linear fashion A correlation of 0 means that there is no relationship between the variables. The relationship gets stronger as the correlation moves from a value of 0 towards -1 or 1. See Appendix C for a discussion of the relationship between the correlation and the mean and variability of revenue.

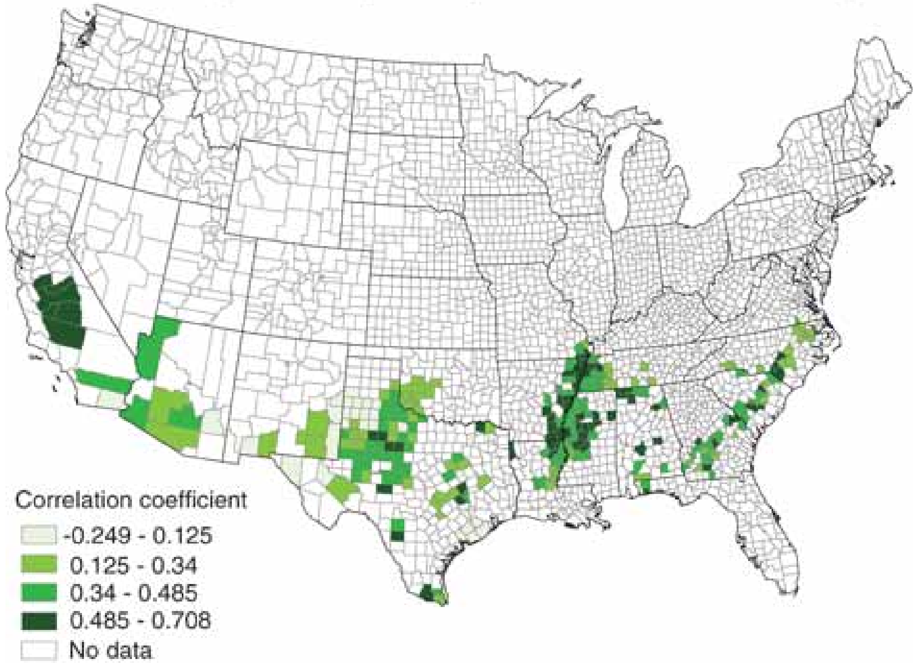
[10]In figure 2, the broad geographic area of high correlation in California should not be taken as an indication that the counties in the San Joaquin Valley are dominating U.S. cotton production, but simply that the large size of these counties can exaggerate their apparent influence.

[11]The price-yield correlations shown in figures 3 and 4 are specifically the correlation of within-season county yield change to within-season national price change. Within-season price change is defined as the percent difference between the harvest time price and the pre-planting time price (an expected price measure). Within-season yield change is defined as the percent difference between harvested yield and expected yield. Converting price and yield to deviation form avoids the need to make arbitrary decisions of how to deflate historic prices to correspond to the detrended yield values (Cooper, 2009b).

Figure 2

Correlation of county upland cotton yield with national yield

The darker the county, the more its yield changes in the same direction as national yield.



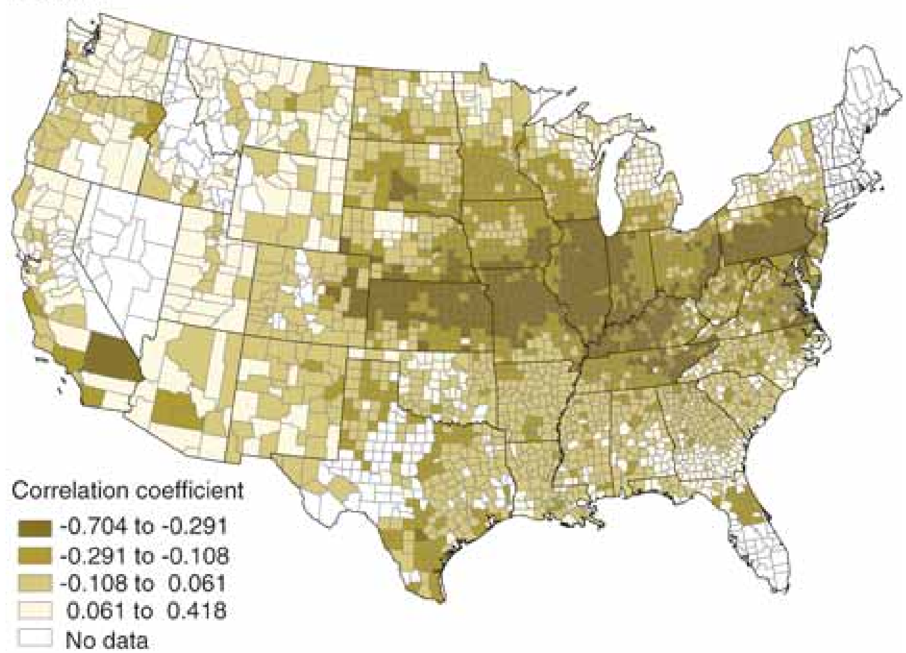
Note: Analysis by ERS based on detrended yields per planted acre for upland cotton over 1975 to 2005 for all counties for which NASS reports continuous production over the period.

Source USDA, Economic Research Service.

Figure 3

Correlation of county yield to national price for corn

The darker the county, the more pronounced the inverse relationship between price and yield.



Note: Analysis by ERS based on Chicago Boards of Trade futures prices for corn and on detrended yields per planted acre for corn for grain and silage over 1975 to 2005 for all counties for which NASS reports continuous production over the period.

Source USDA, Economic Research Service.

As upland cotton does not have any particularly large areas where the correlation between county yield and national price is highly negative (fig. 4), the likelihood of systemic underpayments or overpayments is relatively low and the benefit to the government of a revenue-based payments system in addressing payment variability is likely to be more modest. Nonetheless, even in the case of a low natural hedge, a revenue-based payment more directly targets the economic situation of the farm (assuming revenue as a proxy for this measure) than does a price-based payment, all else being equal.

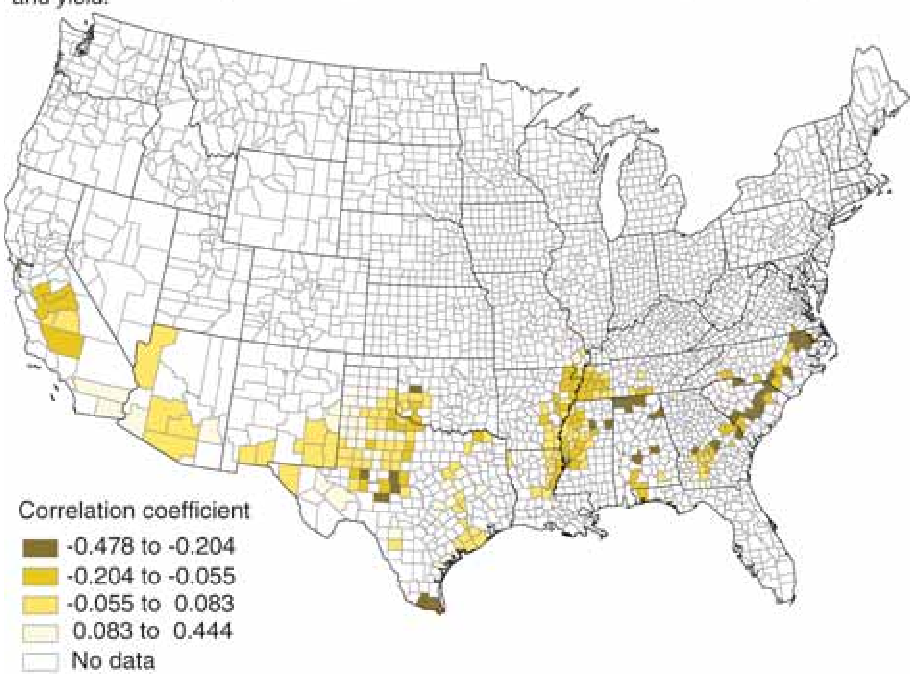
As with price-based payments, revenue-based payments will vary with program details. Still, the guiding principle for a (national or regional) revenue-based payment is that the producer is compensated for the difference between a reference level of revenue per acre and realized revenue per acre. Appendix A demonstrates how payments might actually be made under such programs, with payment schemes that are variations on current marketing loan benefits (MLBs) and countercyclical payments (CCPs).

However, a statistical analysis is necessary to predict at the beginning of the crop season how payments under a revenue-based commodity support system might differ from those under a traditional commodity support structure. The next section presents the results of such an analysis for a county-based payment approach, demonstrating how the mean, variability, and other characteristics of the statistical distribution of payments can be estimated, and how different types of payment program compare to each other on this basis.

Figure 4

Correlation of county yield to national price for upland cotton

The darker the county, the more pronounced the inverse relationship between price and yield.



Analysis by ERS based on cash prices and detrended yields for upland cotton over 1975 to 2005 for all counties for which NASS reports continuous production over the period.

Source USDA, Economic Research Service.

Stochastic Evaluation of Commodity Support Program Alternatives

Introduction

Farmers are generally averse to risk – in particular, to uncertain and economically unfavorable outcomes (Hardaker et al., 2004). While many sources of uncertainty have been identified (Moschini and Hennessy, 2001), this report focuses on the exposure of the farmer and the government to production (specifically, yield) and price uncertainty, which together translate to revenue uncertainty. Given that the producer is unlikely to be indifferent (or neutral) to risk, the producer is concerned with more aspects of revenue than simply its mean value. In short, risk aversion means that a farmer would tend to prefer a commodity support program under which some yearly average level of revenue is forgone in return for lower variability in year-to-year revenue.

While the risk preferences of individuals have received extensive study in the academic literature, the risk preferences of government have not. In the case of support payments, risk preferences may be defined as the Government's desire to decrease the variation in payments from projected budget levels. But the Federal Government is a large and heterogeneous body, and anecdotal evidence suggests that it has no uniform risk preference. However, certain program rules suggest that government agencies have at least some risk aversion with respect to costs. For example, starting with the 1996 Farm Bill, the Congressional Budget Office has used probability, or stochastic, scoring to estimate farm program costs (Jagger and Hull, 1997; Gardner, 1996). In addition, the Office of Management and Budget requires agencies to use probability scoring for estimating program costs if costs are uncertain.

Regardless of government agencies' risk preferences with respect to variability in payment levels, evaluating program costs in a probabilistic framework can identify costs that might not be identified otherwise. Specifically, given the highly stochastic (random) nature of prices and yield (and the many other variables that may affect prices), estimating program costs based simply on the point estimates of variables may not capture full budgetary costs of program change (Jagger and Hull, 1997). For example, just because the expected season-average price for a crop is greater than the trigger price (loan rate) for a marketing loan program does not mean support payments will be nonexistent, given that the average can mask prices that fall below the loan rate during the loan availability period.

Probability scoring is a cost estimate procedure that uses different projection paths for the key variables that are likely to affect corresponding program costs, thereby generating a statistical distribution of program costs. Even if the probability scoring provides only the mean of the estimated distribution of program costs, as it usually does, some aspect of the budgetary risk can still be captured. For example, a proposed program may show no costs using point estimates but higher costs when the mean is based on a probabilistic analysis. Nonetheless, the estimated distribution of program costs (in particular, farm support payments) provides additional information that may be of policy relevance to the government and of practical relevance to producers. For instance, if the government intended to reduce the likelihood that payments exceed a certain ceiling, then such an objective could be examined using the probabilistic approach.

To gain some insights into the policy implications of revenue support programs, this chapter compares the statistical distribution of payments from hypothetical revenue-based programs to those from a suite of programs similar to the traditional set of commodity support programs. While probability-based program analysis, as used in legally required government cost estimates, summarizes the distribution of program costs into mean estimates, other summary statistics – such as the variance and skewness (shape) of the distribution – are useful too. The estimated payment distributions have implications both for government policy and for farm-level benefits.

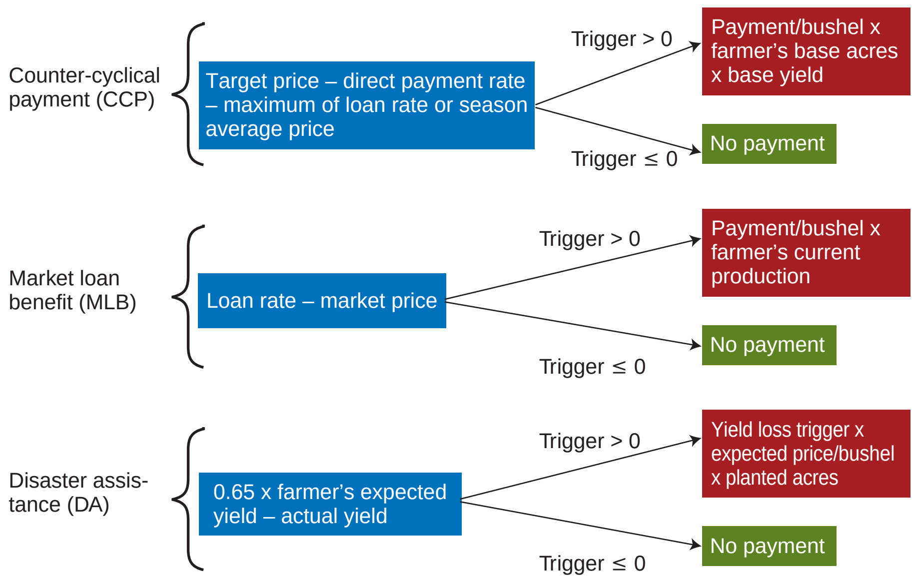
Commodity Support Program Scenarios

Actual program payments are sensitive to a broad array of program provisions, and seemingly small changes in these can cause large changes in payment levels. Hence, to make the support programs comparable, our program scenarios are designed to differ only in the fundamental program provisions. The goal is to investigate how payments are affected by using revenue targets rather than price or yield targets, and not how payments are affected by program parameters inherent to these targets. The traditional-style program scenario is compared with two revenue-based program scenarios, one based (in part) on revenue shortfalls with respect to a target revenue, and one based on revenue shortfalls with respect to an expected market revenue (see “Appendix B. Technical Details of the Stochastic Analysis”).

Traditional-Style Domestic Program Scenario

Our scenario for a generic version of traditional commodity support has three components: countercyclical payments (CCP), marketing loan benefits (MLB), and disaster assistance (DA) payments. Disaster assistance payments are usually based on a shortfall in yield with respect to expected yield, where the lost production is valued at an “established” or expected price (see the three boxes in this section for representations of these program scenarios using flow diagrams). We assume that DA payments operate in this manner, but on a permanent rather than ad hoc basis, like a form of crop yield insurance that is free to the producer. As is frequently the case in actual practice (e.g., the 2001 and 2002 *ad hoc* disaster programs), we assume that payments are made when the producer’s yield is reduced by more than 35 percent from the expected yield. Unlike the MLB, DA payments can be nonzero even if harvested yield is zero.

Schematic of payments under the traditional-style support program scenario



Farmer's total payment = CCP + MLB + DA

Target Revenue Program Scenario

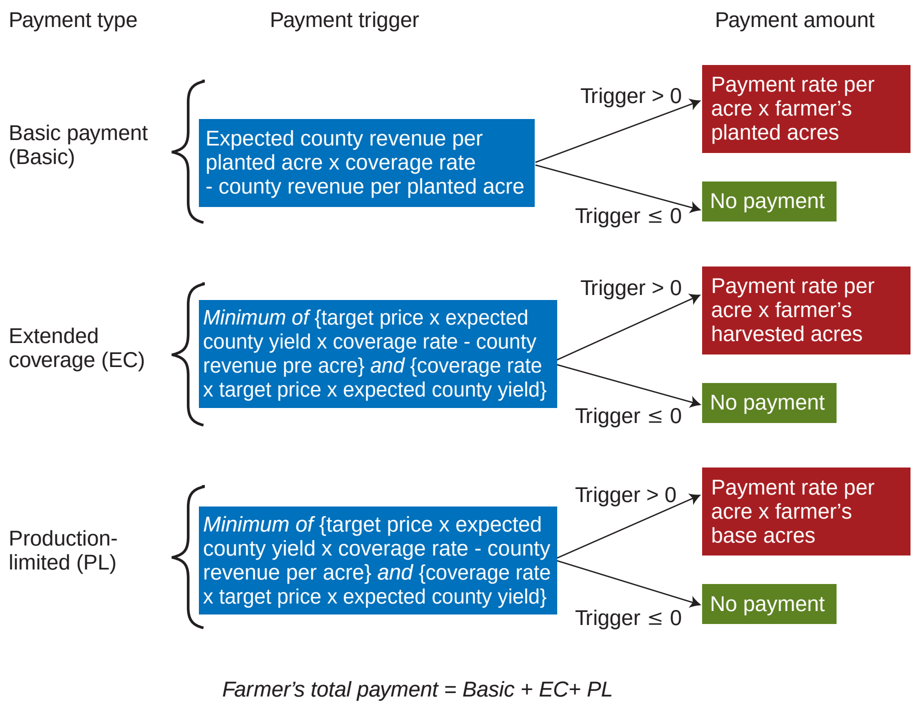
We base the three components of this county-area revenue program on Babcock and Hart (2005) and NCGA (2006), with some minor differences (e.g., we use futures prices rather than cash prices). The "basic" component is a payment per planted acre to cover shortfalls with respect to expected revenue per acre, calculated at the county level. Expected county revenue is multiplied by a coverage rate between 0 and 1 such that, as with an insurance program, less than 100 percent of expected revenue is covered.

The "extended coverage" payment per harvested acre is based on a shortfall in revenue with respect to a target revenue based on a statutory price, and provides supplemental coverage over the basic payment. The revenue coverage rate for this component is greater than for the "basic" component, but still less than 1. As with the "basic" component, the payment rate for "extended coverage" is multiplied by the farmer's planted acreage for the current crop year.

The "production-limited" payment is similar to the extended coverage payment but applied to a fixed base acreage for the farmer, and provides supplemental coverage over the extended coverage payment. This payment is similar to the CCP in that payment does not require current production. The revenue coverage rate for this component is greater than for the "extended" component, but still less than 1.[12]

[12]The terms "basic," "production limited," and "extended coverage" substitute for the terms Babcock and Hart (2005) use, which are "green", "blue", and "amber," respectively. These colors ("boxes") are references to categorizations by the World Trade Organization's Agreement on Agriculture (AoA) of domestic subsidies according to their impacts on production. Since it is impractical to speculate on how a proposed program might be notified to the WTO and given the political controversy in multilateral negotiations over which support programs should be associated with each of these WTO "boxes," for the sake of avoiding the potential for confusion we avoid using the WTO terminology in our scenarios.

Schematic of payments under the target revenue program



Note: The coverage rate (value between 0 and 1) in each payment type are designed so that the farmer's total payment per acre does not exceed the target revenue per acre.

Market Revenue Program Scenario

The market revenue program proposal has two components: a national revenue payment (e.g., Zulauf, 2006; AFT, 2007a) and a supplemental county-area revenue payment. The national revenue payment (NRP) is calculated as a percentage decrease in national expected total revenue with respect to national average realized total revenue, times the farmer's expected revenue per planted acre times the farmer's planted acres.

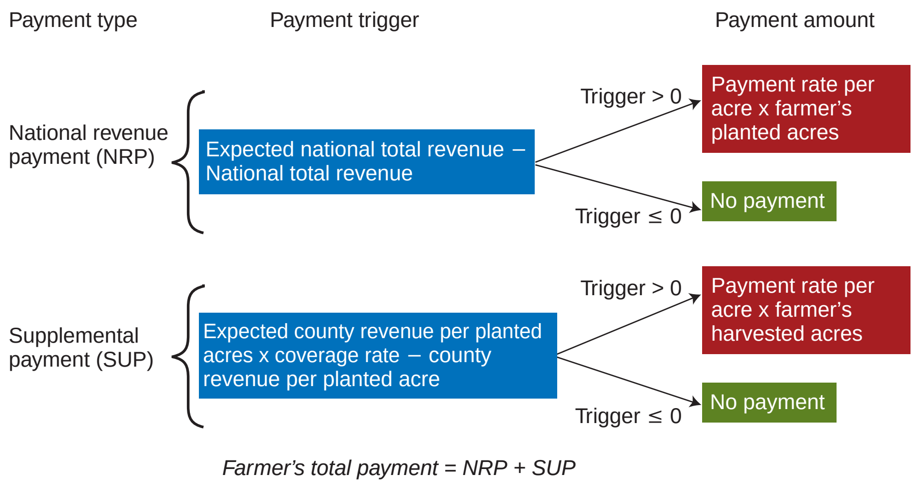
With the NRP triggered only by national shortfalls in revenue, Zulauf assumes that a Federal crop insurance program payment is used to ensure that the farmer is covered up to a guaranteed level. However, for the sake of comparability across scenarios, we instead use a supplemental county-area revenue payment to ensure that the farmer is covered up to a guaranteed level.

Comparability of the Payment Scenarios

Our target revenue program operates at the county level. To put each of the program scenarios on an equal footing for the simulation, all three are constructed to operate at the county level as well.

For the expected and harvest-time prices, we utilize futures prices, as discussed in more detail below. In the traditional-style and the target revenue programs, 2004 levels for acreage and yield serve as base acreage and yield. To calculate benefits in time t, we use the Olympic average of the prior 5 years' worth of yield data from USDA's National Agricultural Statistics Service (NASS), which is consistent with the approach used in various insurance products

Schematic of payments under the market revenue program



administered by the USDA's Risk Management Agency (RMA), various disaster payments administered by the USDA's Farm Services Agency (FSA), and the revenue-based ACRE program passed into law in the 2008 Farm Act.

Programs can be compared against each other in many ways. Given limited information on the risk preferences of producers, it seems reasonable from a policy standpoint to assume that payment recipients would be reluctant to support a revised direct support program unless it provided at least the same support levels as the program it replaces. Hence, to narrow the range of possible program parameters, we calibrate the models by setting the program parameters so that the mean of total annual payments evaluated at each of the 31 price-yield points (over 1975 to 2005) is equal across the program scenarios. By doing so, we are not favoring one scenario over another with respect to the mean of the payment distribution. Given this calibration, other characteristics (for example, variance or skewness) of the distribution of payments can be compared, as can the program parameters necessary to achieve equality of mean total payments across programs. Details of the calibration procedure are presented in Appendix B, as is the methodology for estimating payments and the data sources.

Discussion of Results

Table 1 summarizes the results of the stochastic analysis, using 2005 data for planted acres and for the expected yield and price against which the price and yield deviations are applied. The first row under each scenario shows mean payments from the stochastic simulation and the next row the coefficient of variation of the payments. The coefficient of variation provides a measure of variability (the higher the value, the higher the variability) that allows for easier comparability across program scenarios than the standard deviation. The overall coefficients of variation for the two revenue approaches are roughly equal at 0.32 and 0.34. However, the coefficient of variation for the traditional program scenario is twice as high (0.68), with most of the contribution to this value coming from the fully production-coupled MLBs (the disaster payments have a higher coefficient of variation but account for a smaller portion of total payments).

Table 1
Stochastic analysis of the distribution of corn program payments under alternative U.S. programs (2005 expected prices and yields)

	Payment type			
Target Revenue Program	Total	Extended Coverage	Production Limited	Basic[1]
Mean payment ($ billion)	3.03	1.16	1.64	0.22
Coefficient of variation[2]	0.32	0.52	0.24	1.06
90% confidence interval (lower, upper)	1.62, 4.80	0.39, 2.28	1.06, 2.37	0.02, 0.73
Market Revenue Program	Total	National[3]	Supplmental	
Mean payment ($ billion)	3.17	2.33	0.85	
Coefficient of variation	0.34	0.430	0.59	
90% Confidence interval	1.55, 5.09	0.76, 4.06	0.37, 1.97	
Traditional-Style Program	Total	P-MLB	P-CCP	Disaster
Mean payment ($ billion)	3.11	1.26	1.67	0.19
Coefficient of variation	0.68	1.35	0.53	1.46
90% confidence interval	0.38, 7.10	0.00, 4.78	0.00, 2.28	0.02, 0.83

[1]The “basic” payment covers shortfalls in county revenue per acre with respect to expected county revenue per acre. The “extended coverage” payment is based on a target revenue using a statutory price, and provides supplemental coverage over the basic payment. The “production-limited” payment is similar to the extended coverage payment but applied to a fixed base acreage for the farmer, and provides supplemental coverage over the extended coverage payment.

[2]The coefficient of variation in this application is a measure of the dispersion of the probability distribution of revenue per acre that allows comparisons across populations with different means, and is the standard deviation of revenue per acre divided by the mean revenue per acre. The smaller the coefficient of variation, the lower the dispersion relative to the mean value of the distribution.

[3]The “national” revenue payment rate is based on the difference between national expected and actual revenue per acre, and the “supplemental” revenue payment provides additional coverage based on a county- level payment rate.

Among the three traditional-style program payment types, the price-based CCP has the lowest coefficient of variation (0.53), which is not surprising given the hard ceiling on the CCP payment rate. In fact, the coefficient of variation for the price-based CCP is lower than for the “basic” component (1.06) of the target revenue approach, but more than twice the value (0.24) of the “production limited” component. This difference is attributed to the formula for the “production limited” revenue payment rate (equation B.8 in Appendix B) versus the price-CCP payment rate (equation B.1) – the former has a more explicit limit on the payment rate than the latter.

The third row in table 1 presents the 90-percent confidence intervals calculated from the same bootstrap output. The lower bound of the 90-percent confidence band for the current-style scenarios includes zero or near-zero payment levels in all three payment types, but also several billion dollars at the upper end.[13] The traditional-style program scenario has a 90-percent lower bound that is more than $1 billion lower than for either of the two revenue-based programs, but an upper bound that is over $2 billion higher. This indicates that both farmers and the Government would face less uncertainty in budgeting for expected payments under the revenue-based alternatives examined here.

The Government is concerned with more than just the mean and variance of the empirical payment distribution. For example, in comparing program alternatives, it would be useful to have information on the probability that

[13]Actual production-coupled corn payments vary greatly from year to year. For instance, over 1996-2006, actual LDPs for the crop year were $0 in each of 4 years, but as high as $4.3 billion in the 2005 crop year (payment variation is less extreme on a fiscal-year basis).

commodity support levels will exceed those agreed to under a multilateral agreement on domestic support. The right-hand tail of the frequency distribution (a graph of how may times the bootstrapped payments fall within each billion-dollar interval) provides this information. Figures 5a-5c show both the frequency of total payments and the subset of payments most likely to face payment ceilings in future multilateral agreements on agricultural support. For example, the traditional-style scenario shows payments net of disaster payments given that disaster payments can under certain conditions be exempt from support ceilings (fig. 5a). Likewise, under the target revenue program, the basic portion of payments could be exempt from support ceilings, and so figure 5b shows payments net of basic payments as well as total payments. Figure 5c shows the market revenue payment net of the supplemental payment, although this breakdown is not intended to suggest that any portion of the market revenue payment be exempt from payment ceilings.

Given the premise of achieving the same mean annual payment level across the program scenarios, figures 5a-5c clearly show that the traditional-style support scenario has a fatter right-hand tail – or higher probability of exceeding a support ceiling – than the two revenue-based programs. For example, excluding the portion of payments that may not be subject to limits, the two revenue-based programs would exceed $6.5 billion less than 1 percent of the time, while the traditional-style program would exceed $6.5 billion in payments 12 percent of the time.

Budgetary Impacts Under Alternative Scenarios

This section presents an approach to empirically demonstrating how the within-season probability distribution of U.S. domestic commodity support for corn differs between traditional-style approaches to support and revenue-based support. In general, official government assessments of the costs of a program that use a probabilistic setting (known as "probability scoring") present only the mean of the probability distribution of program costs. However, other summary statistics, such as variance or skewness (shape) of the distribution of payments, may provide useful information as well, especially when comparing across program alternatives. For the revenue-based support scenarios evaluated here, variability around total expected annual payments and the probability of high payments are both lower than for the traditional-style approach. These results suggest less budgetary uncertainty for the Federal Government and easier adherence to multilateral commitments regarding limits to domestic commodity support. Of course, the empirical results in this section showing the benefits of revenue-based support with respect to the Federal budget pertain to the specific program scenarios examined here, and may not necessarily hold for program scenarios not examined here.[14]

Regional Implications of Revenue-Based Versus Price-Based Direct Commodity Support

The previous section examined the implications for Federal budgetary planning of the three support proposals by summing up the county-level payments from the stochastic simulation to the national level. This section examines how payments vary by region, focusing (for brevity's sake) on

[14]For instance, a price-based support program that is production-limited (that is, not coupled to current production) and has a hard ceiling on the effective farm price could have a lower coefficient of variation than a revenue-based support program that is production-limited but does not have a hard ceiling on the payment rate.

Figure 5a

Frequency of commodity payments for corn – traditional-style program

The traditional style programs more frequently have high payment

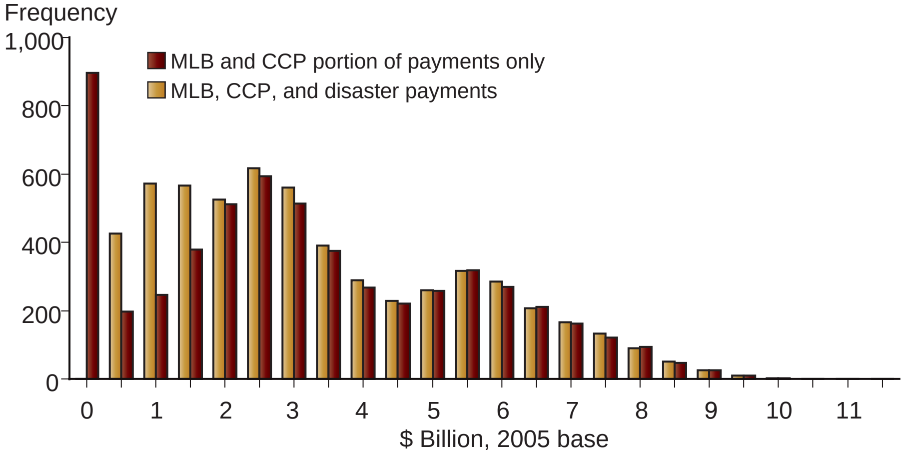


Figure 5b

Frequency of commodity payments for corn – target revenue program

The target revenue programs produces a tighter range of payments.

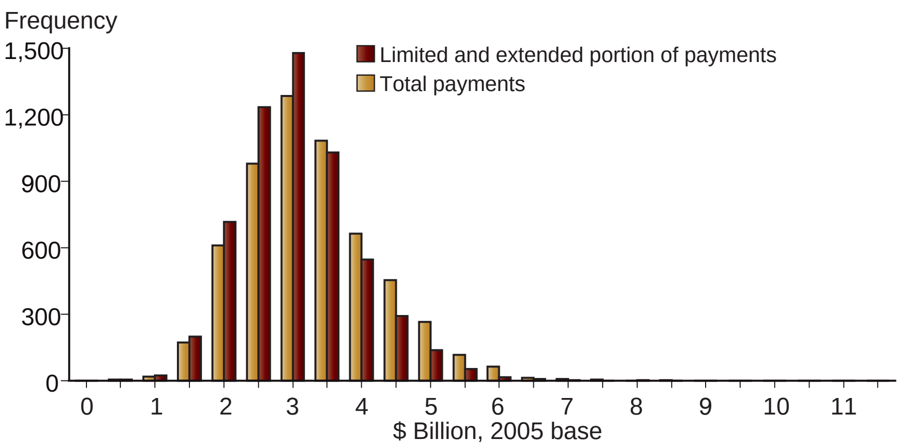
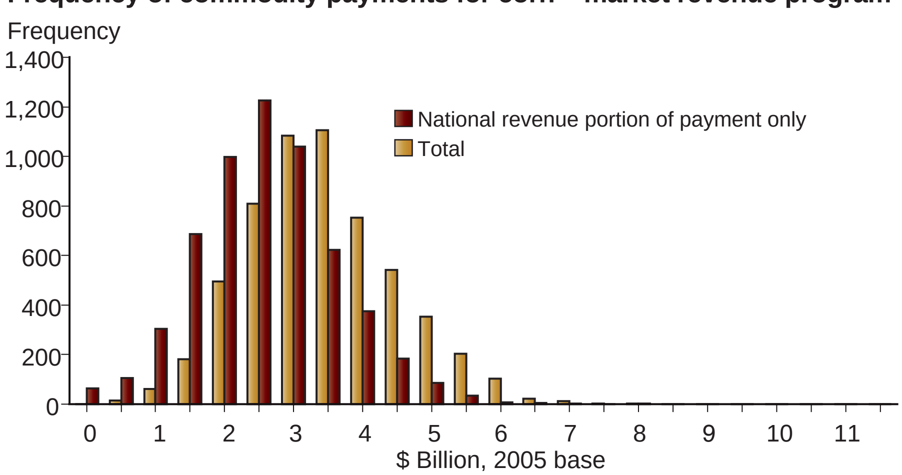


Figure 5c

Frequency of commodity payments for corn – market revenue program



Note: Each bar covers a $500 million range of payments. The taller the bar, the greater the number of payments falling in the associated range.

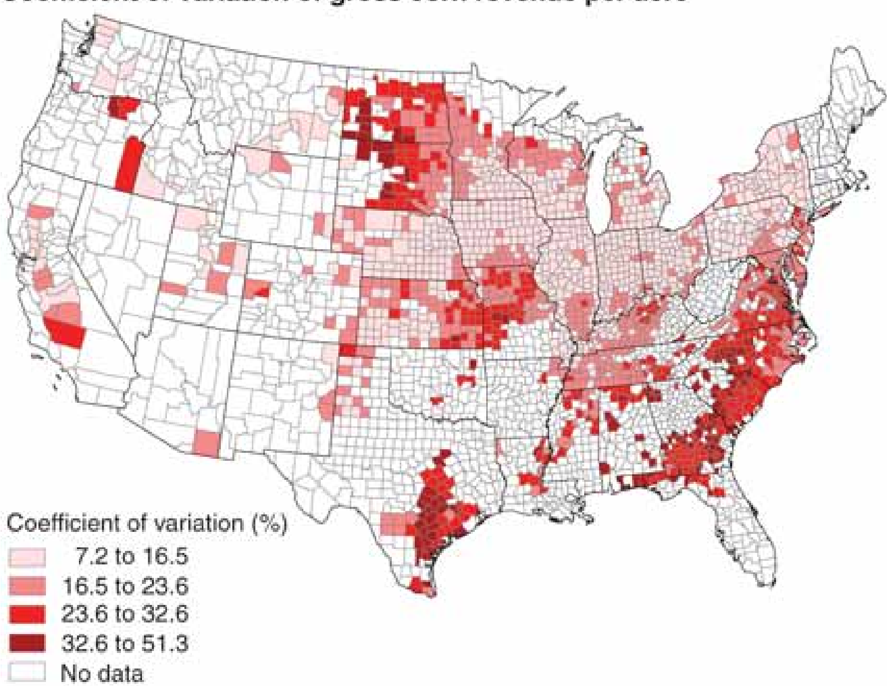
the traditional-style program versus the target revenue program. The results for the market revenue program are similar to those for the target revenue program, however, and can be found in Cooper (2007, 2009b).

Figure 6 shows the coefficient of variation for gross corn revenue by county. The smaller the coefficient, the lower the variation in average county revenue per acre relative to its mean. The pattern of groupings in the map suggests that the coefficient of variation has a significant regional component. Table 2 presents average county returns per acre and the associated coefficient of variation for corn, as summarized by ERS Farm Resource Regions (Heimlich, 2000). The table lists both the gross returns per acre (price times yield per acre) as well as total gross returns (gross returns plus the per-acre government payment) under both the current-style and target revenue programs.

Perhaps not surprisingly, the Heartland region has the lowest coefficient of variation for gross corn returns, indicating its comparative advantage in corn production. The coefficient of variation for total gross returns is lower under the target revenue than traditional-style programs for each region except the Fruitful Rim, where it is the same across programs (table 2). For the Heartland region, it is almost three times lower. Since the mean returns are roughly the same (by design) under either approach, a safety net intended to reduce variability in total gross income might benefit from a revenue-based approach, for corn at least.

Figure 6

Coefficient of variation of gross corn revenue per acre



Note: The coefficient of variation in this application is a measure of the dispersion of the probability distribution of revenue per acre that allows comparisons across populations with different means, and is the standard deviation of revenue per acre divided by the mean revenue per acre. The smaller the coefficient of variation, the lower the dispersion relative to the mean value of the distribution.

Source USDA, Economic Research Service.

Table 2
County-level revenue per acre with and without program payments, by farm resource region

Farm resource region	Share of total corn acres *(percent)*	County gross revenue: Mean *($/acre)*	County gross revenue: Coefficient of variation *(percent)*	County traditional-style plus gross revenue: Mean *($/acre)*	County traditional-style plus gross revenue: Coefficient of variation *(percent)*	County target revenue payment plus gross revenue: Mean *($/acre)*	County target revenue payment plus gross revenue: Coefficient of variation *(percent)*
Heartland	61.6	286	15	326	14	330	5
Northern Crescent	13.5	246	16	277	13	277	7
Northern Great Plains	5.8	220	24	248	19	248	11
Prairie Gateway	12.4	241	20	272	16	272	10
Eastern Uplands	1.3	188	22	227	14	236	12
Southern Seaboard	2.7	214	28	251	20	269	11
Fruitful Rim	1.4	226	34	268	15	269	15
Basin and Range	0.1	339	17	380	12	379	9
Mississippi Portal	1.2	241	22	277	17	283	11

Note: The coefficient of variation in this application is a measure of the dispersion of the probability distribution of revenue per acre that allows comparisons across populations with different means, and is the standard deviation of revenue per acre divided by the mean revenue per acre. The smaller the coefficient of variation, the lower the dispersion relative to the mean value of the distribution.

Figure 7 maps the percentage change in the coefficient of variation for total gross revenue under the target revenue program versus the traditional-style program. The lighter the color, the greater the decrease in variation offered by the target revenue program. Areas with high levels of correlation between national average yield and county average yield (e.g., the Heartland) tend to show a greater decrease in the coefficient of variation of the target revenue program with respect to the current-style program. In only a few randomly occurring counties does the coefficient of variation in the target revenue program increase over that in the current-style program.

Producer Preferences for Mean Versus Variability of Gross Revenue

If gross revenue plus support payments are a proxy for the annual contribution to a grower's wealth (defined as total gross revenue) and if the only information available on estimated payments under various program alternatives is the mean level of payments, one would expect the eligible producer to prefer the program that offers the greatest mean total gross revenue.[15] But what if the decision criteria involved variability in payments and gross revenue? While the coefficient of variation for total gross revenue may help in determining a preference for mean versus variance, the coefficient is only a measure of dispersion. By itself, it cannot indicate whether a farmer would prefer a program that results in lower mean total gross revenue and lower variability in revenue to one that results in higher mean revenue with higher variability.

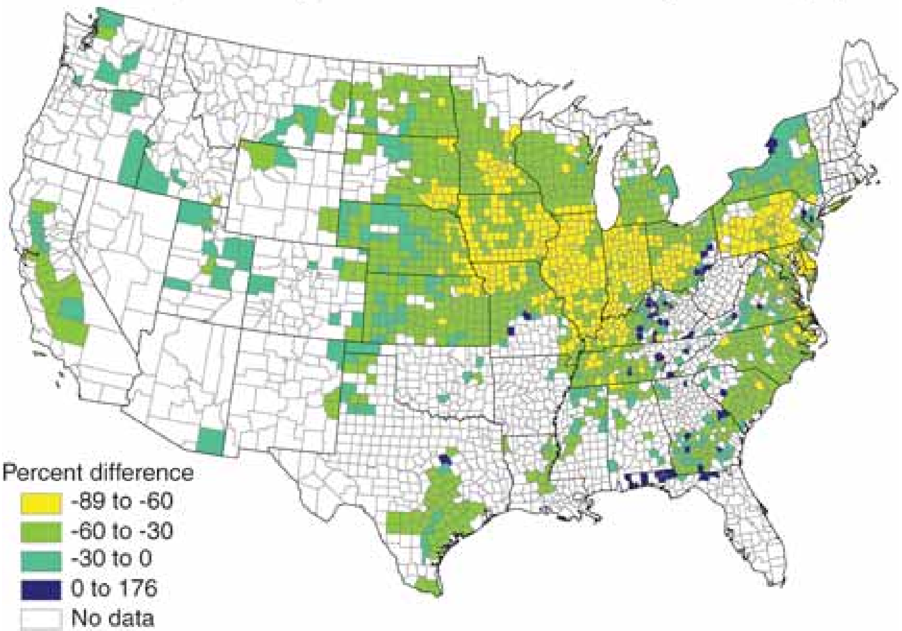
Economic theory suggests that producers may balance the mean level of total gross revenue against the variability in the total gross revenue in deciding which support program they would prefer. In particular, almost any individual would view an increase in their mean level of total gross revenue as desirable,

[15]As costs of production do not figure in the calculation of the support payments, we simplify the analysis by using total gross revenue rather than total net revenue.

Figure 7

Difference in coefficient of variation for total gross revenue under target revenue versus traditional-style program payments

In most counties, the volatility of revenue is lower under the target revenue program.



Note: The lighter the color, the lower the coefficient of variation of total gross revenue under the revenue program relative to the traditional style programs.

Source USDA, Economic Research Service.

whereas farmers are typically risk averse and would view increasing variability in total gross revenue as undesirable (Serra et al., 2006).

Serra, Zilberman, and Goodwin (2006) present parameter estimates of the preferences of Kansas farmers for mean level of returns versus variability in returns. To assess whether farmers would prefer the target revenue program over the traditional-style program scenario, we apply that preference structure to the estimated means and variances in county-level total gross revenue from the target revenue-based and current-style payment scenarios. More specifically, for a generic corn farmer in each county (that is, on a corn farm with a yield the same as the county's mean), we calculate the farmer's preference level for expected total gross revenue and variability of total gross revenue. The farmer's preference levels are dictated from an equation in which benefits to the farmer increase as mean revenue increases and decrease as variability of revenue increases.[16] If the estimated preference level is higher under the target revenue program than under the current style program, then a typical farmer in the county is assumed to prefer the former program to the latter. Details of this approach to comparing payment programs are presented in Cooper (2008).

The results of the simulation suggest that the target revenue program is preferred over the current-style program by representative corn farmers in 60 percent of counties. While the main purpose of this simulation is to demonstrate that program preferences depend on tradeoffs between mean payments and the variance of payments, results do indicate that farmer preferences for

[16]The last section of Appendix B provides technical details of this approach.

type of support program have a geographic component (fig. 8). Comparing this pattern with that in figure 3 suggests that farmer preference for program type is more complex than a mere a function of the "natural hedge" between price and yield.

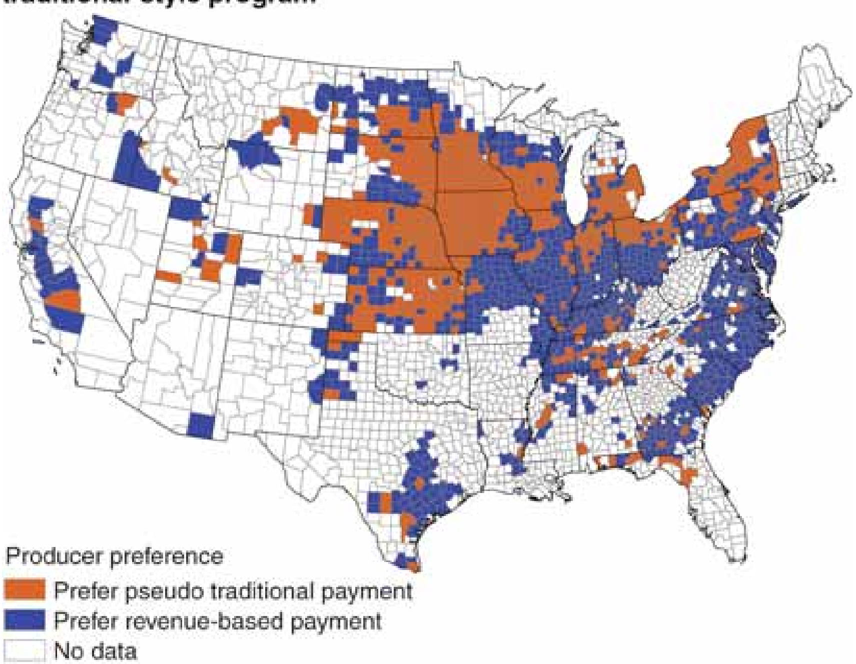
There is a pronounced preference for the target revenue program over the current-style program in the Southern Seaboard, a region where the natural hedge between price and yield is relatively low (figs. 3 and 8). Recall that the national price/national average yield correlation for corn is significantly negative, and that the correlation of corn yields in the Southern Seaboard with national average yield tends to be fairly low (fig. 1). For farmers such as these, the potential benefits of a revenue-based versus price-based program are higher than for farmers whose yields correlate more closely with national aggregate yields, generating more negative correlation between price and farm-level yield.

While the representative farmer shows a preference for the target revenue program in most Illinois, Indiana, and Ohio counties, for Iowa this tends to be the case only in the eastern portion of the State. This suggests that for some Heartland counties, less variable revenue under the target revenue program does not fully compensate for a reduction in mean revenue from the traditional-style program, which tends to over-compensate for revenue losses in areas with more negative price-yield correlations.

Comparing the mean level of returns to variability in returns ignores farmer preferences regarding skewness (shape) of the distribution of revenue. For

Figure 8

Simulation of producer preference for a target revenue versus traditional-style program



Note: For the simulation, support program parameters are chosen such that average total national payment levels are equal between the two programs when evaluated using historical price and yield data.

Source USDA, Economic Research Service.

example, the entrepreneur may prefer positively skewed revenue distributions because the likelihood of extremely low earnings is smaller (Fisher and Hall, 1969). However, preferences of U.S. farmers for attributes other than the mean and variance of income have received little empirical examination to date.

The stochastic analysis in this report has attempted to outline the implications of the statistical distribution of payments for both the government and producers. Still uncertain is the extent to which government and producer attitudes to risk differ, and whether those differences can be balanced in the final policy outcomes. For example, a support program that reduces the chance of total payments exceeding some ceiling may not be the same program that provides the greatest benefit to producers.

Provisions of Revenue-Based Support Determine Much

The guiding principle for a revenue-based payment is that the producer is compensated for the difference between a reference level of revenue per acre and a realized (that is, actual) revenue per acre. However, considerable scope is possible in crafting the details of revenue-based payment programs. Seemingly minor differences in program provisions may have significant impacts on, among other things, payment levels, year-to-year variability in payments, and administrative costs.

Among the program provisions that need to be set is the geographic administrative unit for the program. That is, are the differences between reference and realized revenue to be determined at the national, State, crop district, county, or even individual level? The more precisely the program is targeted geographically, the closer the payments will match actual farm-level changes in revenues.

At the same time, administrative costs will increase with more precise targeting of payments. Basing payments on the difference between an individual producer's reference (target or expected) revenue and realized revenue is likely to be prohibitively expensive. The other extreme would be to base payments on the difference between a national reference revenue and national realized revenue. While such an approach minimizes administrative costs, it potentially ignores even regional variations in revenues. To reduce the costs of commodity support under any level of aggregation, the potential for overlap of Title I support with Federal crop insurance could be assessed.

This analysis, in keeping with contemporary farm legislation, assumes that payments are not adjusted by costs of production. Factoring the costs of production (COP) into the calculation of payments – as originally suggested by the National Corn Growers Association (2006) – raises several problems. First, how one determines the costs of production is subjective: what costs and categories should be covered, and should they include only fixed or variable costs or both? Second, including COP in the calculation of payments may be indefensible from an economics standpoint (Pasour, 1980). In particular, government payments tend to get capitalized into the prices of inputs (land in particular), thereby raising COP. Hence, if the revenue-based program factors in COP, the payment itself will lead to increases in future payments *(*ibid*.)*.

Finally, economic theory suggests that support tied to prices and/or production can stimulate more production than would occur without the support. While studies have examined the impacts of commodity support on production in both the European Union (EU) and the United States (for example, USDA/ERS, 2007c; USDA, 2004; Sckokai and Moro, 2006; Goodwin and Mishra, 2006; Anton and Le Mouel, 2004; Hennessy, 1998), none have addressed the potential production impacts of revenue-based support.[17]

As with price-based programs, economic principle suggests several avenues through which a revenue-based program may have impacts on production. For price-based programs such as marketing loan benefits, the more often

[17]An analysis of the potential impacts of revenue insurance on output (Turvey, 1992) found that such insurance could increase plantings of higher risk crops.

the marketing loan rate is above the market price and/or the greater the loan rate over the market price, the greater the effective price of the commodity (Westcott and Price, 2001). In other words, the greater the expected difference between the market price and the loan rate, the higher the effective price, and consequently the greater the impact on production.[18] Production impacts will be lower the less coupled the program is to current production (Westcott et al., 2002).

A revenue-based support program could also have production effects, in this case by offering the producer a revenue floor via the revenue target. The more often the revenue target exceeds the realized revenue, and the greater the difference, the more production is likely to be stimulated. The degree of this impact can depend on whether the revenue target is fixed or moves with the market. The extent of the program's regional influence on production may also be affected by the geographic level at which payments rates are set. In addition, price- or revenue-based support programs can also affect the producer's wealth or variability of revenue, which can influence production decisions (Hennessey, 1998).

[18]The concept of the effective price as discussed in this section should not be confused with the "effective price" construct that is used in the countercyclical payment. The latter simply refers to a program provision that prevents the market price used in the payment rate calculation from falling below the loan rate.

Conclusion

At planting time, the prices and yields that will be realized at harvest are uncertain, and so any support payments contingent on price and/or yield are likewise uncertain. This report examines how the uncertainty in domestic commodity support payments for corn may differ between traditional-style approaches (defined as price-based payments plus yield-based disaster payments) and two revenue-based approaches (target and market). For the scenarios developed here, the support program parameters were chosen so that the expected value of total national payments is the same across the programs. Hence, from a national perspective (e.g., the taxpayer), the programs differ only in the variability (or volatility) of payments and in differing probabilities of making any particular level of payments.

Results seem to favor revenue-based payment scenarios over the traditional-style support. Variability around the total expected annual payment was lower, as was the probability of high payments. These results suggest that revenue-based support may reduce budgetary uncertainty for the Federal Government and better ensure that agricultural support outlays stay below a predetermined level.

This report also examined the impact of the support programs on total gross revenue per acre (i.e., gross revenue plus the support payment). The variability of corn revenue (measured in terms of coefficient of variation) at the county level in almost all U.S. corn producing counties was lower under the revenue-based alternatives than under the traditional-style approach. The reduction in revenue variability was most pronounced in Corn Belt counties, which tend to have a high correlation of county yield with national average yield.

On the other hand, mean revenue-based support may be higher or lower at the farm level (and at the county level, as measured in this report) than mean revenue from traditional-style support. In many Corn Belt counties, price-based support overcompensated on average for revenue losses relative to revenue-based support. Hence, while revenue-based support scenarios generally reduced the downside risk of farming more than did the traditional-style support, farmer preferences for type of support would depend on their preferences for increasing mean returns versus decreasing the variability of returns.

Appendix A. A Nonstochastic Comparison of Price- and Revenue-Based Support

Before planting, the producer can only guess at harvested yields and harvest-time prices due to their stochastic nature (that is, random variation). To simplify the discussion of the basic differences between program alternatives, this appendix uses a stylized, nonstochastic analysis. In other words, we abstract away from price and yield uncertainty by evaluating the differences in the programs at the end of the crop year. The section of this report entitled "Stochastic Evaluation of Commodity Support Program Alternatives," implements an empirical analysis that explicitly addresses the stochastic component of prices and yield. This appendix examines two general classes of support payments—one with payments tied to current production and one to past production.

Price and Revenue-Based Marketing Loan Benefits

In simplified terms, the price-based marketing loan benefits (Price-MLB) are based on a payment rate determined by shortfalls in the market price with respect to the statutory loan rate, multiplied by quantity of the crop the producer places under the loan (see box, "Calculation of Price and Revenue-Based Marketing Loan Benefits"). In contrast, revenue-based marketing loan benefits (Revenue-MLB) are based on a payment rate determined by shortfalls in revenue per acre with respect to a statutory target revenue, multiplied by the producer's planted acreage. For simple comparability with this Price-MLB, the stylized graphs in this section assume that the Revenue-MLB payment rates are determined by average national yield. Additional analysis for program scenarios based on lower levels of yield aggregation—in particular, a county-based program—is presented as part of the stochastic analysis in the main body of this report.

To demonstrate the relationship between prices, yields, and payments, we need to consider the relationship between price and yield. Figure A.1 shows price per bushel and gross revenue per acre as a function of harvested yield for the case of a stylized crop with a significantly negative correlation between price and yield (that is, a correlation approaching -1).[1] Note that the "price" curve should not be interpreted as a supply or demand function. Instead, each point along the curve represents the mean harvest-time price associated with a level of harvested yield, given the expected yield and price at planting time.[2] In the figure, price per bushel and gross revenue per acre are expressed as percentage changes from the expected price and revenue at planting time. As indicated in figure A.1, harvest-time price tends to fall as harvested yield increases. In this example, price decreases faster than yield increases, and hence gross revenue per acre falls as yields increase. The strongly negative relationship between price and yield means that, as yield increases, the decrease in revenue is smaller than the decrease in price, as shown by comparing the revenue and price deviation functions in equation A.1.

Figures A.2 and A.3 show the relationship between Price-MLB payments per acre and harvest-time revenue per acre for the stylized crop as a function of yield and price, respectively. Two target revenue choices are used in

[1]While we use a stylized crop for the sake of generality, Cooper (2008; 2009b) shows that the depictions in the figures in this section can hold for certain actual crops, like corn.

[2]This price-yield function does not imply a statistical probability associated with any point along the line, but is simply the mean harvest-time market price that an analysis of the historical data says would be associated with a realized harvest. The section of this report on the stochastic analysis of program payments, which predicts at the beginning of the crop year the possible costs of the support program, assigns probabilities of occurrence to price-yield pairs.

Calculation of Price and Revenue-Based Marketing Loan Benefits

For farmer *i* of a crop in region *j* in time *t*, the existing price-based loan deficiency payment, or the marketing loan benefit, is calculated as:

$$\text{Price-MLB}_{ijt} = \max\{0, LLR_{jt} - ALR_{jt}\} \cdot A_{ijt} \cdot Y_{ijt}\,, \qquad \text{(A.1)}$$

where the statutorily set local loan rate *(LLR)* is the national loan rate *(LR)* adjusted by various region-specific (county or other region) and quality factors. The alternative loan repayment rate, or *ALR*, is a USDA-determined market price that varies daily or weekly (depending on the crop) according to market conditions, and is adjusted to reflect quality of the product. Depending on the crop, the *ALR* may be a county (wheat, feed grains, oilseeds), national (peanuts), or world (upland cotton and rice) "posted" price. The term $max\{\, 0, (LLR_{jt} - ALR_{jt})\}$ in equation A.1 is a shorthand way of saying that the payment rate = $(LLR_{jt} - ALR_{jt})$ if $LLR_{jt} > ALR_{jt}$, or 0 if $LLR_{jt} \leq ALR_{jt}$. The payments are applied to current production on each farm, which equals harvested area, *A*, times yield, *Y*.

For a revenue-based version of equation A.1, the payment would be the difference between a target revenue and actual revenue per acre, or

$$\text{Revenue-MLB}_{ijt} = \max\{\, 0, (LTR_{jt} - ALR_{jt} \cdot Y_{jt})\} \cdot \; Y_{ij}^{APH} \,/\, E(Y_{jt}) \cdot A_{ijt}\,, \qquad \text{(A.2)}$$

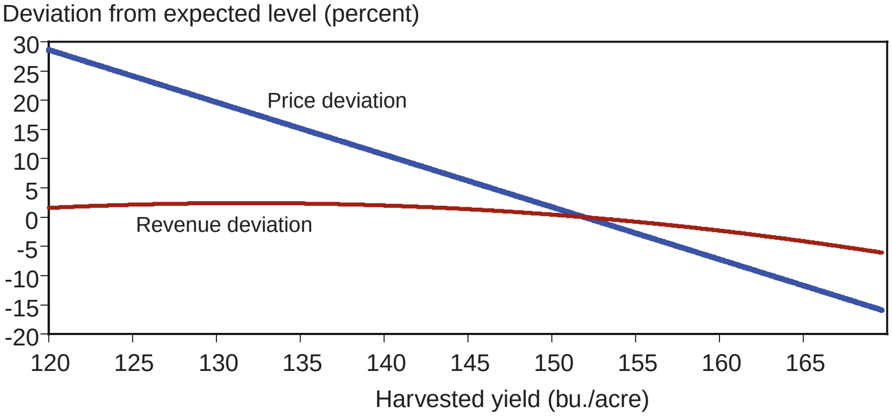
where the statutorily set local target revenue per acre rate, or *LTR*, is the national target revenue rate *LR* adjusted by various county-specific and quality factors (e.g., Miranda and Glauber, 1991). Actual, or realized, yield for the region is Y_{jt}. To account for the difference in productivity of producer *i* with respect to regional productivity, the payment is multiplied by the ratio of the producer's actual production history, Y_{ij}^{APH}, and expected yield for the region in time *t*, or $E(Y_{jt})$.

Figure A.1

Crop price and revenue deviations as a function of crop yield

Stylized crop with a significantly negative correlation between price and yield

Deviation from expected level (percent)



Note: The price deviation is defined as the percentage difference between the realized price at harvest time and the expected price at pre-planting time. A positive value means that the harvest-time price is higher than the pre-planting price. The revenue-per-acre deviation is defined similarly.

the figure: one in which the target revenue is set slightly above the expected revenue (Example I), and one in which the target revenue is set below the expected revenue per acre (Example II).

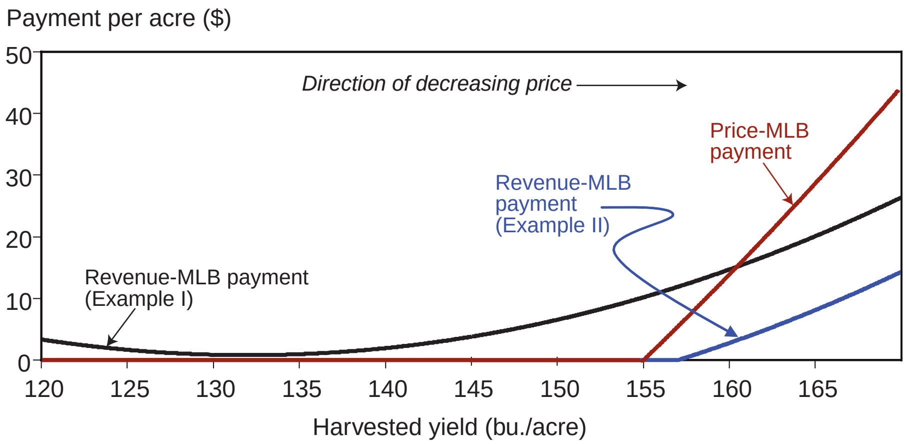
In figures A.2 and A.3, the shape of the Revenue-MLB line inversely mirrors the shape of the revenue line in figure A.1. The kink in the Price-MLB line occurs at the loan rate, and the payment rate falls to zero for prices in excess of the loan rate. The Revenue-MLB payment rate for Example II is zero when actual revenue per acre is below the target value.

Revenue-MLB payments go to zero when realized gross revenue is above the target revenue level. With the high inverse correlation between crop

Figure A.2

Possible relationships between two types of marketing loan benefits and yield

Stylized crop with a significantly negative correlation between price and yield

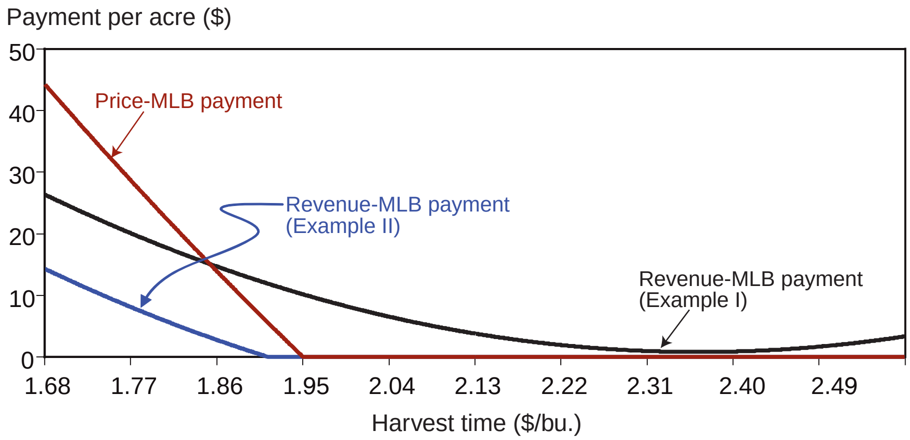


Note: For Revenue-MLB (Example I), the target revenue is set to be slightly higher than the expected revenue. In Revenue-MLB (Example II), the target revenue is set to be lower than the expected revenue.

Figure A.3

Possible relationships between two types of marketing loan benefits and price

Stylized crop with a significantly negative correlation between price and yield



Note: For Revenue-MLB (Example I), the target revenue is set to be slightly higher than the expected revenue. In Revenue-MLB (Example II), the target revenue is set to be lower than the expected revenue.

price and yield, the Revenue-MLB line changes more slowly with respect to revenue change than does the Price-MLB line, suggesting greater predictability for the revenue-based MLB than the price-based MLB under this price-yield scenario.

The general shape of the Price-MLB function per acre as a function of yield or price will be the same regardless of crop, as long as the price-yield correlation is less than zero. That is, the Price-MLB function per acre will be increasing in yield, as increasing yield will always cause some decrease in price (as long as price-yield correlation is less than zero). By design, the Price-MLB per acre will increase as price decreases, even in cases where the price decrease is less than the yield increase (that is, revenue per acre increases).

For the Revenue-MLB, the stylized graphs in figures A.1-A.3 should generally hold for a crop with a price-yield correlation that is relatively negative (that is, closer to -1). For a crop where the price-yield correlation is low (that is closer to 0), however, the general shapes of some of the relationships between payments, prices, and yields can differ from those in figures A.1-A.3, bearing in mind that the Revenue-MLB payment per acre always decreases as revenue per acre increases.

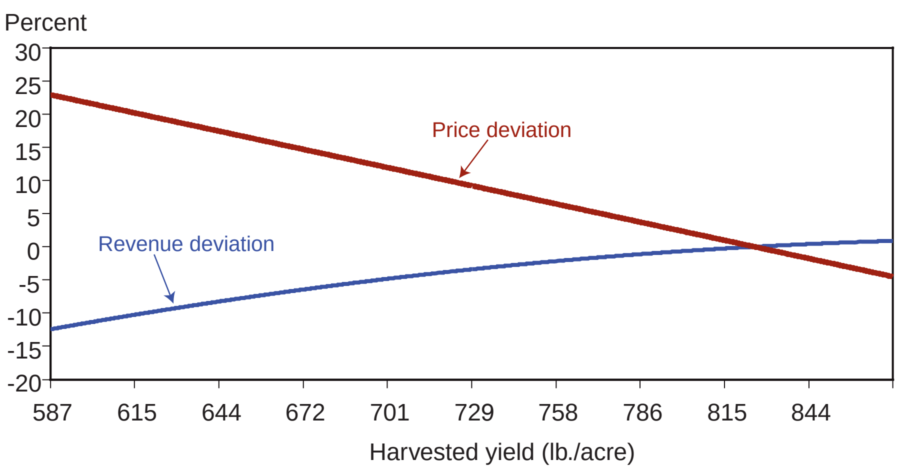
Now consider a crop with a price-yield correlation closer to 0 (but still negative), say a crop for which U.S. production is not a significant driver of world price changes for that crop. Here, price changes as a result of yield changes are muted relative to the scenario in figure A.1, and consequently, so are changes in the Price-CCP. As depicted in figure A.4, the price deviation line for such a crop would be less steep than that depicted in figure A.1, and the revenue per acre deviation line can actually be increasing in yield.

In this case with the relatively low price-yield correlation, the Revenue-MLB payment may actually be seen as decreasing in yield or increasing in price (over a feasible ranges of prices and yields). For instance, decreasing yield may not be fully offset by increasing price, causing gross revenue per acre to fall.

Figure A.4

Crop price and revenue deviations as a function of crop yield

Stylized crop with a price-yield correlation close to zero



Price and Revenue-Based Countercyclical Payments

Price-based countercyclical payments (Price-CCP) are based on a payment rate determined by shortfalls in an “effective” price with respect to a statutory target price, multiplied by a fixed base acreage and yield. In contrast, revenue-based countercyclical payments (Revenue-CCP) are based on a payment rate determined by shortfalls in “effective” revenue (effective price times season-average yield) with respect to a statutory target revenue, multiplied by the fixed base acreage and the ratio of the producer’s base yield to national average base yield (see box, “Calculation of Price and Revenue-Based CCPs”). While the base acreage and yield values are calculated from historic period(s) and are fixed, the payment rate itself is a function of contemporary season prices. USDA’s Farm Service Agency (2006a) specifies how the Price-CCP program determines the base acreage and yield.

For the sake of creating a direct analogy to the current price-based CCP, this appendix considers the revenue CCP program to operate at the national level. That is, the payment rate for this revenue-CCP program is determined using national average yield in addition to national average price. A benefit of this approach is that its administrative costs should be no higher than for the price-based CCP. A disadvantage—depending on one’s point of view—of using a national payment rate in the revenue-CCP payment rate is that the correlation between the revenue support payments and farm level revenue is likely to be lower than if the payment rate were based on more regionalized expected and actual yield. Cooper (2008) finds little difference in the impact of the Price-CCP and Revenue-CCP on the variability of total revenue. As such, a national-level implementation of revenue-based support would not necessarily reduce or eliminate calls for ad hoc disaster assistance. A revenue-CCP based on regional yield averages is considered in the stochastic simulation in the next section.

As an aid in contrasting the properties of Price-CCP and Revenue-CCP, figures A.5 and A.6 depict an average relationship between payments per base acre and harvested yield, price, or gross revenue for the same stylized crop with a significantly negative price-yield correlation depicted in figure A.1. In figures A.5 and A.6, the Price-CCP curve has kinks at the loan rate and at the effective target price, which is the target price less the direct payment rate. The Price-CCP is linear between the kinks given that the payment rate varies in price only. The Revenue-CCP curve slopes up to the point where price equals the loan rate, given that the minimum price used in the formula is the loan rate; after that, the price point slopes down. Lest the reader be perturbed by this seemingly idiosyncratic kink in the Revenue-CCP, this characteristic is simply a result of the program not permitting the effective price to fall below the loan rate—effective farm price falls as yield increases, but only down to the loan rate. The dashed line shows what the Revenue-CCP payment would be if the effective market price in the payment calculation were allowed to fall below the loan rate.

In the case of a price-yield correlation closer to 0 (figure A.4), the Price-CCP payment per acre would be increasing as yield increases, given low but still negative price-yield correlation. However, for such a crop, the price decrease

Calculation of Price- and Revenue-Based CCPs

The total Price-CCP option for a CCP recipient in year t is calculated as:

$$\text{Price - CCP}_{it} = 0.85 \cdot \max\{0, (TP - (\text{Max}(NP_t, LR)) - D)\} \cdot (\overline{A}_i^B \cdot \overline{Y}_i^B), \quad \text{(A.3)}$$

where TP, LR, and D are the statutory per bushel target price, national average loan rate, and direct payment rate, respectively, for a covered crop for which the recipient is eligible to receive a CCP payment. For each covered crop, NP is a national market price (season-average price for the marketing year). The "base" acreage and yield for recipient *i* are $\overline{A}_i^B$ and $\overline{Y}_i^B$, respectively.

In contrast, a target revenue-based CCP (Rev-CCP) payment is

$$\text{Revenue - CCP}_{it} = 0.85 \cdot \max\{0, TR - Y_t \cdot \max(NP_t, LR_j)\} \cdot \left(\frac{\overline{Y}_i^B}{\overline{Y}^B} \cdot \overline{A}_i^B \right), \quad \text{(A.4)}$$

where TR and $\overline{Y}^B$ are the statutory national target revenue per acre and statutory national program yield (bu/acre), respectively, for the crop. In particular, $\overline{Y}^B$ is the national average payment yield per base acre under the countercyclical payment program. The product $Y_t \cdot \max(NP_t, LR)$ is the national "effective" revenue per acre for year *t*, where Y_t is national average yield.

The rationale for calculating actual revenue using the "effective price" of $\max(NP_t, LR)$ is to lower the payment rate as prices fall below the loan rate LR, given that CCP recipients can receive marketing loan benefits if they produce the program crop in time *t*.

in response to the yield increase is smaller than the yield increase. As such, gross revenue can be increasing as yield increases.

One difference of the Revenue-CCP examined in this section relative to the Price-CCP is that the former does not exhibit the same hard cap on the payment rate that the Price-CCP does. Namely, the payment rate in the Price-CPP has a ceiling equal to the target price (less the direct payment rate) minus the loan rate. In contrast, while the effective price in the Revenue-CCP is restricted from falling below the loan rate, national yield is not subject to a program floor. Hence, the ceiling on the Revenue-CCP payment rate is the target revenue per acre itself (times 0.85), although to achieve this payment rate would be highly improbable as it would require national average actual yield to be zero. Hence, it is possible for the variability of Price-CCP payments to be lower than for the Revenue-CCP payment rate. This result is not due to the general principle of targeting revenue rather than price, but simply to the hard ceiling on the payment rate in the Price-CCP.

In contrast, with the Price-LDP, the payment rate per unit of production continues increasing as price decreases, at least in principle. For the same mean level of payments then, and if the coefficient of variation of revenue is less than that of price, the Revenue-LDP should have a lower variability of payments than the Price-LDP.

At the same time, depending on what the target revenue is set at, revenue-based payments can be significantly lower than price-based payments for

Figure A.5
Relationship between two CCP payment types and yield
Stylized crop with a significantly negative correlation between price and yield

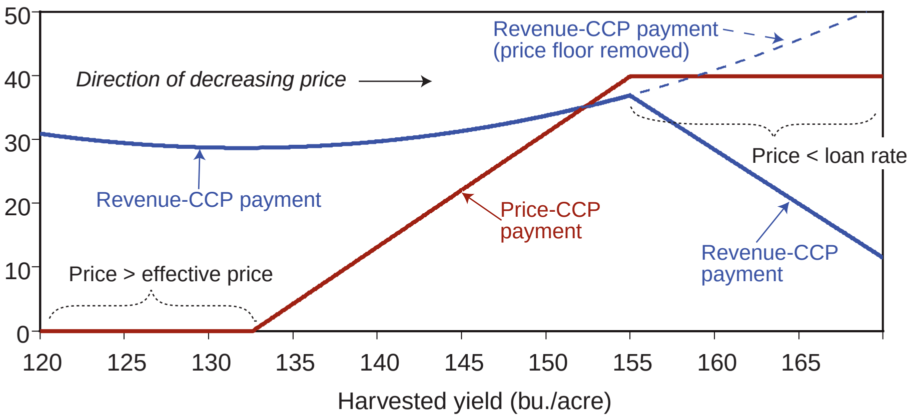
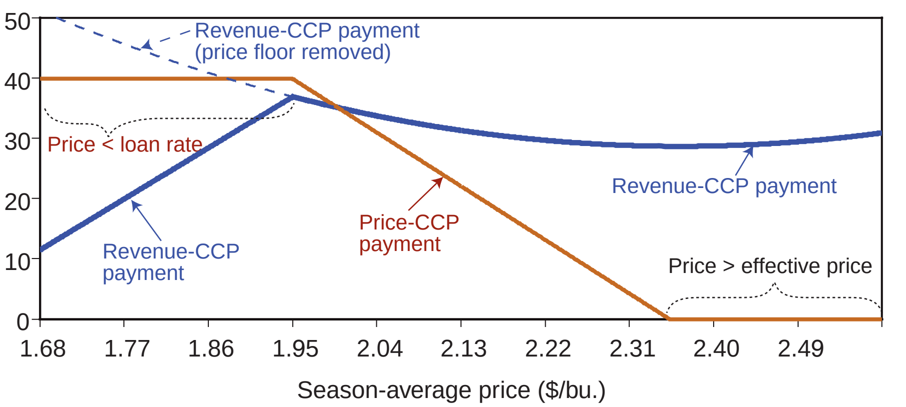


Figure A.6
Relationship between two CCP payment types and price
Stylized crop with a significantly negative correlation between price and yield



a given market price, yield, loan rate, direct payment rate, and target price (figs. A-2, A-3). One potential drawback of setting the target revenue low enough that, on average, the revenue-based support would produce a significantly lower payment rate than the price-based support is that it could lead producers receiving the revenue-based support to request additional forms of domestic support, such as disaster assistance. One way to reduce the probability of such a scenario occurring would be for the Government to set the target revenue to a level that would return, on average across a span of years, the same payment level as the price-based program. Even in such a case, the benefits to producers and the Government of a revenue-based program would be evident in payments that more accurately compensate for revenue decreases and (generally) reduce variability in payments from year to year.

However, to set the parameters of the payment programs so that they produce, on average, the same level of payments across time requires a statistical analysis of the relationship between price and yield. Figures A.2, A.3, A.5, and A.6 demonstrate how the programs differ in their response to revenue changes over an average price-yield relationship estimated from historic data. The goal of these charts is to illustrate general properties of these payment schemes. To simplify this evaluation, the program payments are evaluated at harvest time—that is, prices and yield are realized, not expected, prices.

However, yields and price are stochastic when evaluated at the time planting decisions are made. As such, payments are viewed as being drawn from a probability distribution. In other words, each price-yield point along the price-yield lines in figures A.1 and A.4 has an unequal probability of occurring. As such, each payment rate defined over the payment graphs in this section does not have an equal probability of occurrence. Hence, a statistical analysis is necessary to predict at the beginning of the crop season how payments under a revenue-based commodity support system might differ from those under a traditional commodity support structure. The main body of this report presents the results of such an analysis for a county-based payment approach, demonstrating how the mean, variability, and other characteristics of the statistical distribution of payments can be estimated, and how different types of payment programs compare to each other on this basis.

Appendix B. Technical Details of the Stochastic Analysis

Calculation of Traditional-Style Domestic Program Benefits

The countercyclical payment (CCP) for a producer *i* of crop *j* in year *t* is calculated as:

$$\text{(B.1)}\ \text{CCP}_{ijt} = 0.85 \cdot \max\{0, (TP_j - (\text{Max}\,(NP_{jt}, LR_{ijt})) - Dj)\} \cdot (\ A_{ij}^B \cdot Y_{ij}^B),$$

where *TP*, *LR*, and *D* are the statutory target prices, loan rates, and direct payment rates, respectively, specified in farm legislation, NP is a national market price (season average price for actual CCPs), A^B is base acreage, and Y^B is base yield.

For farmer *i* of crop *j* in time *t*, the marketing loan benefit, or equivalently, the loan deficiency payment, is calculated as:

$$\text{(B.2) MLB}_{ijt} = \max\{\ 0,\ (LR_{jt} - ALR_{jt})\ \} \cdot A_{ijt}^H \cdot Y_{ijt}^H\ ,$$

where *LR* is the national loan rate adjusted by various county-specific and quality factors. The alternative loan repayment rate *ALR* is the market price at the time of harvest. The payments are applied to current production on each farm—i.e., harvested area, A^H, times yield, Y^H.

We assume that the disaster assistance program operates in this manner, but on a permanent basis as free crop yield insurance rather than on an ad hoc basis:

$$\text{(B.3)}\ DA_{ijt} = \max\{\ 0,\ (0.65 \cdot \text{E}(Y_{ijt}^P) - Y_{ijt}^P)\ \} \cdot E(P_{ijt}) \cdot A_{ijt}^P\ ,$$

where Y_{ijt}^P is actual realized yield per planted acre, $\text{E}(Y_{ijt}^P)$ is the expected yield per planted acre, A_{ijt}^P is the planted acreage, and $E(P_{ijt})$ is the expected price.

Market Revenue Program Scenario

The market revenue program proposal has two components: a national revenue payment (e.g., Zulauf, 2006; AFT, 2007a) and a supplemental county area revenue payment. The national revenue payment is calculated as percentage decrease in national expected total revenue with respect to national average realized total revenue, times the farmer's expected revenue per planted acre times the farmer's planted acres:

$$\text{(B.4)}\ NRP_{ijt} = \max\{0,\ (E(TR_{jt}^P) - TR_{jt}^P)\,/\,E(TR_{jt}^P)\} \cdot E(R_{ijt}^P) \cdot A_{ijt}^P$$

where TR_{jt}^P is total national revenue for the commodity.

With the *NRP* triggered only by national-level shortfalls in revenue, Zulauf assumes that a Federal crop insurance program payment is used to ensure that the farmer is covered up to a guaranteed level. However, again for the sake of comparability across scenarios, we instead use a supplemental county area revenue payment to ensure that the farmer is covered up to a guaranteed level:

$$\text{(B.5)}\ \ SUP_{ijt} = \ \max\{\ 0,\ (\gamma \cdot E(R_{ijt}^P) - R_{ijt}^P) \cdot A_{ijt}^P\ - NRP_{ijt}\ \}$$

where γ $(0 < \gamma < 1)$ is the desired coverage level. Equation B.5 represents the farm-specific revenue payment (based on a payment rate using the farmer's expected and actual revenue, or on the more practical level used in our numerical illustration, a payment rate based on county-level expected and actual revenue) less the national revenue payment, NRP_{ijt}, that the farmer receives.

Target Revenue Program Scenario

The "basic" component is a payment per planted acre to cover shortfalls in county revenue per acre with respect to expected county revenue per acre in the county corresponding to farm *i*, or:

(B.6) $\text{Basic}_{ijt} = \max\{0, [\delta \cdot E(R^P_{ijt}) - R^P_{ijt}]\} \cdot A^P_{ijt}$,

where $R^P_{ijt} = P^1_{jt} \cdot Y^P_{ijt}$ is the county average revenue per planted acre at harvest in farmer *i*'s county, P^1_{jt} is the season-average cash price or the futures price at harvest, $E(R^P_{ijt})$ is the expected average revenue per planted acre at planting time, A^P_{ijt} is the farmer's planted acreage, and *g* is the coverage rate $(0 < \delta < 1)$.

The "extended coverage" payment per harvested acre is based on the shortfall in revenue with respect to a target revenue based on a statutory price, and provides supplemental coverage over the basic payment, or:

(B.7) $\text{EC}_{ijt} = \min\{\max(0, \alpha \cdot ETP_j \cdot E[Y^H_{ijt}] - P^1_{jt} \cdot Y^H_{ijt}), (\alpha - \delta) \cdot ETP_j) \cdot E[Y^H_{ijt}]\} \cdot A^P_{ijt}$

where Y^H_{ijt} is the average actual harvested yield for farmer *i*'s county, $E[Y^H_{ijt}]$ is the expected value, α $(\delta < \alpha < 1)$ is the extended coverage level, and ETP_j is the statutory target price. Note that Y^H_{ijt} is used here rather than Y^P_{ijt}, as per NCGA (2006).

The "production-limited" payment is similar to the extended coverage payment but applied to a fixed base acreage for the farmer, and provides supplemental coverage over the extended coverage payment:

(B.8) $\text{PL}_{ijt} = \min\{\max(0, \beta \cdot ETP_j \cdot E[Y^H_{ijt}] - P^1_{jt} \cdot Y^H_{ijt}), (\beta - \alpha) \cdot ETP_j \cdot E[Y^H_{ijt}]\} \cdot A^B_{ijt}$

where β $(\alpha < \beta < 1)$ is the production-limited box coverage level and A^{B}_{ijt} is the farmer's fixed planted acreage base.

Calibration of Program Scenarios

Before running the simulation of the distribution of payments given the regression results, we calibrate the payment scenarios by setting the program parameters so that the average of total annual payments evaluated at historic price-yield points is equal across the program scenarios. We set the coverage rate γ in the market revenue program to 0.95 to match the upper coverage rate β proposed by Babcock and Hart (2005). Similarly, the basic (δ) and extended coverage (α) rates are set to 0.70 and 0.85, respectively (ibid). As the only parameter to set in the market revenue approach is γ, we choose the rest of the parameters in the other program scenarios to achieve the same level of annual mean payments that the market revenue scenario produces, or $2.47 billion. For the target revenue program to produce the same average historical payment, an expected target price (ETP) of $2.42 per bushel is necessary. We choose the parameters of MLB and CCP so that the ratio of the CCP to total payments under the current scenario is similar to the ratio of the production-limited payments (equation B.8) to total target revenue scenario payments. The required loan rate LR is $2.04 per bushel, and with a CCP target price TP of $2.35, a direct payment rate D of $0.09 is necessary for the calibration (note that for CCPs, decreasing D is one-for-one the same as increasing TP).[1]

Methodology for Estimating Payments

We estimate the distribution of corn payments for each county, given the yield history for that county and the historic relationship between national price and national average yield. Payments to county *i* in crop year *t* are assumed to be a function of planted acres in *i* at the beginning of *t*, the parameters of the commodity programs, and the stochastic price and yield relationships. For corn especially, which has a more negative correlation between national average yield and price, one cannot treat the distributions of price and yield as being independent.

In particular, the yield distribution is generated as a percent deviation in actual (that is, harvested) yield from expected yield, where the latter is taken as the trend yield. The price distribution is taken as the percent deviation in the harvest time price from the price at planting time. Regression analysis is used to estimate the relationship between the national price deviation and the national average yield deviation. Given this estimated relationship and given assumptions for the expected yield and expected price, we can then use statistical techniques to generate harvest price and aggregate yield distributions. Details of the approach are in Cooper (2007; 2009b).

Generating the Empirical Distribution of Payments

While national average yields are necessary for modeling the price-yield relationship, county-level yield values are necessary for estimating the commodity payments in a county-based program. Adding to the complexity of the analysis, county yields are not only stochastic, they are spatially stochastic. That is, yield shocks tend to have a systemic component. Similar weather variations can cover large geographic regions. For instance, a drought can affect yields across counties in a wide region. Furthermore, if a climatic event affects many counties across a major production region in a fairly uniform fashion, as it can in the Heartland (the USDA’s typology for the Corn Belt [Heimlich, 2000]), it can affect national price. However, a weather shock across another region that accounts for a small portion of U.S. corn production will have little effect on price.

Given the spatial component to yield shocks, to achieve a realistic estimate of commodity payments under yield uncertainty, we must simulate county-level yield shocks under the assumption that the between-county variations in yields are not independent of each other. Our analysis accounts for this assumption by maintaining a pairwise relationship between county yields in a given year when generating sets of county yields to use in the analysis. Details of the approach are in Cooper (2007; 2009b).

[1]We should not be surprised to see some deviation of the simulation means (first column of table 1 in the main text) from the simple average of $2.47 billion that we used to calibrate the models before running the simulation. Parametric choices necessary to arrive at the $2.47 billion were calculated simply on the basis of the 31 historic price-yield data points; the simulation mean on the other hand is based on an econometric model with a constant term and coefficients that correct for change in the farm legislation and other variables over time. In other words, the payment estimation procedure using simply the 31 historic price-yield data points is not an econometric relationship and has no adjustment factors such as the change in farm legislation.over time. However, this simple approach is arguably more reasonable for the purpose of determining the parameters of the payment programs.

Data Sources

Data on county yields, planted acres, and harvested acres for all U.S. counties producing corn are supplied by USDA's National Agricultural Statistics Service (NASS). A tradeoff exists between increasing the number of years from which the empirical yield distribution is created and the availability of county-level data. One limitation on how many years of data can be used in a county-level analysis for the whole country is that NASS county-level coverage prior to the mid-1970s is less comprehensive than since that time. For instance, counties with continuous NASS planting histories over 1969-2005 accounted for only 53 percent of total U.S. corn production in 2005. Counties with continuous year-to-year NASS planting histories over 1975-2005 accounted for over 98 percent of total U.S. corn production in 2005.[2] We therefore settled on the 1975-2005 time period. Furthermore, price data before the mid-1970s do not reflect China and Russia as regular participants in global grain markets, and are unlikely to be representative of contemporary global markets. Given the 1975-2005 time span, 2,784 counties are included in our analysis.

For the expected corn price at pre-planting time, we utilize the average of the daily February prices of the December Chicago Board of Trade corn future (CBOT abbreviation CZ) in period t, t = 1975,…,2005. The harvest-time price is the average of the daily November prices of the December CBOT corn future in period t. These choices of the expected and realized corn price are consistent with USDA's Risk Management Agency (RMA) pricing of crop revenue insurance products for corn.

[2]In addition, county-level production data are not reported by NASS in cases where either the county has no acreage planted to the commodity or the sample size of farmers is deemed too low to report the county data. In our analysis, for estimating the county-level yields, missing yield data points are substituted by crop district estimates. Data substitutions are used only where necessary for the purpose of estimating the yield trend equation for each county. No payments are calculated in t for counties where NASS has not reported planted corn acreage in t.

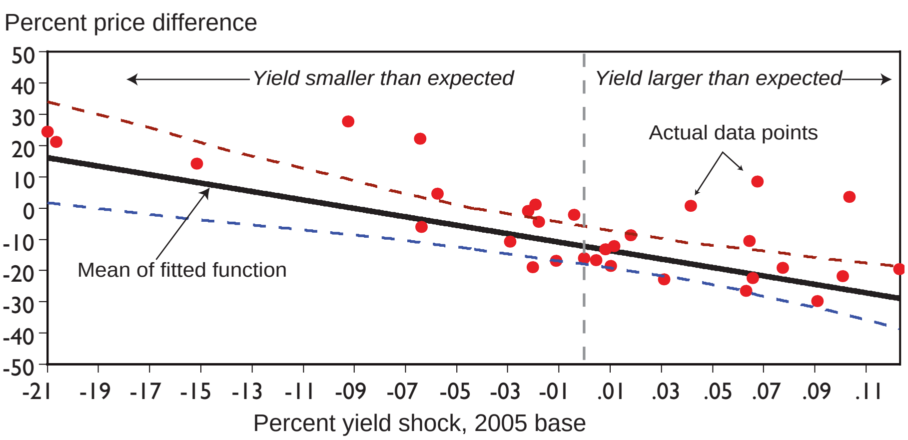
Graphical Depiction of the Econometric Results

Figure B.1 shows the statistical relationship between the price and yield deviations for corn. The downward slope of the fitted line in the figure suggests that the greater the increase in harvested yield over expected yield (that is, the greater the yield deviation), the more likely the deviation in the harvest price from the expected price at planting will be negative. In other words, given a base expected yield and price, higher realized yields will tend to lead to lower harvest-time prices.

Figure B.1

Within-season price deviation versus yield deviation – corn

The dashed lines are 99 percent confidence intervals for the fitted price-yield relationship



Measuring Producer Preferences for Support Payment Type

To measure the preference of producers over the mean and variability of revenue, the analysis assumes that the producer's utility (or benefits) function is defined over these two statistics. In particular, the analysis uses Saha's (1997) flexible utility function, $u = W^{\theta} - \sigma_{w}^{\beta}$, where W is the producer's current wealth (including initial wealth plus current earnings), σ is the standard deviation of wealth, and $\theta > 0$ and β are parameters. Risk aversion is defined by the second moment of the distribution of payments (σ), where risk aversion (neutrality) [affinity] corresponds to β >(=)[<] 0. For our simulation of producer preferences for CCP programs, we use estimates of θ and β for Kansas farmers (Serra et al., 2006), or $\theta = 1.08$ and $\beta = 0.74$.

Appendix C. Relationship Between the Mean and Variability of Revenue and the Price-Yield Correlation

This appendix examines the impact of the correlation between price and yield on revenue. Correlation measures the strength and direction of the linear relationship between two variables. The Pearson correlation in particular can take on values from -1 to 1, and is a measure of the relationship between two random variables. A correlation of -1 means that the two variables move in opposite directions in a perfectly linear fashion (i.e., the movements track along a straight line), and a correlation of 1 means that the two variables move in the same direction in a perfectly linear fashion A correlation of 0 means that there is no relationship between the variables. The relationship gets stronger as the correlation moves from a value of 0 toward -1 or 1. One would expect the price-yield correlation to be 0 or less for crops, with the values varying across crops.

Analysis of national average corn yield and price over 1975 to 2005 suggests that the correlation between these two variables is -0.71 using the statistical approaches discussed in Cooper (2009b, 2007). The correlation between local corn yields and price will tend to be less negative than at the national level, but still less than zero. For example, in Logan County, Illinois, the correlation between county yield and national price is estimated to be -0.68. The value of the natural hedge can be relatively low for counties outside the major producing regions. For example, in Barnes County, North Dakota, the correlation between county yield and national price is relatively low at -0.21. In general, price-yield correlations at the farm level are likely to be lower than at the county level, but to the extent that farm-level yields are correlated with aggregate yield for the region, the price-yield correlation for a farmer in Logan County, Illinois is likely to be higher than for one in Barnes County, North Dakota.

What is the implication for revenue of a nonzero correlation between price and yield? This correlation affects both the mean and variability of revenue. The main text focused on the effect of the natural hedge (the negative correlation) in stabilizing revenue (that is, decreasing the variability of revenue). That the variability of revenue decreases the more negative the correlation is between price and yield can be demonstrated by the statistical formula for the variability of revenue (e.g., Goodman, 1960), but the complexity of this formula is beyond the scope of this report.

What is not generally part of the public discussion of the natural hedge and its implications for revenue is that the more negative the correlation between price and yield, the lower the mean value of revenue. Say that price per bushel = P and yield per acre = Y. Using the formula for the expected value product of two correlated random variables (Mood and Graybill, 1963), the expected value (or mean) of revenue per acre R, which is P times Y, is

(C.1) $E[R] = E[P]\cdot E[Y] + COV(P,Y)$,

where $E[P]$ is the expected value of P, and $E[Y]$ is the expected value of Y. $COV(P,Y)$ is a measure of the statistical relationship (covariance) between P and Y and equal to the correlation (P,Y) times the standard deviation of P times the standard deviation of Y. The correlation is essentially a covariance that has been adjusted to fall between -1 and 1. Equation C.1 shows that the more negative the *COV(P,Y)*, the lower the expected revenue, all else being equal. Note that no current or proposed revenue-based commodity support plans include the covariance term in the calculation of expected or target revenue. Doing so would likely lower the probability of a payment being made.

If one is to fix revenue, *R*, at a commodity revenue coverage level, R_Z, then we can define the combinations of *P* and *Y* that will yield the revenue level R_Z, or

$$\text{(C.2)}\quad E[P] = \frac{R_Z - COV(P,Y)}{E[Y]}$$

This function (known as an iso-revenue line) identifies a curve for which, given an expectation of yield, the required price is determined so that the stated revenue R_Z is met (fig. C.1). Say that R_Z is the revenue guarantee to be provided by a revenue support program, and that any actual price-yield combination that produces a revenue lower than R_Z will trigger a support payment that covers the difference. The price-yield combinations that will trigger a support payment are those below the curves in the figure.

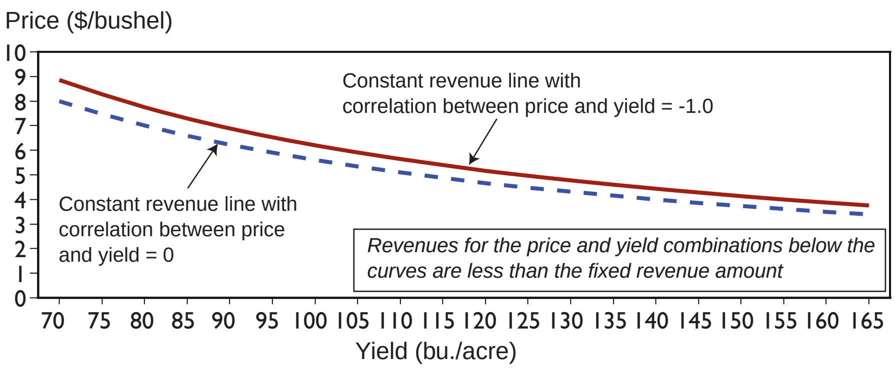
Figure C.1 demonstrates the significance of the statistical relationship between price and yield—as defined by the covariance between *P* and *Y*—to meeting a given level of revenue. The lower line is the combination of prices and yields that gives the revenue value R_Z when there is no statistical relationship between *P* and *Y* (the covariance and the correlation are zero). When the correlation between *P* and *Y* is less than 0, the curve moves up, as in the case for the correlation of -1 in the figure.

The more negative the correlation between *P* and *Y*, for any given value of yield, the farmer with the more negative price-yield correlation will need a higher price to attain the revenue R_Z, all else being equal.[1]

[1]Before the reader is tempted to draw some implications for regional differences in revenue from figure c.1, note that the only difference between the lines in the figure is the covariance between price and yield—the lines are the same in mean price, mean yield, and the standard deviations of price and yield.

In summary, there is clearly a tradeoff when it comes to the impact on producers of the natural hedge between price and yield: increasing the magnitude of the natural hedge lowers the mean value of revenue, but it also lowers the variability of revenue. Producer preference for accepting lower mean revenue in exchange for lower revenue variability is discussed in "Producer Preferences for Mean Versus Variability of Gross Revenue."

Figure C.1
Price-yield relationship over which revenue is constant (hypothetical crop)
The curve shifts upward as the correlation between price and yield becomes more negative



Note: The revenue for both lines is fixed at $560, and the standard deviation of price and yield are fixed at 1.5 and 40, respectively.

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