

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:

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

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:

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

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:

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

where Y_{ijt}^P is actual realized yield per planted acre, $E(Y_{ijt}^P)$ 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:

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

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:

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

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:

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

where $R_{ijt}^P = P_{jt}^1 \cdot Y_{ijt}^P$ is the county average revenue per planted acre at harvest in farmer i 's county, P_{jt}^1 is the season-average cash price or the futures price at harvest, $E(R_{ijt}^P)$ is the expected average revenue per planted acre at planting time, A_{ijt}^P is the farmer's planted acreage, and δ 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:

$$(B.7) EC_{ijt} = \min\{\max(0, \alpha \cdot ETP_j \cdot E[Y_{ijt}^H] - P_{jt}^1 \cdot Y_{ijt}^H), (\alpha - \delta) \cdot ETP_j \cdot E[Y_{ijt}^H]\} \cdot A_{ijt}^P$$

where Y_{ijt}^H is the average actual harvested yield for farmer i 's county, $E[Y_{ijt}^H]$ is the expected value, α ($\delta < \alpha < 1$) is the extended coverage level, and ETP_j is the statutory target price. Note that Y_{ijt}^H is used here rather than Y_{ijt}^P , 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:

$$(B.8) PL_{ijt} = \min\{\max(0, \beta \cdot ETP_j \cdot E[Y_{ijt}^H] - P_{jt}^1 \cdot Y_{ijt}^H), (\beta - \alpha) \cdot ETP_j \cdot E[Y_{ijt}^H]\} \cdot A_{ijt}^B$$

where β ($\alpha < \beta < 1$) is the production-limited box coverage level and A_{ijt}^B 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).

¹We 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 , $t = 1975, \dots, 2005$. 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.

²In 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

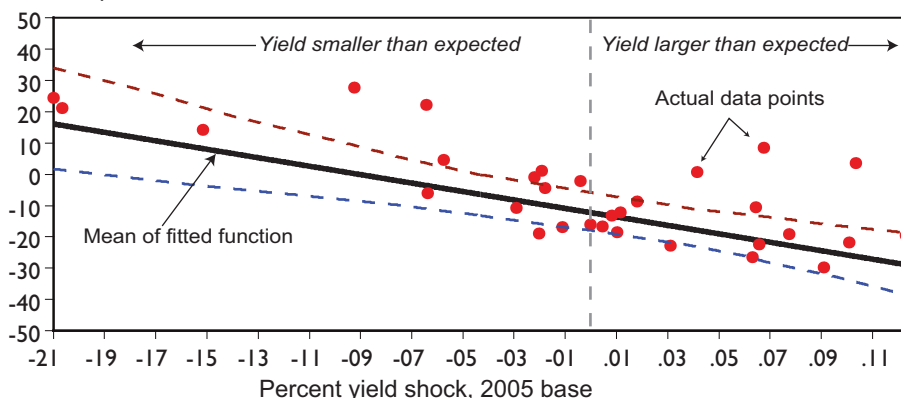
Figure B.1 shows the statistical relationship between the price and yield deviations for corn. The downward slope of the fitted line in the figure suggests that the greater the increase in harvested yield over expected yield (that is, the greater the yield deviation), the more likely the deviation in 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

Percent price difference



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 $\beta >(=)[<] 0$. 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 $\beta = 0.74$.