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A Revenue-Based Alternative to the Counter-Cyclical Payment Program

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Abstract

This paper develops a stochastic model for comparing payments to U.S. corn producers of a revenue-based counter-cyclical payment (R-CCP) that is offered as an alternative in the 2007 House "Farm Bill" (H.R. 2419) to the current price-based CCP (P-CCP). We minimize the potential for miss-specification bias in the model by using nonparametric and semi-nonparametric approaches as specification checks in the model. Using this model, the paper examines the sensitivity of the density function for payments to changes in expected price levels. A mean-variance utility function approach is used to assess producer preferences for choice of CCP program alternative. The results show that as risk reduction instruments at the farm level, there appears to be little effective difference between the P-CCP and the R-CCP. At the national level, however, the R-CCP has the potential for increasing Federal budgetary exposure relative to the P-CCP when expected prices are low.

Key words

Domestic support, counter-cyclical payments, revenue, price, corn, yield, pairs bootstrap, kernel density, semi-nonparametric, combinatorial optimization

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Introduction

Current domestic commodity support programs in Title I of the 2002 Farm Act base payment rates on shortfalls in market prices from target prices or loan rates. One such support mechanism is the counter-cyclical payment (CCP) program, in which the payment rate per unit of production is the (positive) difference between the target price and an effective farm price (FSA, 2006a). Since their inception under the 2002 Farm Act, total annual CCP payments across all eligible crops has ranged from a low of $809 million in fiscal year 2003 to $4.36 billion in 2006.

In 2007 however, the House of Representatives passed a Farm Bill (H.R. 2419) that allows the producer the choice of receiving CCPs as defined in the 2002 Act, or alternatively, as the shortfall in an effective farm revenue per acre with respect to a target revenue per acre. In principle, a revenue-based support CCP program would provide producers protection against an unexpected decline in revenues, whether due to low yields, low prices, or some combination thereof. If passed into law, not only would this CCP provision be novel in providing direct support based on deficiencies in revenue rather than in price, it would also be novel for permitting the producer a choice between payment types.

While a fair number of studies have been published that empirically examine the impacts of commodity-support on production (e.g., Sckokai and Moro, 2006; Goodwin and Mishra, 2006; Anton and Le Mouel, 2004; and Hennessy, 1998), the academic

literature is thin on examinations of the implication of the empirical distribution of commodity support payments for both government policy and for producer preferences.

However, there are a variety of reasons to examine the probability density function of commodity support payment. For example, since farmers are generally considered to be risk averse, farmer preference for payment programs should be expressed over at least the first two moments of the payment distribution. In addition, the probability of high payments can be of interest to the federal government both from the domestic budgetary perspective and in relation to multilateral agreements on domestic support.

The goal of this paper is to develop and estimate a stochastic model for estimating potential revenue support payments to U.S. corn producers that can be used to address policy issues, such as the two above, that relate to the empirical distribution of Federal commodity support. Before turning to the model, we provide a brief background on the CCP program.

Background

Price-based counter-cyclical payments (P-CCP) are established using a payment rate determined by shortfalls in an "effective" price with respect to a statutory target price, multiplied times a fixed base acreage and yield, and would carry over from the 2002 Farm Act legislation. The total P-CCP option for a producer *i* of crop *j* in year *t* would be calculated over 2008 to 2012 as:

(1a) $\text{P-CCP}_{ijt} = 0.85 \cdot \max\{ 0, (TP_j - (\text{Max}(NP_{jt}, LR_j)) - Dj) \} \cdot (\overline{A}_{ij}^{B} \cdot \overline{Y}_{ij}^{B})$,

where TP_j, LR_j, and Dj are the statutory per bushel target price, national average loan rate, and direct payment rate, respectively, for a covered crop as specified in the farm legislation.[1] For each covered crop, NP_{jt} is a national market price (season average price for the marketing year), $\overline{A}_{ij}^{B}$ and $\overline{Y}_{ij}^{B}$ are farm-specific "base" acreage and yield, respectively, i.e., historic values calculated as per government rules (FSA, 2006a). In other words, current production of the commodity is not required for the producer to receive a CCP payment. However, while the acreage and yield values in equation (1a) are fixed, the payment rate itself is a function of contemporary season prices.

In contrast, the target revenue-based CCP (R-CCP) option in H.R. 2419 for a producer *i* of crop *j* in year *t* would recast the CCP over 2008 to 2012 as:

$$\text{(1b) R-CCP}_{ijt} = 0.85 \cdot \max\left\{0, TR_j - Y_{jt} \cdot \max\left(NP_{jt}, LR_j\right)\right\} \cdot \left(\frac{\overline{Y}_{ij}^{B}}{\overline{Y}_{j}^{B}} \cdot \overline{A}_{ij}^{B}\right),$$

where TR_j and $\overline{Y}_{j}^{B}$ are the statutory national target revenue per acre and statutory national program yield (bu./acre), respectively, for a crop. In particular, $\overline{Y}_{j}^{B}$ is the national average corn yield per base acre under the 2002 Farm Bill's countercyclical payment program. The product $Y_{jt} \cdot \max\left(NP_{jt}, LR_j\right)$ is the national actual revenue per acre for year *t*, where Y_{jt} is national average yield. The rationale for the effective farm price being $\max\left(NP_{jt}, LR_j\right)$ rather than NP_{jt} is that when NP_{jt} is below LR_j, producers can receive marketing loan benefits (e.g., loan deficiency payments) for covered crops, albeit for actual production in *t*.

The R-CCP is equation (1b) is functionally equivalent to that proposed by the USDA (USDA, 2007). However, for some commodities, the recommended target prices

and/or loan rates differ between the HR 2419 and USDA (2007), leading to different payment levels, but such is not the case for corn.

Methodology for estimating the density function for CCP payments

The only two stochastic variables that we explicitly need for calculating CCP payments at the national level are realized yield and season average price, although other variables can usefully feed into the econometric analysis, both to reduce omitted variable bias, and as intercept shifting terms that can be useful for policy simulations. For the simulation of payments then, we need to generate the distributions of price and yield. However, the procedure for doing so is considerably complicated by the fact that price and yield are correlated, and hence the estimated distributions must take this correlation into account. We estimate the density function for payments given: 1) econometric estimates of the historic relationship between national price and national average yield; 2) estimates of the distribution of yield density for a particular base year; and 3), a bootstrap approach that links 1) and 2).

Modeling the price-yield relationship using price and yield deviates

Our focus is on estimating the distribution of payments for a given reference crop year *t*, given that at pre-planting time in *t*, season average prices and realized yield are stochastic. As such, sector level modeling that separately identifies supply, demand, and storage is unnecessarily complex to service our needs and diverts attention away from focus of the paper. A convenient way to address our questions is to model prices and yield as percentage deviations of realized prices and yields at the end of the season from

the expected values at the beginning of the season when planting decisions are made. If one accepts that the observed distribution of percentage changes in price and yield between pre-planting and harvest are representative of their future distribution, then our econometric specification of the price-yield relationship can be reduced to one equation.

While the academic literature is rich on papers on price estimation for commodities (e.g., Goodwin, 2002, for an overview), few express prices in deviation form. One example that does is Lapp and Smith (1992), albeit as the difference in price between crop years rather than between pre-planting time and harvest within the same crop year. As price deviation in their paper was measured between years, yield change was not included in that analysis. Paulson and Babcock (2007) provide a rare example of the examination of the price-yield relationship within a season in an examination of crop insurance. Like them, for the purposes of estimating the relationship between price and yield, we re-express the historic price and yield data as proportional changes between expected and realized price and expected and realized yield within each period, respectively. We can then apply this history of proportional changes in yield and price to 2005 data to develop the distribution of payments. However, among the differences in our approach from that in Babcock and Paulson is that ours uses a modeling approach that easily permits multiple explanatory variables, thereby decreasing the chance of misspecification of the price-yield relationship, and permitting sensitivity analysis with respect to parameters of policy interest.

For the model, the realized national average yield, Y_t , is transformed to the yield deviation ΔY_t according to $\Delta Y_t = \left(Y_t - E(Y_t)\right) \Big/ E(Y_t)$. The expected value of Y_t, or $E(Y_t)$, is calculated from an estimated trend equation (as described below). To generate a

distribution for Y_{2005} based on historic yield shocks, the historic yields must be detrended to reflect the proportional change in the state of technology between that in 2005 and that in time *t*, i.e., Y_{it} is detrended to 2005 terms as

(2) $Y_{it}^{d} = E(Y_{i2005})(\Delta Y_{it} + 1), \forall\, i$ counties, *t* periods, $t \neq$ 2005.

It is convenient to specify the yield deviate as the deviation of detrended yield from expected yield in the base year used for detrending, which we denote as ΔY_t^d.

To separate the stochastic component of yield from the upward trend in yields over time due to technological and managerial innovations, we estimate the yield trend using nonparametric LOESS (Cleveland and Devlin, 1988) predictions of the yield trend instead as a specification check on the simple parametric approaches used in the literature. For the trend regression, the bandwidth is artificially inflated to avoid over-fitting the trend regression, with the bandwidth being chosen to be high enough that any departure from strict concavity or convexity of the trend equation is minimal. The conservative LOESS yield trend used here provides some limited flexibility to modeling $E(Y_{it}) = f(t) + \varepsilon_{it}$ over the linear model (the latter which will predict negative trends for some counties) while minimizing the likelihood that the equations capture the stochastic component.

As with yield, price is transformed into deviation form, i.e., the realized price at harvest, P_t, is the difference between the expected and realized price, or $\Delta P_t = (P_t - E(P_t)) \big/ E(P_t)$. The derivation of $E(P_t)$ is discussed further in the data section.

Given the estimated trend yields as the predictions of $E(Y_t)$, we can construct ΔY_t^d and estimate the relationship between ΔP_t and ΔY_t^d. In particular, we assume that

ΔP_t can only be partially explained by ΔY_t^d, and that the uncertainty in this relationship can be incorporated into the empirical distribution. We do so by specifying ΔP_t as

(3) $\Delta P_t = g\left(\Delta Y_t^d, z_t\right) + \varepsilon_t,$

where ε_t is *i.i.d.* with mean 0 and variance σ_ε^2 given $\left\{\Delta Y_t^d, z_t\right\}$, and where z_t is a vector of other variables that may explain the price deviation. We expect that $d\Delta P_t \big/ d\Delta Y_t^d < 0$, i.e., the greater the realization of national average yield over the expected level , the more likely harvest time price will be lower than expected price. To examine the potential for bias due to miss-specification in estimating equation (3), in addition to a linear parametric estimate of the equation, we also estimate equation (3) using a semi-nonparametric (SNP) econometric approach based on the Fourier transformation (Fenton and Gallant, 1996).

Generating the empirical distribution of payments – overview

To generalize our empirical distribution of payments, we use a bootstrap method that allows for flexible right-hand-side regression modeling and for modeling interactions between variables. In particular, we use a paired bootstrap approach in a resampling methodology that involves drawing *i.i.d.* observations with replacement from the original data set (Efron, 1979; Yatchew, 1998), maintaining the pair wise relationship in each observation between the variables, e.g., variable values y_i and x_i are always kept together as a row. The bootstrap data-generating mechanism is to treat the existing data set of size T as a population from which G samples of size T are drawn. Equation (3) is re-estimated for each of these bootstrapped data sets. Variation in estimates results from the fact that

upon selection, each data point is replaced within the population. We can use this standard bootstrap to generate a distribution of ΔP given ΔY^d.

However, while we can directly estimate $\Delta\hat{P}_{gt}$, g = 1,…,*G*, by substituting the G sets of bootstrapped coefficients and the (*T*x1) vector ΔY_t^d into equation (3), we can increase the smoothness of the bootstrapped distribution of ΔP by substituting ΔY_t^d with yield deviations – denoted as ΔY^{d*} – that are generated from a random sample drawn from an estimated yield distribution. Doing so will allow us to estimate a set of price shocks associated with an arbitrarily large set of yield shocks, albeit defined by the actual data. While smoothing the distribution of yield will of course reduce the coefficient of variation of yield, we minimize this reduction by sticking to a nonparametric approach. As we find that smoothing the yield distribution has approximately the same impact (within 2.5 percent) on the decreasing the coefficient of variation of the density functions for the P-CCP and R-CCP, for the purposes of comparing the two programs, the cost of smoothing the yield density is low.

Smoothing the distribution of yield

Like Deng, Barnett, and Vedenov (2007) and Goodwin and Kerr (1998), we utilize the nonparametric kernel-based probability density function (Hardle, 1990; Silverman, 1986) for generating a smoother yield density than that which would be supplied by the bootstrap of equation (3). This function, as applied to our notation, is

$\hat{f}\left(y_j^d\right) = \frac{1}{Th}\sum_{t=1}^{T} K\left(\frac{y_j^d - Y_t^d}{h}\right)$, j = 1,…,*J*. This function allows us to generate values of

ΔY^d from a distribution that approaches a continuous function as *J* approaches infinity. This function gives support to generating yield values over the observed range of detrended yields, i.e., the (J x 1) vector y^d is drawn over the range $\{\min(Y_t^d)\ldots\max(Y_t^d)\}$, $t = 1\ldots T$, where y_i^d are the yield points for which the density function is estimated. The function $K(.)$ is a Gaussian kernel (*ibid.*), and h is the bandwidth used for smoothing the density function (Silverman, 1986).[2] We simulate the yield distribution by taking N draws of yield values, denoted as, Y_n^{d*}, from the estimated kernel density, with the yield draws denoted as ΔY_n^{d*}. Given the expected (trend) yield for a reference year, the yield deviate ΔY_n^{d*} is calculated for each Y_n^{d*}.

Generating the empirical distribution of payments given the estimated yield distribution

The estimated price shocks given ΔY^{d*} and the coefficient estimates from the bootstraps of equation (3) and are calculated as:

(6) $\Delta\hat{P}^* = \hat{\beta}_0 + \hat{\beta}_1 \Delta Y^{d*}$

where ΔY^{d*} is the N x 1 vector of yield shocks derived from the kernel yield distribution, $\hat{\beta}_1$ is the (1 x G) vector of draws of the coefficient on the yield deviate from the regression bootstraps, and $\hat{\beta}_0$ is the "grand mean", i.e., the product of the bootstrap draws of the other bootstrapped coefficients times the assigned values of the explanatory variables in z. The resulting $\Delta\hat{P}^*$ is a (N x G) matrix, i.e., every yield shock ΔY_n^{d*} is associated with a (1 x G) distribution of price shocks. For our simulation, $N = G = 1000$.

The process for generating $\Delta\hat{P}^*$ for a specification of equation (3) that is SNP in the yield deviate is similar, but with more columns in $\hat{\beta}_1$ associated with the higher order terms.

To calculate the CCP payments $\Delta\hat{P}^*$ must be transformed back to the price per bushel, $\hat{P}^*$. For a reference year, say 2005, the simulated price per bushel is $\hat{P}_{gn}^{*2005} = E(P_{2005}) \cdot \left(\Delta\hat{P}_{gn}^{*2005} + 1\right)$, $g = 1,\ldots,G$, $n = 1,\ldots,N$. Finally, by substituting the vectors $\Delta\hat{P}^{2005*}$ and ΔY^{2005d*} into Equations (1a) and (1b), we generate the probability density functions of 2005 CCP distributions at the beginning of the 2005 crop year.

The values of the parameters used in the CCP payment calculations include a national base corn yield per acre of 114.4 and total national base corn acres of 86,850,934. Other parameters used in the CCP calculations are the H.R. 2419 corn loan rate of $1.95 per bushel, direct payment rate of $0.28/bu., target price of $2.63/bushel, program yield of 114.4 bu./acre, and target revenue of $344.12/acre. To asses the sensitivity of payments to price, we conduct the analysis for several expected price levels, including the actual planting time price in 2005, in particular, the February 2005 cash price of $1.86/bu. (Illinois No. 2 yellow Corn).

Data

Data on planted yields and acres for corn are supplied by the National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture. As support payments can be collected for corn for silage as well as corn for grain, and because silage can be a significant portion of corn production in some regions outside the Heartland, we merge

together data on corn for grain and corn for silage. We convert tons of silage to bushels using a conversion rate of 7.94 bushels per ton, as per FSA (2006b).

For the realized P_t, we use the average of the daily October to December prices of the December CBOT corn future in period t. As an alternative, the average November price of the December contract could be used as the realized price, but our results are relatively insensitive among these prices.[3] Under each of these choices, the correlation between these average harvest time futures prices and the season average cash price is at least 0.97. For the expected value of price P_t, or $E(P_t)$, we utilize a non-naive expectation, namely the average of the daily February prices of the December Chicago Board of Trade corn future (CBOT abbreviation CZ) in period t, $t = 1975,\ldots,2005$. While we have prices back to 1969, the data before the mid-1970s does not reflect China and Russia as regular participants in global grain markets, and is unlikely to be representative of contemporary global markets.

In addition to the yield shock, we include several other explanatory variables in our regression of Equation (3). The dummy variable *FarmAct* takes the value of "1" for years 1996 and above (and 0 otherwise), reflecting the Federal government being out of the commodity storage business under recent Farm Acts.[4] As commodity storage may be expected to have a stabilizing influence on futures prices (Tomek and Grey, 1970), we include the corn stocks to use ratio, as measured at the beginning of the crop year in order to maintain Equation (3) in reduced form. As the inflation rate may impact price variability (e.g., Lapp and Smith, 1992), we include the inflation rate (CPI-U) over the quarter immediately prior to planting, the idea being that a lag may exist in the impact of near term inflation on the commodity price, with a higher rate increasing the price shock.

To model international linkages in a reduced form, we include deviation of actual yield from expected yield of corn in time *t* in the rest of the world, as calculated from FAOSTAT data. To account for the difference in the timing of seasons north and south of the equator, this variable is disaggregated into northern and southern hemispheres. The expectation is that a negative yield shock in the rest of the world will increase the U.S. corn harvest time price relative to the expected price. Finally, as exchange rate changes can be expected to have an impact on corn exports (Babula, Rupple, and Bessler, 1995), we include the percent change in the nominal exchange rate between planting time and harvest, where the expectation is that an increase in this value lowers the export demand for U.S. corn, and therefore, its price.

Econometric results

Table 1 provides the econometric results for the parametric and the SNP models, including parametric results for a specification that includes all the variables discussed above (Parametric-II) and with only 2 explanatory variables (Parametric-I). The latter is nested in the SNP regression, which is limited by degrees of freedom in the number of variables that can receive the SNP treatment.

The coefficient on ΔY is significant at the 1 percent level in all regressions. The higher order transformation terms in the SNP regression (the "sin s(ΔY)" and "sin s(ΔY)") are not significant, and the value for $d\Delta P \,/\, d\Delta Y$ at the bottom of the table are close across the regressions.[5] A bootstrap-based test (Efron, 1987) of the hypotheses Ho: $d\Delta P^k \,/\, d\Delta Y^k - d\Delta P_t^j \,/\, d\Delta Y_t^j = 0$, where the superscript refers to one of the 3 regression models, cannot be rejected at the 90 level or better for all $j \neq k$. At the same

time, while likelihood ratio tests cannot reject the hypothesis of the equivalence of the Parametric-I and SNP results, they do reject the equivalence of the Parametric-II results to the other two regressions. Together, the bootstrap test and the likelihood ratio tests suggest that while the additional explanatory variables are not correlated with $d\Delta P \,/ d\Delta Y$ in any significant fashion, their inclusion – in particular π and Δr – do add in a statistically significant fashion to explaining ΔP.

Discussion of payment simulation results

Table 2 summarizes the results of the *ex ante* stochastic analysis that predicts at planting time the probability distribution of corn CCPs given the distribution functions for price and yield.[6] Except at the first and second (in the case of alternative C) lowest expected price levels, the mean R-CCPs as well as the upper bound of their 90 percent confidence intervals are lower than for the P-CCPs. Over the examined expected price range, the coefficient of variation for both approaches is increasing in the expected price but there is no consistent relationship in the level of this measure across the two approaches. *A priori*, one might assume that because the coefficient of variation of revenue is less than the coefficient of variation of price, that the coefficient of variation of R-CCP will be consistently less than that of P-CCP. However, the relatively complex interactions of the program parameters with the stochastic variables do not support such a generalization.

Figures 1a and 1b present the density functions of payments for P-CCP and R-CCP, respectively.[7] As Figure 1a shows, given the actual expected (February) 2005 price of $1.86/bu., a high level of payments were virtually certain. Building from higher expected price bases – as with the $2.20/bu. in this example, the probability of high

payments falls and probability of $0 payment levels increases. As Figure 1b suggests, the distribution of R-CCP payments is notably more symmetric and with a fatter right hand side tail than P-CCP. The greater symmetry of R-CCP relative to P-CCP is to be expected given effect of multiplying price by yield in the former, as long as price and yield are not positively correlated. Figure 1a demonstrates a significant kink in the P-CCP density – its tendency is to have a spike at the bottom or top ends of the density function, with relatively low probability of other events occurring.

As seen in Figure 1 and Table 2 for the lower expected price scenarios, the fatter right hand tail of the R-CCP density compared to that of the P-CCP is due to the particularities of the P-CCP payment design, and not to any general trait of a revenue-based payment. Namely, the payment rate in the P-CPP has a ceiling equal to the target price (less the direct payment rate) minus the loan rate. In contrast, while the effective price is limited in the R-CCP to not fall below the loan rate, national yield is not subject to a programmatic floor. If the price-floor was to be removed in both CCPs, then the P-CCP would have a fatter tail than the R-CCP.

While Figure 1 depicts the CCP density in the context of total payments, how do these payments contribute to the density function of revenue for a corn producer? Figures 2a and 2b show the distribution of revenue per base acre with and without the CCP payments, on the assumptions that: 1) the producer has actually planted corn on the base acre; and 2) the producer's yield density exactly mirrors national yield density. Given a pre-planting price of $1.86/acre, the probability of the effective farm price being truncated at the loan rate is high, and as such, the R-CCP cannot effectively truncate the distribution of total revenue (i.e., gross revenue plus the payment) at the target revenue

but does shift the distribution of revenue to the right. At this pre-planting price, while the Price-CCP has a spike in the right hand tail of the distribution, it also has a fat left hand tail, suggesting high frequencies of underpayment relative to the R-CCP. Given a pre-planting price of $2.45/acre, the probability of harvest time prices being below the loan rate is low, and the R-CCP can effectively truncate the distribution of total revenue below the target revenue, and be equal to the distribution of gross revenue above the target revenue. At the pre-planting price of 2.45/acre, the Price-CCP overpays relative to a revenue target. Of course, the producer may also receive loan deficiency payments, but these would be the same regardless of the CCP option chosen.

Figure 2 represents a stylized analysis useful for demonstrating the general properties of the CCP programs with respect to their impacts on revenues of corn producers. However, few real producers have the national yield density as their own. While recalling that the CCP payment rate is invariant with respect to the producer's actual current production, impacts of the payments on the density of total revenue of producers will depend on the moments of their own yield densities and the correlation of their yield density with the national yield.

As such, Figure 3 relaxes assumption (2) above, and show the distribution of revenue per base acre with and without the CCP payments for two less stylized producers, one whose production region is outside the cornbelt and one inside. Namely, Figure 3a depicts the revenue density of a producer whose yield density is the same as that of Barnes County, North Dakota, and Figure 3b that for Logan County, Illinois. Over 1975 to 2005, the Pearson correlation coefficients between yields for each of these counties and national yields are 0.421 and 0.722, respectively.

To generate the simulations summarized in Figure 3, county-level yields were drawn using the same kernel density-based approach as used for national yield. Nonparametric Monte Carlo techniques were then applied to these *i.i.d.* national and county yield densities to induce them to have the same correlation as the actual yield data. Specifically, heuristic combinatorial optimization (Charmpis and Pantelli, 2004) was used to rearrange the generated univariate *i.i.d.* samples, in order to obtain the desired Pearson's correlation between them while leaving the yield values unchanged.

In Figure 3, the impacts of payment type on total revenue is less marked that in the highly stylized case in Figure 2 due to the departures of their yields from national yield. In Figures 3, the payments act as expected in shifting the distribution of revenue to the right. For the North Dakota producer with a relatively low level of correlation with national yield, the density function for total revenue is largely the same with P-CCPs or R-CCPs. For the Illinois producer, the mode of the total revenue density with P-CCP is higher than for total revenue with R-CPP. This result that P-CCP can over-pay relative to the R-CCP when national prices are low but yields is expected for the producer whose yield is highly correlated with the national average. On the other hand, potential under-payment of the P-CCP when yields are low and prices high appears to be minimal. Adding either type of CCP payment to revenue does not have major impacts on reducing the coefficient of variation of revenue (in the low price case, an 11 to 12 percent decrease) as the payment are not tied to current yields on farm.

Producer Preferences for Counter-Cyclical Program Alternatives

In principle, one may expect that a producer's preference with regards to CCP option would be defined over more than just the first 2 moments of the density function of returns or payments. However, no studies have been published for U.S. farmers of bulk crops that define preferences over more than the first 2 moments. Hence, to provide quantitative analysis of preferences, this section assumes that the producer only has information on the first two moments of the CCP payments, and hence, we use a mean-variance utility function approach. In practice, analysis of CCP payments as provided by agricultural extension services and the popular media address only the first moment.

We use 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 earning), 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 $\beta = 0.74$.

As we are interested in the relative utility of the CCP choices, and not the absolute utilities, we do not worry about obtaining exact measures of W. Hence, for our simulation of the preference for type of corn CCP payments, we assume a Kansas producer (or simply, a payment recipient) with the same mean and standard deviation of initial wealth W_0 as in Serra *et al*. , i.e. $W_0 =$ \$656,214 and $\sigma_{W_0} =$ \$577,945. We assume that producers would make the same crop production choices regardless of which CCP program they enroll in. Since we are only interested in relative utility differences, and

since the CCP payments do not require current production, we ignore the latter in the utility calculation. Since any recipient of corn CCPs is also receiving the lump sum direct payment for corn, we add the direct payment to W_0. Given these base yield and acre estimates, we estimate the distribution of payments as described earlier, but applied to a recipients with these estimated base yields and acres.[8]

Table 3 provides utility levels associated with price and revenue-based CCPs for a range of expected corn prices. The utility levels are normalized by $u(W_0)$. At the lower expected prices ($1.70 and $1.86/bu.), the producer prefers R-CCP to P- CCP for both target revenue scenarios, which would be the same result as for a decision process that ignored risk. For some of the higher expected prices, R-CCP is preferred even when its mean payout is lower. At the highest expected price levels, the lower variance of the R-CCP does not compensate for its lower mean payments with respect to the P-CCP, and the producer will prefer the latter. As pay-offs are likely to be low in any case when prices are high, a producer may focus on how a program pays out at lower price levels. If so, the R-CCP would likely be the preferred choice, at least in the case of corn.

Concluding Remarks

In the first half of 2008, corn were high enough that a stochastic analysis of prices at harvest would preclude any reasonable possibility of CCP payments for that year, and as such, one may conclude that such payments are irrelevant. As farming is a competitive industry, even if the current price regime will continue well into the future, then costs will increase sufficiently to bring average economic profits back to zero. If so, the government could be under considerable pressure to raise loan rates and target prices.

Our analysis suggest that if, for the sake of argument, CCPs are treated as a risk reduction device at the farm level, then there appears to be little effective difference between the P-CCP and the R-CCP. Both reduce the downside risk caused by low prices by shifting the mean of total revenue to the right. But while the R-CCP explicitly accounts only for national aggregate yield in its payment rate, the precision of the R-CCP payment rate in targeting farm-specific shortfalls in current revenue differs little from that of the P-CCP. This result holds both for farms with relatively low or high correlation of farm level yield with national aggregate yield. Differences between the coefficient of variation of total revenue with the R-CCP or P-CCP payments become distinct only for a stylized producer whose yield density is the national average yield density.

If one views CCPs simply as income transfers divorced from current production (as they are by design), then our mean-variance analysis does suggest that the R-CCP should be more popular than the P-CCP when expected prices are low relative to the target price and loan rate. As the expected price increases, the differences are more nuanced and the mean-variance tradeoff becomes apparent. Nonetheless, at least when utility is expressed over the first two moments of the payment density function, the differences in utility provided by the two approaches does not appear to be high.

Larger differences between the two programs are seen at the national level, however, where the R-CCP has the potential for significantly increasing Federal budgetary exposure relative to the P-CCP when expected prices are low. In particular, mean total support is not vastly different but the upper tail of the R-CCP distribution is fatter than that for the P-CCP. This result is not unexpected and is due to a particularity of the CCP payment design, and not to general characteristics of making payments based

on revenue versus price: by design, the effective farm price cannot fall below the loan rate in either P-CCP or R-CCP, but no floor is placed on yield in the R-CCP.

One way to reduce the potential budgetary exposure of the revenue-based CCP is to include language in the legislation limiting the revenue-CCP payment rate to not except some multiple of the price-based CCP payment rate. For instance, restricting the R-CCP payment rate to not exceed 2 times the P-CCP rate will decrease the size of the upper tail of the R-CCP, but perhaps still maintain it as an attractive alternative to the P-CCP for payment recipients.

Finally, allowing the producer a choice between CCP options is itself not without additional potential budgetary costs to the government. In particular, if at harvest time there turns out to be a substantial difference between payments under the two approaches, it could be possible that producers who choose the option with the lower payment may lobby the government for a rule change to permit them to switch back to the other option. If such lobbying would be successful, the result would be higher CCP expenditures than if only one CCP option was available. Notwithstanding these issues however, a benefit of the R-CCP is that it may help direct future Title I support in directions that are more consistent with economic principles embodied in making revenue the basis for payments.

Endnotes

[1] An exception to the average national loan rates for the purposes of CCPs is made for rice and barley, for which the Secretary of Agriculture would determine the average loan rates.

[2] We found the estimated density of CCP payments for corn to be insensitive to the choice between Gaussian and biweight kernels.

[3] For certain Federal crop insurance products, the USDA's Risk Management Agency uses a smoothed November price of the December contract as the harvest time price for corn.

[4] This variable might be interpreted as the change in the weather premium after the 2006 Farm Act. A negative sign on its coefficient would suggest an increase in the weather premium, which might be expected without the government holding significant reserve stocks after 1996.

[5] The transformation function $s(.)$ prevents periodicity in the SNP model by rescaling ΔY_t so that it falls in the range $[0, 2\pi - 0.000001]$ (Gallant, 1987).

[6] The explanatory variables in z are evaluated at 0, except for *FarmAct*, which is set equal to 1.

[7] In Figure 1b, the density functions for the \$1.86 and \$2.20 pre-planting prices are fitted to the bootstrap output using kernel smoothing methods. The other density functions in Figures 1a and 1b are fitted to the bootstrap data using the histogram approach, as kernel approaches do not realistically model the abrupt changes in slope of the density functions near the payment extremes.

[8] For lack of additional information, we assume that Cov(W, CCP) = 0.

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Table 1. Parametric and Semi-Nonparametric (SNP) Regression Results for the Function Explaining ΔP_t

Variable	Parametric - I		SNP		Parametric - II	
Constant	-0.047	(-2.006)	-0.045	(-1.821)	-0.193	(-3.116)
ΔY_t	-1.362	(-5.663)	-1.300	(-4.979)	-1.502	(-6.025)
sin s(ΔY_t)	–		0.010	(0.653)	–	
cos s(ΔY_t)	–		0.005	(0.353)	–	
FarmAct	-0.079	(-1.93)	-0.076	(-1.67)	-0.019	(-0.435)
Stocks/use	–		–		0.177	(1.322)
ΔY_t^{SH}	–		–		-0.252	(-1.225)
ΔY_t^{NH}	–		–		-0.335	(-0.683)
π	–		–		9.268	(2.587)
Δr_t					-0.445	(-2.054)
Ln-L	27.029		27.351		33.173	
R^2	0.572		0.581		0.712	
$d\Delta P_t / d\Delta Y_t$	-1.362 {-1.8, -1.0} [a]		-1.361 {-1.8, -0.9}		-1.502 {-2.0, 1.0}	

Notes: *T*-values are shown in parentheses.

ΔY_t is the percentage deviation in US corn yields from the expected (trend) yield. *Stocks to use ratio* is the ratio of total U.S. corn stocks at the end of the previous crop year to total utilization of U.S. corn (source: ERS). *FarmAct* equals 1 for 1996 to 2005 and 0 otherwise. ΔY_t^{NH} is the percentage deviation in Northern hemisphere corn yield (less the U.S.) from the trend yield in that world region, and ΔY_t^{SH} *Southern Production* is the percent deviation in Southern hemisphere corn yield (less the U.S.) from the trend yield in that world region (data source: FAOSTAT). π is the inflation rate (CPI-U) over the quarter prior to planting. Δr_t is the percentage change in the nominal exchange rate (Euro/$) between planting and harvest time.

[b] The BCa 90% confidence intervals apply the bias corrected accelerated approach (Efron) to 1000 bootstrap runs, and are shown in brackets.

Table 2. Summary statistics – distribution of counter-cyclical payments for corn

Pre-planting price ($/bu.)	Total payments ($ billion)					
	Mean	Median	Standard Error	Coefficient of Variation [a]	90% Confidence Interval (lower, upper)	
A. Price-Based CCP						
1.86	2.90	3.38	0.92	0.32	0.39	3.38
2.20	1.48	1.34	1.30	0.88	0.00	3.38
2.45	0.52	0.00	0.90	1.71	0.00	2.64
2.70	0.11	0.00	0.38	3.58	0.00	0.88
B. Revenue-Based CCP			(target revenue = $344.12 per acre)[c]			
1.86	3.05	3.10	1.12	0.37	1.25	4.80
2.20	1.00	0.98	0.88	0.89	0.00	2.52
2.45	0.09	0.00	0.31	3.37	0.00	0.80
2.70	0.00	0.00	0.08	16.18	0.00	0.00
C. Revenue-Based CCP			(target revenue = $353.67 per acre)[d]			
1.86	3.75	3.81	1.13	0.30	1.96	5.51
2.20	1.56	1.68	1.07	0.69	0.00	3.22
2.45	0.22	0.00	0.51	2.32	0.00	1.50
2.70	0.01	0.00	0.13	11.25	0.00	0.00

Note: Loan rate = $1.95 per bushel; target price = $2.63 per bushel; direct payment rate = $0.28/bu.; base year for the yield calculation is 2005.

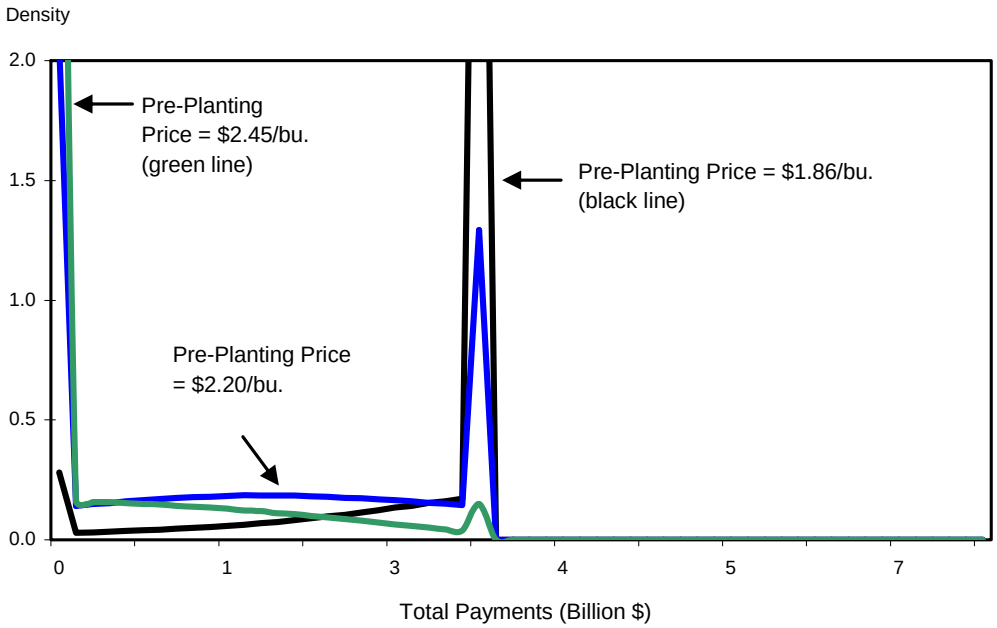
[a] The coefficient of variation measure is not denominated in dollars.

[c]The target revenue of $344.12 per acre is from H.R. 2419, and is $(TP_j - Dj)$ multiplied by the 5-year Olympic average of corn yield (bu./acre) over 2002 to 2006.

[d]The target revenue is obtained by by multiplying $(TP_j - Dj)$ by the predicted trend yield for 2006, based on a linear trend regression over 1980 to 2005.

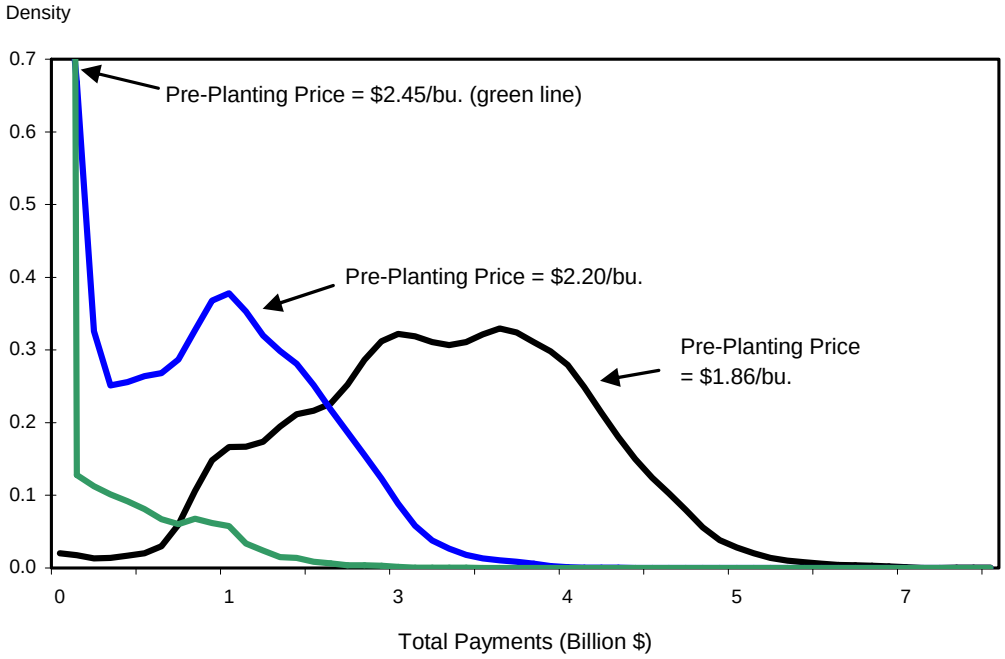
Figure 1. Probability Density of Total CCP Payments for Corn

(a) Price-based CCP payments



Note: For the pre-planting price (PPP) of $1.86, the peak density = 5.11 at $3.8 billion. For PPP = $2.20, the peak density = 2.06 at $0 billion. For PPP = $2.45, the peak density = 4.63 at $0 billion.

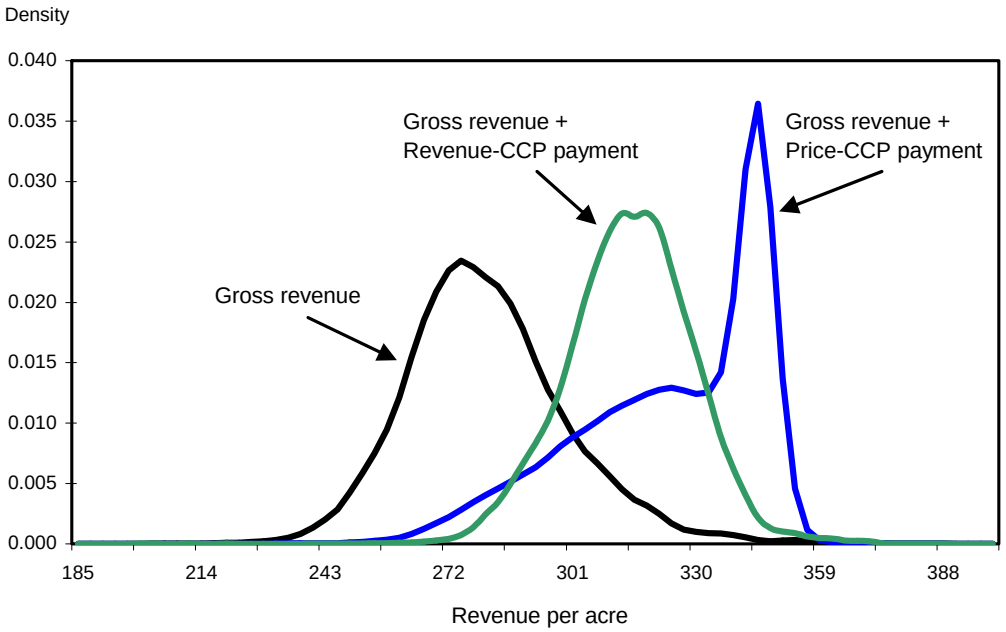
(b) Revenue-based CCP payments



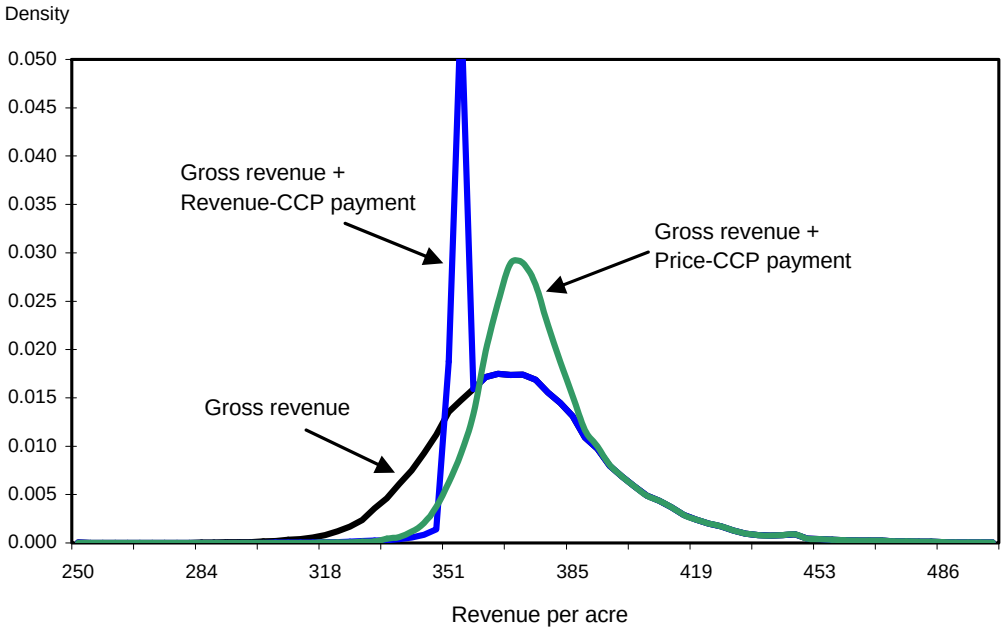
Note: For the pre-planting price (PPP) of $2.20, the peak density = 1.97 at $0 billion. For PPP = $2.45, the peak density = 6.45 at $0 billion.

Figure 2. Probability Density of Revenue per Acre – Generic National Corn Producer (Stylized corn producer whose yield density is the national yield density)

(a) Pre-planting price = $1.86/bu



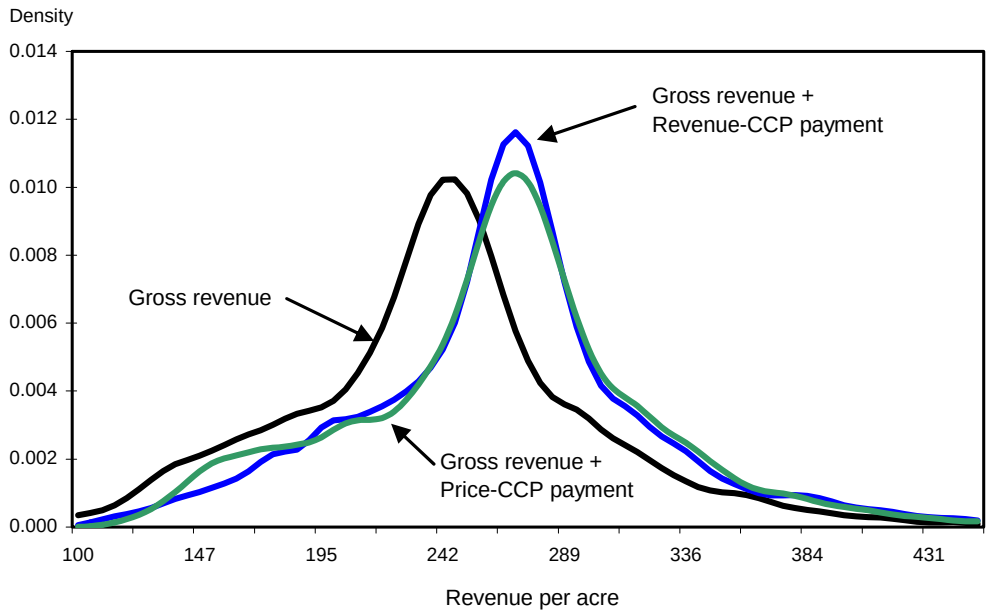
(b) Pre-planting price = $2.45/bu



Note: The assumption is that the producer receives CCP payments for corn and produces corn on the base acre. Target revenue = $353.67 per acre.

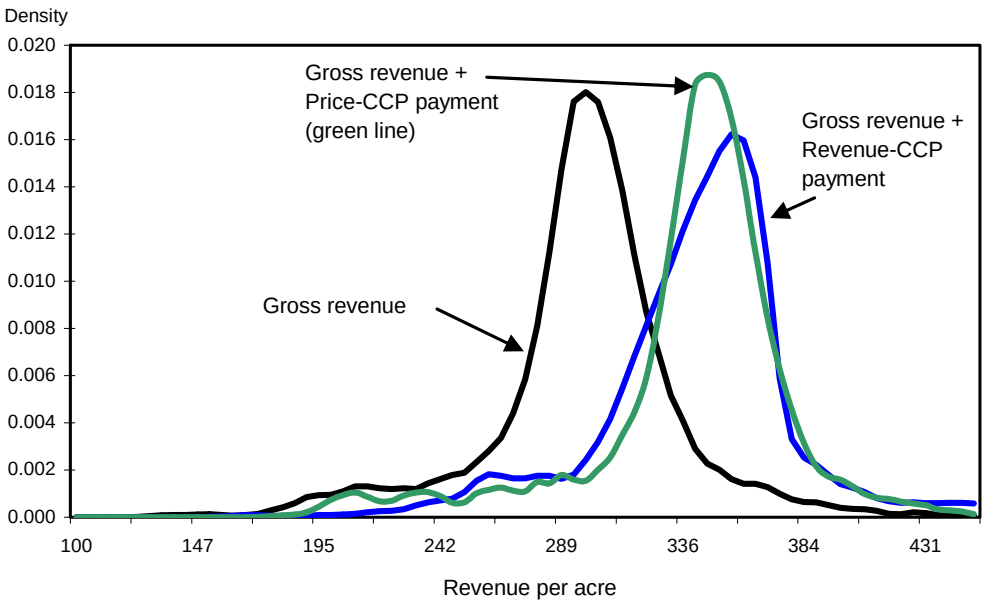
Figure 3. Probability Density of Revenue per Acre – Generic County Corn Producer (Pre-planting price = $1.86/bu)

(a) Corn producer with the Barnes County, North Dakota, average yield density



Note: The assumption is that the producer receives CCP payments for corn and produces corn on the base acre in Barnes County, ND. Target revenue = $344.12 per acre.

(b) Corn producer with the Logan County, Illinois, average yield density



Note: The assumption is that the producer receives CCP payments for corn and produces corn on the base acre in Logan County, Ill. Target revenue = $344.12 per acre.

Table 3. Utility of corn CCP payments for a representative Kansas farm

Scenario	Expected Price ($/bu.)	Payment per corn farm		Wealth per farm			
		Mean ($/farm)	Standard Error	Mean ($/farm)	Standard Error	Utility (Normalized)	Preference for Rev-based vs. Price-based CCP
A. Price-Based CCP							
A0	1.70	15,898	2,705	684,684	2,705	1.057	
A1	1.86	14,345	4,538	683,131	4,538	1.054	
A2	2.20	7,289	6,422	676,075	6,422	1.042	
A3	2.45	2,592	4,422	658,806	4,422	1.014	
A4	2.70	526	1,884	669,311	1,884	1.031	
B. Revenue-Based CCP (target revenue = $344.12 per acre)							
B0	1.70	17,124	6,524	685,910	6,524	1.059	B0 $\succ$ A0
B1	1.86	15,065	5,530	683,851	5,530	1.055	B1 $\succ$ A1
B2	2.20	4,934	4,367	673,720	4,367	1.039	A2 $\succ$ B2
B3	2.45	450	1,519	669,236	1,519	1.031	B3 $\succ$ A3
B4	2.70	24	381	668,809	381	1.031	A4 $\succ$ B4
C. Revenue-Based CCP (target revenue = $353.67 per acre)							
C0	1.70	20,607	6,526	689,393	6,526	1.065	C0 $\succ$ A0
C1	1.86	18,529	5,588	687,315	5,588	1.061	C1 $\succ$ A1
C2	2.20	7,695	5,289	676,481	5,289	1.043	C2 $\succ$ A2
C3	2.45	1,094	2,538	669,880	2,538	1.032	C3 $\succ$ A3
C4	2.70	57	638	668,842	638	1.031	A4 $\succ$ C4

Note: Loan rate = $1.95 per bushel; target price = $2.63 per bushel; direct payment rate = $0.28/bu.; target revenue = $344.12 per acre, base year for the yield calculation is 2005. Utility values are normalized by utility at the base wealth level, $u(W_0)$. The farm is assumed have 430 corn base acres and a base corn yield of 123 bu./acre, and not to engage in crop production for the year.