Average Crop Revenue Election (ACRE) Program or Traditional Government Payment Programs: What Factors Matter?

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Abstract

Rankings of different risk management portfolios including Average Crop Revenue Election (ACRE), traditional government payment programs, crop insurance and hedging in futures; and optimal choices of insurance coverage levels and hedge ratios are evaluated for a representative central Indiana corn farm, using Monte Carlo simulation and optimization of expected utilities. The changes of preference between ACRE and traditional government programs under comprehensive scenarios of price and yield risks are studied. Also, interactions between ACRE and other risk management instruments are examined, and government costs and risk management efficiencies between ACRE and traditional government programs are compared. The results show a strong preference of ACRE for the representative central Indiana corn farm in 2009, due to high ACRE guarantee price and expected drop in corn price from 2008 level. Even if the farm faces weak dependence between farm and aggregate yield, the risk could not offset the additional value ACRE could provide for this year. Also, it is found that there are synergistic effects between ACRE and two individual crop insurance plans but antagonistic effects between ACRE and group insurance plans. ACRE is more efficient than traditional government programs in terms of expected program costs.

Keywords: ACRE, Farm Bill, crop insurance, willingness to pay, government expenditure, government programs

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Introduction

The 2008 Farm Bill introduced Average Crop Revenue Election (ACRE), which is the first revenue based commodity program. Although ACRE's market-driven revenue protection gives farmers a better shield against financial stress when both crop price and production costs are high (Zulauf et al. 2008), individual farmers will still face a difficult decision between ACRE and traditional government programs. One of the reasons is that ACRE's double payment triggers and moving revenue benchmarks require farmers to consider both price and yield risks, including mutual dependence between individual and aggregate yields and between yields and prices.

Several studies have identified that the relative payments from the two programs depend on the relative levels of guaranteed price parameters in the policies. Cooper (2009) compared payments to corn producers from a stylized version of ACRE program and payments from traditional government payment programs. Olson and DalSanto (2008) compared expected government payments between ACRE and traditional government programs under scenarios of different expected price and ACRE guaranteed price. They concluded that traditional programs are favored when expected price stay at or above ACRE guaranteed price level. However, their comparison is based on expected payments without considering risk management values. Power et al. (2009) found that traditional government programs are valued higher than ACRE by both Texas cotton and Illinois corn farmers. No comprehensive studies are found to investigate the relative values of ACRE and traditional government programs being influenced by the joint yield-price risks.

Another issue under debate is the interaction of ACRE with existing crop insurance programs. Zulauf et al. (2008) concluded that although ACRE looks like a revenue insurance program, based on historical data and ACRE's design of double trigger and 25% revenue guarantee ceiling, ACRE cannot substitute crop insurance and there are no serious double payment problems. Power et al. (2009) argue that Actual Production History (APH) and Crop Revenue Coverage (CRC) insurance instruments work more effectively in combination with traditional government programs than with ACRE. In addition, interactions between ACRE and group based insurance programs are not investigated.

From the government point of view, both programs are fully financed by the federal government. It is thus interesting to compare government's costs in supporting farmers to mitigate natural and market risks.

Our study will fill the gaps in the literature by providing a comprehensive scenario analysis on factors affecting farmers' choices between ACRE and the traditional government programs. We will also examine impacts of ACRE on existing crop insurance programs including APH, CRC, Group Risk Plan (GRP), and Group Income Protection Plan (GRIP) in the presence of hedging in futures market. Government costs of alternative programs are compared in scenarios in which programs provide equivalent levels of support to farmers.

The rest of paper is organized as follows. The next section describes models of different risk management instruments used in the portfolio analyses, expected utility model used to derive optimal decisions and portfolio rankings, and the structure to calculate farmers' willingness to pay (WTP) as a welfare measure to rank each portfolio. Then, the data and methods of modeling stochastic joint yield and price distributions are discussed. The next section presents results from the base scenario and then analyzes factors affecting the relative values of ACRE and traditional government programs. The results section concludes with a discussion of the government costs. Conclusions and implications are drawn in the last section of the paper.

Decision Model

The analysis is based on simulated data for a representative corn farm in Clinton County, Indiana. We assume at pre-planting time, the farmer makes a choice between ACRE and traditional government programs, one crop insurance program among APH, CRC, GRP, and GRIP, and the hedging ratio in futures market. His/her wealth at the harvest time, based on the chosen risk management portfolio, is stochastic and can be denoted by (1) on per acre basis:

$$w = w_0 + \pi, \tag{1}$$

where w is total stochastic wealth; w_0 stands for initial wealth estimated as per acre equity of $2,039 from the financial characters of 2009 grain farms in Indiana (Richardson et al. 2010). π is the total harvest time profit per acre, including net profit from cash sales, revenue from government programs, crop insurance payments, and hedging profits:

$$\pi = NP + (ACRE\ or\ CDL) + (APH\ or\ CRC\ or\ GRP\ or\ GRIP) + FI. \tag{2}$$

Definitions of the terms in equation (2) are below:

$NP = P_L Y_F - C_P$ is net profit from net sales, where P_L is stochastic local corn cash price at harvest time, Y_F is stochastic farm yield, and C_P is average production costs per acre which is $505 (Miller et al. 2009).

$ACRE = 0.833 * \min\{[T_S * T_F * (R_G - R_S)],[T_S * T_F * 0.25 * R_G]\} * (Y_{BF}/Y_{BS}) + 0.8 * DP$ $+ 0.7 * LDP$, is per acre payment the farmer receives from ACRE program, where T_S and T_F are state and farm triggers respectively. $Ts = \max(R_G - R_S, 0)/(R_G - R_S)$ and $T_F = \max(R_{BF} - R_F, 0)/(R_{BF} - R_F)$ so that the two triggers could be only one or zero. R_G is

ACRE guaranteed state revenue, R_S is actual state revenue, R_{BF} is benchmark farm revenue, and R_F is actual farm revenue. Y_{BF} is benchmark farm yield, Y_{BS} is benchmark state yield, *DP* is Direct Payment and *LDP* is Loan Deficiency Payment.

Terms in the ACRE payment include, $R_G = 0.9 * Y_{BS} * P_G$, where Y_{BS} is five-year Olympic moving average state yield; P_G, the ACRE guaranteed price, which is the larger of the average of previous two years' Market Year Average (MYA) price and 70% Loan Rate. One provision of R_G when calculating multiple year ACRE payments is that R_G could not increase or decrease more than 10% of previous value; $R_S = Y_S * P_{MYA}$, where Y_S is stochastic state yield and P_{MYA} is stochastic Market Year Average (MYA) price in 2009; $R_{BF} = Y_{BF} * P_G + PREi$, where Y_{BF} is five-year Olympic moving average farm yield, which equals to five-year Olympic moving average county yield as we assume the representative farm's yield equals to county yield; *PREi* is pre acre crop insurance premium paid by the farmer and *i* stands for a particular crop insurance program; $R_F = Y_F * P_{MYA}$, where Y_F is stochastic farm yield; $DP = 0.833 * R_{DP} * Y_{DP}$, where DP covers 83.3% of acreage; R_{DP} is DP payment rate, \$0.28/bu in 2009 (USDA, ERS, 2009a); Y_{DP} is DP payment yield, 115bu/acre for Clinton County (USDA, ERS, 2009b); and $LDP = Y_F * \max(0, LR - P_L)$, where LR is Loan Rate, which is \$1.95/bu in 2009 (USDA, ERS, 2009c).

$CDL = CCP + DP + LDP$ are traditional government program payments including Counter-cyclical Payment (CCP), DP and LDP. $CCP = 0.85 * Y_{CCP} * \max[P_{CCP} - R_{DP} - \max(P_{MYA}, LR), 0]$, where Y_{CCP} is CCP payment yield, which equals to 131 bu/acre for Clinton County (USDA, ERS, 2009b), and P_{CCP} is CCP target price, which is \$2.63/bu (USDA, ERS, 2009c).

$APH = P_{APH} * \max(C_{APH} * Y_{APH} - Y_F, 0) - PRE_{APH}$ is per acre net payment the farmer received from individual yield insurance program, where P_{APH} is Risk Management Agency (RMA) defined APH price, which is \$4.00/bu (William, 2009). C_{APH} is an individual crop insurance coverage level chosen by the farmer. Y_{APH} is historical average yield for the farm and in the simulation it is defined as the average of stochastic farm yield in 2009. PRE_{APH} is premium paid by the representative farmer. Assuming the crop insurance is actuarially fair, PRE_{APH} equals to the expected payments of APH times a subsidy level corresponding to the chosen coverage level.

$CRC = \max[C_{CRC} * Y_{APH} * \max(P_{FU0}, P_{FU}) - P_L * Y_F, 0] - PRE_{CRC}$ is per acre net payment the farmer received from individual revenue insurance program, where C_{CRC} is an individual crop insurance coverage level chosen by the farmer. P_{FU0} is average price of harvest-time futures contract in the pre-planting month and P_{FU} is stochastic harvest-time futures price. PRE_{CRC} is premium paid by the representative farmer. Assuming the crop insurance is actuarially fair, PRE_{CRC} equals to the expected payments of CRC times a subsidy level corresponding to the chosen coverage level.

$GRP = \max(R_{GRP} * (C_{GRP} * Y_{GRP} - Y_C)/(C_{GRP} * Y_{GRP}), 0) - PRE_{GRP}$ is per acre net payment the farmer received from Group Risk Plan (GRP), where R_{GRP} is GRP protection rate, which is \$480/acre (USDA, RMA, 2009), and C_{GRP} is a group crop insurance coverage level chosen by the farmer. Y_{GRP} is GRP payment yield, which is defined as the average of stochastic county yield Yc, in 2009. PRE_{GRP} is premium paid by the representative farmer. Assuming the crop insurance is actuarially fair, PRE_{GRP} equals to the expected payments of GRP times a subsidy level corresponding to the chosen coverage level.

$GRIP = \max(C_{GRIP} * P_{FU0} * Y_{GRIP} - Y_C * P_{FU}, 0) - PRE_{GRIP}$ is per acre net payment the farmer received from Group Income Risk Protection (GRIP), where C_{GRIP} is a group crop insurance coverage level chosen by the farmer, and Y_{GRIP} is GRIP payment yield, which is defined as the average of stochastic county yield Yc, in 2009. PRE_{GRIP} is premium paid by the representative farmer. Assuming the crop insurance is actuarially fair, PRE_{GRIP} equals to the expected payments of GRIP times a subsidy level corresponding to the chosen coverage level.

$FI = x_{FU} * mean(Y_F) * (P_{FU0} - P_{FU}) - C_F * |x_{FU}| * mean(Y_F)$ is the farmer's net gain from futures contract, where x_{FU} is hedging ratios chosen at pre-planting time, and C_F is hedging transaction cost, which is set at \$0.017/bu (Makus, et al, 2007). The simulated futures price is adjusted as $E(P_{FU}) = P_{FU0}$ to avoid speculating effects (Makus et al, 2007).

Table 1 shows the summary of defined parameters of government programs and crop insurance contracts for Indiana corn farm in 2009.

The farmer is assumed to choose crop insurance coverage level, hedging ratio, and whether ACRE or traditional program to maximize his/her expected utility, and the utility function describing the farmer's attitude towards risk is defined as:

$$U(w) = (1-\theta)^{-1} w^{(1-\theta)},$$

where w is stochastic wealth and θ is relative risk aversion coefficient. This utility function shows Constant Relative Risk Aversion (CRRA). This CRRA function is also widely used by previous research in applied risk management and our study will follow their estimations to set the value of θ at 2 (Makus et al. 2007; Wang et al. 2003; Coble et al. 2000).

To measure and compare risk management values of different portfolios, Willingness to Pay (WTP) is calculated. It is the amount of sure income the representative farm is willing to receive in exchange for the benefit from a particular portfolio. WTP for each risk management portfolio is calculated by solving WTP in the equation below:

$$\max E[U(w_0 + NP + (ACRE\ or\ CDL) + (APH\ or\ CRC\ or\ GRP\ or\ GRIP) + FI)] = E[U(w_0 + NP + WTP)]$$

Data and Simulation

We use Monte Carlo Method to simulate the joint distribution of historical farm, county and state level yields combining with futures price, local cash price, and Market Year Average (MYA) price. To achieve this goal, marginal distributions of each variable are first estimated and then the copula method is used to create and simulate joint distribution based on marginal distribution parameters of those variables.

Data

Yield data from Clinton County, Indiana, are obtained from the National Agricultural Statistics Service (NASS). Actual farm yield data in Clinton County is collected from Actual Production History (APH) record. 516 farms with more than 8 years of actual yield records between 1985 and 2006 are used.

Daily futures prices of November corn futures contract in February (pre-planting) and October (harvest) from 1987 to 2008 were collected from Chicago Board of Trade (CBOT), and average prices in those two months were calculated for each year. Weekly local cash price in October were collected from central Indiana grain elevators, starting from year 1986, by Department of Agricultural Economics, Purdue University. Annual cash prices in October were then calculated by averaging weekly prices by year. National average market price from 1987 to 2008 was collected from NASS.

Yield Trend

To model yield risk, trends need to be estimated to accurately distinguish deterministic and stochastic components of yield, as Just and Weninger (1999) point out that misspecification of deterministic measurement will invalidate moment assessment of stochastic components. To achieve this goal, appropriate yield data range must be first chosen. Longer time range was preferred for a more powerful estimation of stochastic yield, as long as a deterministic yield trend could be well justified. In this paper, county and state yields from 1930 to 2008 are used (Figure 1), because 1930 is the era for Indiana's agriculture to change from low-input to high-input system (Egli 2008).

Suggested by heteroskedasticity test, Box-Cox Transformation Tests, and literature (Power et al. 2009; Wang et al. 1998; Deng et al. 2007), state and county yield are modeled using log-quadratic trend. Due to limited data for individual farm yield, we assumed that sample farms' yield in the same county would follow the same trend as the county yield. The details of estimation are in Appendix.

Detrended Yield Distribution

Parametric distributions are used to model aggregate yield residuals. First, Shapiro-Wilk Tests reject the null hypothesis of normality for both state and county residuals. Second, Maximum Likelihood Estimation (MLE) is used to fit residuals to several parametric distributions which are often used stochastic yield modeling. Then, p-values from Kolmogorov-Smirnov (KS) Tests are used to rank fitted continuous distributions (Ricci 2005). The results of MLE and rankings of distributions are shown in Appendix.

According to the p-values of KS Tests, beta distributions are the best one to model state and county residuals among the candidate parametric distributions. This is in accordance with the current view that stochastic yields are skewed and some previous literatures use beta distributions to model yield risks (Babcock and Hennessy 1996; Nelson and Preckel 1989). Also, intuitively the beta distribution's upper-lower bound and left-skewness are considered a good fit to describe weather related non-systematic yield risks and natural limits of crop production (Just and Weninger 1999).

Sample farms are detrended using county trend and their residuals are assumed to follow the same distribution as county residual, with a Mean Preserving Spread (MPS) transformation. We assume the representative farm will have a county average yield but a different standard deviation (SD). To find a SD value which represents average farms in Clinton County, we first calculate SD of detrended yield residuals for each sample farm. Then, for each farm sample, we calculate its corresponding detrended county residual SD using only the years the sample farm report it actual yield. Last, farm to country standard deviation ratios (SD Ratio) for each sample farm is calculated. Last, average value of SD Ratio (1.66) is used in MPS transformation to simulate stochastic yield distribution for the representative farm.

Modeling price risks

Log-normal distribution is commonly used to model the risks for the same futures contract passing from known pre-plant futures price to unknown harvest-time futures price (Coble et al. 2000):

$$d \ln P_{FU} = \ln P_{FU0} - \ln P_{FU}; \quad d \ln P_{FU} \sim N(\mu_{FU}, \sigma_{FU}^2).$$

Shapiro-Wilk test of $d \ln P_{FU}$ could not reject the hypothesis that it is normally distributed. In order to avoid speculating effects, futures price is assumed unbiased by adjusting μ_{FU} equals to zero, indicating expected harvest-time futures price equals to pre-planting futures price (Wang et al., 1998).

Price difference model suggested by Witt et al. (1987) is used to model both linear relationships between local cash price and harvest-time futures price, and between MYA price and harvest-time futures price. Normality tests suggest residuals from both models are normally distributed. The details of model description and estimation are in Appendix.

Correlation Estimation and Joint Distribution

Since P_L and P_{MYA} are modeled as linear relationship with P_{FU}, pairwise correlations among P_{FU}, Y_S, Y_C, and Y_F are estimated and then copula method is used to create joint distribution of the four variables with desired marginal distributions and correlations matrix (Nelsen, 2006). To estimated pairwise correlation between the representative farm yield and P_{FU}, Y_S, or Y_C, 516 sample farm's pairwise yield correlations with the other three variables are first calculated. Then, an average value of each sample pariwise correlation is used to estimate correlations between the representative farm and P_{FU}, Y_S, or Y_C.

After estimating pairwise correlations among P_{FU}, Y_S, Y_C, and Y_F, Normal Copula function is chosen to create joint distributions with desired marginal distributions and correlations matrix. Normal Copula has been used in previous research creating joint distributions among prices and yields (Zhu et al., 2008; Larsen et al., 2009). It is flexible and allows for balanced positive and negative dependence (Trivedi and Zimmer; 2007), which is suitable for purpose of creating joint prices-yields distribution containing both positive and negative correlations. Also, comparing to Frank Copula used in study by Power et al. (2009), Normal Copula has stronger tail dependence (Trivedi and Zimmer, 2007). This feature gives Normal Copula an advantage to describe the situation happening at lower tail, when big disaster usually causes wide region of yield drop (higher dependence between farm and aggregate yield), and this big yield drop will also cause significant price increase (higher dependence between price and yield). Table 2 shows correlation matrix of simulated stochastic price and yield variables and descriptive statistics of those variables.

Results and Implications

In this section, the representative farmer's rank of WTP for each risk management portfolio will be discussed first. Then, studies of the farmer's decisions between ACRE and traditional government programs under different scenarios of price and yield risks are carried out. The scenarios include changes of expected Market Year Average (MYA) price, change of ACRE guarantee price, changes of CCP target price, changes of price-yield correlations, and changes of correlations between individual and aggregate yields. In addition to providing the representative farmer's optimal decisions for each risk management portfolio and his/her rankings of different portfolios, we also address interactions between ACRE and other risk management instruments. Last, expected government cost of ACRE program under base scenario is estimated, and risk management efficiencies between ACRE and traditional government programs are compared when they share the same WTP values.

Base Scenario Results

The representative farmer's rankings of different portfolios and his/her optimal choices of insurance coverage level and hedge ratio for each risk management portfolio under base scenario are presented in Table 3. Portfolios containing ACRE always are ranked higher than corresponding ones containing traditional government program, irrespective of the crop insurance type. Similarly, CRC has the highest value followed by APH, GRIP and GRP, with either ACRE or traditional programs. Highest coverage levels are always the optimal choice for any insurance programs, and the portfolio of ACRE+CRC+Futures has the highest WTP.

Interactions between ACRE and crop insurance programs could not be observed, as the optimal coverage levels of crop insurance programs do not change when ACRE is included in portfolios.

Hedging in futures is a complement to yield insurance, shown by the 29% optimal hedging ratio which is highest among the scenarios when it goes with APH only. Although it only contributes a small value to portfolios, we still observe the substitutive effect of ACRE on futures. The optimal hedge ratios for portfolios containing ACRE decrease significantly, when they are compared with the corresponding ones containing traditional or no government programs.

These results differ from the recent study by Power et al. (2009) in two ways. First, in their paper, both representative cotton farmer in Texas and corn farmer in Illinois prefer the traditional program over ACRE. We find that one of important reasons lies in their assumption that market year average prices are higher than ACRE guarantee prices. In the analysis of alternative scenarios, we observe the value of ACRE program drops when expected MYA price is higher than ACRE guaranteed price. Second, they concluded that APH and CRC are more effective under traditional government programs while our following study shows synergy between ACRE and the two insurance plans.

Scenario Analysis

Several scenarios are analyzed when some policy or market parameters are evaluated at different levels ceteris paribus (Table 4). In the first scenario, we examine the effect of increase in the expected futures price. MYA and cash price will also increase as they are linearly related to futures price. As MYA price increases, WTP of ACRE decreases quickly because of lower possibility to trigger payments, and vice versa. WTP of traditional government program also decreases when expected futures price increase because of decrease in CCP payment. However, the decrease is trivial as the value of CCP is already very low in base scenario. As a result, the difference between ACRE and traditional government programs becomes smaller as the expected futures price increases. The second column in Table 4 shows when the increase in expected futures price reaches $0.66/bu, the farmer's WTPs of ACRE and traditional government programs are equal. At this indifference point between ACRE and traditional programs, interactions between ACRE and crop insurance programs could be observed: when APH and CRC are combined with the two programs at their indifference point, portfolios containing ACRE become more valuable than the corresponding ones containing traditional government program; however, combining with GRP and GRIP creates the opposite effects which causes WTPs of portfolios containing ACRE to be lower than those of traditional government program. The observations indicate synergistic (complement) effects between ACRE and two individual crop insurance plans (APH and CRC) and antagonistic (substitutive) effects between ACRE and group insurance plans (GRIP and GRP), comparing to traditional government program. The results are reasonable considering ACRE is a group based revenue protection program.

In the second scenario, we consider the change in ACRE guarantee price. When a change in 2008 MYA price is assumed, it will cause the same directions of changes in ACRE guaranteed price, which is the larger of the average of previous two years' Market Year Average (MYA) price and 70% Loan Rate. Increasing 2008 MYA price will raise the WTP of ACRE as the higher ACRE guarantee price makes the program's payments easier to be triggered, and vice versa. The WTP of traditional government program does not change under this scenario, so the changes of ACRE's values indicate the changes of WTP gap between the two programs. As the third column in Table 4 shows, $1.24/bu decrease of 2008 MYA price makes WTP of ACRE and traditional government programs equal each other.

Changes in CCP target price are analyzed in the third scenario. When CCP target price starts to increase, WTP of traditional government program begins to increase, while WTP of ACRE stays the same. Thus, WTP difference between ACRE and traditional government program deceases. The fourth column in Table 4 shows a $1.24/bu increase of CCP target price makes WTPs of ACRE and traditional government programs very similar. We also consider a scenario when the price-yield correlations change. When the negative farm yield-futures price, county yield-futures price, and state yield-futures price correlations increase in magnitude, the WTP of ACRE decreases, and vice versa. The WTP of traditional government program is not affected. Because ACRE is revenue targeted program, its risk management value will decrease when revenue risk is reduced by higher price-yield dependency. However, as the fifth column in Table 4 shows, since current ACRE guarantee price is much higher than CCP target price, ACRE could not be reduced to the same value as traditional government program even price-yield correlations are increased to the maximum feasible levels (65% increase of correlations between futures price and yields).

The last scenario is for the effect of the farm-aggregate yield correlation change. The WTP of ACRE decreases as farm-aggregate yield correlations decrease, and vice versa, while WTP of traditional government program stays at the same level. This is because the ACRE's double trigger will favor those farms having higher yield correlations with state level yield. Again, as the last column in Table 4 shows, since current ACRE guarantee price is much higher than CCP target price, ACRE could not be reduced to be indifferent to traditional government program even farm-aggregate correlations are decreased to the minimum (the correlations between farm yield and state/county yield is decreased to almost zero).

Expected Government Cost

Expected government cost of current ACRE is $49.0/acre and $27.0/acre for traditional government program, indicating ACRE is way more expensive to the federal government. However, ACRE provides way higher benefit to farmers. To compare risk management efficiency between ACRE and traditional government program, their expected costs are compared at equivalent points when the two programs have the same WTP. Table 5 shows the comparison of expected costs at three equivalent points found in previous scenario study. The results indicate that ACRE is more efficient, as in all three indifferent points when farmers have the same WTPs for the two programs, ACRE always has lower expected government costs.

Conclusion

Portfolio rankings in base scenario indicates a strong preference of ACRE for the representative central Indiana corn farm in 2009, due to high ACRE guarantee price and expected drop in corn price from 2008 level. Substitutive effects between ACRE and hedging in futures could be observed through the changes of optimal hedge ratio. ACRE is also more valuable when used together in individual insurance than group insurance.

Scenario studies suggested that farmers consider several price and yield risks together when evaluating the value of ACRE, including comparing the expected MYA price, ACRE guaranteed price, and CCP target price together. The latter two are known early enough with certainty, however, the former, expected market year average price made based on historical experience, which makes the value of ACRE different if the past two years observed high price versus low price.

Farmers also consider if corn price have a strong correlation with their state and count yield, and whether their own yield have a weak correlation with aggregate yield. What makes the decisions difficult is that even both negative and positive factors affecting the value of ACRE are known, it is usually hard to combine positive and negative factors together to weigh the decision accurately. In year 2009, even if the farm faces weak dependence between farm and aggregate yield, the risk could not offset the addition value ACRE could provide for this year..

Furthermore, expected government costs of ACRE is lower than those of traditional government programs at the equivalent points, which implies that ACRE is a more efficient program.

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Table 1. Policy parameters in government programs and crop insurance for Indiana corn in 2009

Price Parameters		Yield Parameters	
C_P	\$505/acre	Y_{BS}	155 bu/acre
P_G	\$4.05/bu	Y_{BF}	176.7 bu/acre
LR	\$1.95/bu	Y_{DP}	115 bu/acre
R_{DP}	\$0.28/bu	Y_{CCP}	131 bu/acre
P_{CCP}	\$2.63/bu	Y_{APH}	178.66 bu/acre
P_{APH}	\$4.00/bu	Y_{GRP}	174.64 bu/acre
P_{FU0}	\$4.08/bu	Y_{GRIP}	174.64 bu/acre
R_{GRP}	\$480/acre		
C_F	\$0.017/bu		

Table 2. Descriptive statistics of simulated stochastic price and yield variables

	Correlation Matrix								
	Y_F	Y_C	Y_S	P_{FU}	P_L	P_{MYA}	Mean	SD	Unit
Y_F	1						178.68	43.46	Bu/acre
Y_C	0.64	1					174.64	26.79	Bu/acre
Y_S	0.42	0.86	1				156.84	20.24	Bu/acre
P_{FU}	-0.44	-0.39	-0.45	1			4.08	0.69	$/Bu
P_L	-0.44	-0.38	-0.45	0.99	1		3.87	0.68	$/Bu
P_{MYA}	-0.42	-0.37	-0.43	0.95	0.93	1	3.71	0.68	$/Bu

Table 3. Optimal Hedge Ratios, Insurance Coverage Levels, and WTPs under the Base Scenario

Risk Management Instrument	No Government Program			Under Traditional Government Program			Under ACRE Program		
	Hedge Ratio	Insurance Coverage level	WTP ($/acre)	Hedge Ratio	Insurance Coverage level	WTP ($/acre)	Hedge Ratio	Insurance Coverage level	WTP ($/acre)
GP Only	NA	NA	0	NA	NA	27.05	NA	NA	50.33
Futures	0.056	NA	0.022	0.050	NA	27.07	0.00	NA	50.33
APH	NA	0.85	16.51	NA	0.85	43.52	NA	0.85	67.58
CRC	NA	0.85	28.38	NA	0.85	55.35	NA	0.85	79.55
GRP	NA	0.9	9.38	NA	0.9	36.42	NA	0.9	59.66
GRIP	NA	0.9	13.96	NA	0.9	40.96	NA	0.9	63.45
APH+Futures	0.29	0.85	17.08	0.28	0.85	44.05	0.11	0.85	67.66
CRC+Futures	0.29	0.85	28.92	0.28	0.85	55.86	**0.11**	**0.85**	**79.62**
GRP+Futures	0.15	0.9	9.54	0.14	0.9	36.56	0.00	0.9	59.66
GRIP+Futures	0.00	0.9	13.96	0.00	0.9	40.96	0.00	0.9	63.45

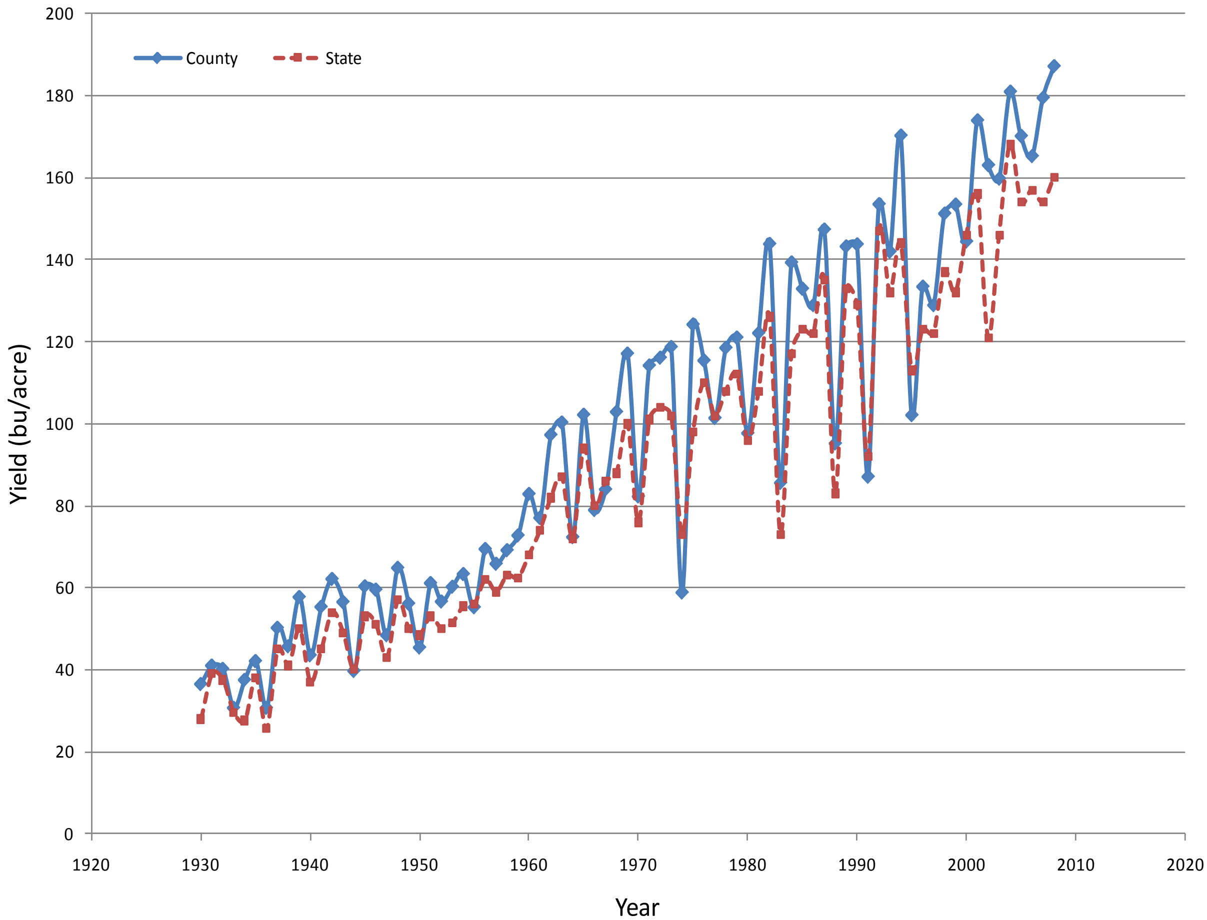
Table 4. WTPs of selected portfolios under different scenarios

		Indifference between ACRE and Traditional			Prefer ACRE at the Maximum Parameter Change	
	Base Scenario	\$0.66/bu increase of expected futures price	\$1.24/bu decrease of 2008 MYA price	\$1.24/bu increase of CCP target price	65% increase of correlations between futures price yields	89% decrease of correlations between farm and aggregate yield
	P_{FU} 4.08	P_{FU} 4.74	P_{FU} 4.08	P_{FU} 4.08	$Corr(P_{FU}, Y_F)$ -0.75	$Corr(Y_C, Y_F)$ 0.069
	P_L 3.87	P_L 4.51	P_L 3.87	P_L 3.87	$Corr(P_{FU}, Y_C)$ -0.65	$Corr(Y_S, Y_F)$ 0.042
	P_{MYA} 3.71	P_{MYA} 4.32	P_{MYA} 3.71	P_{MYA} 3.71	$Corr(P_{FU}, Y_S)$ -0.75	$Corr(Y_C, Y_S)$ 0.86
	P_G 4.05	P_G 4.05	P_G 3.43	P_G 4.05		
	P_{CCP} 2.63	P_{CCP} 2.63	P_{CCP} 2.63	P_{CCP} 3.87		
Traditional	27.1	26.8	27.1	50.3	27.0	27.0
ACRE	50.3	26.8	27.1	50.3	40.0	45.7
APH	17.1	17.8	16.5	16.5	14.9	16.5
APH+Traditional	44.1	44.5	43.5	67.2	42.0	43.5
APH+ACRE	67.7	44.7	43.9	67.6	56.3	63.7
CRC	28.9	31.9	28.4	28.4	24.0	28.2
CRC+Traditional	55.9	58.6	55.4	78.8	51.0	55.2
CRC+ACRE	79.6	58.9	55.8	79.6	66.2	76.1
GRP	9.5	9.8	9.4	9.4	8.7	7.0
GRP+Traditional	36.6	36.6	36.4	59.9	35.7	34.1
GRP+ACRE	59.7	36.4	36.4	59.7	48.9	53.0
GRIP	14.0	14.5	14.0	14.0	7.9	10.9
GRIP+Traditional	41.0	41.3	41.0	63.7	34.9	37.9
GRIP+ACRE	63.4	40.9	40.7	63.4	47.7	56.3

Table 5. Comparisons of Government Costs between ACRE and Traditional Program

	Base Scenario		$0.66/bu increase of expected futures price		$1.24/bu decrease of 2008 MYA price		$1.24/bu increase of CCP target price	
	WTP	Cost	WTP	Cost	WTP	Cost	WTP	Cost
Traditional	27.1	27.0	26.8	26.8	27.1	27.0	50.3	49.9
ACRE	50.3	49.0	26.8	26.2	27.1	26.6	50.3	49.0

Figure 1. Indiana State and Clinton County Corn Yield from 1930 to 2008



Appendix

State and county yields are modeled using the following equation:

$$\ln Y_j = \alpha_0^j + \alpha_1^j t + \alpha_2^j t^2 + \varepsilon_j ,$$

where Y indicates corn yield, t indicates adjusted time data and j represents county (i=C) or state (i=S) level yield. Table A.1. shows parameter estimations of state and county trends.

Table A.1. Parameter estimation of county and state trend

Data	Parameter	Estimation	P-value
County	α_0^c	3.54	<.0001
	α_1^c	0.029	<.0001
	α_2^c	-0.00011	0.0085
State	α_0^s	3.38	<.0001
	α_1^s	0.032	<.0001
	α_2^s	-0.00014	<.0001

Farm yield is assumed to follow county yield trend and detrended residuals are estimated using the following equation:

$$e_F^i = \ln Y_F^i - \hat{\alpha}_0^c - \hat{\alpha}_1^c * t - \hat{\alpha}_2^c * t^2 ,$$

where e_F^i is detrended farm residual, and *i* indicates a particular farm sample.

Table A.2 below shows the rankings of fitted distributions for state and county residuals, with parameter estimations:

Table A.2. Ranking of different candidate distributions for aggregate yield residuals and parameter estimations

Distribution		Parameters				KS Test	P-value
		Alpha	Beta	Max	Min		
Beta	State	13.64	2.72	0.25	-1.26	0.059	0.93
	County	7.81	1.73	0.25	-1.13	0.051	0.98
		Shape	Scale	Shift			
Weibull	State	73.80	7.95	-7.89		0.82	0.069
	County	NA	NA	NA		NA	NA
		Location	Scale				
Logistic	State	0.011	0.075			0.092	0.49
	County	0.017	0.089			0.075	0.74
		Mean	SD				
Normal	State	0	0.14			0.12	0.20
	County	0	0.16			0.10	0.35

Below are equations of price difference models and their parameter estimations:

$P_L = \beta_0 + \beta_1 P_{FU} + \varepsilon$, and $P_{MYA} = \delta_0 + \delta_1 P_{FU} + \nu$

Normality tests suggest residuals from both models are normally distributed. In Table A.3, parameters of two price difference models are summarized.

Table A.3. Summary of mean and variance of simulated stochastic futures price, local price and MYA price, and parameters of two price difference models

	Parameters	P-value
P_L	β_0 = -0.090	0.40
	β_1 = -0.97	<0.0001
P_{MYA}	δ_0 =0.081	0.66
	δ_1 =0.93	<0.0001