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Abstract

A primary change to crop insurance contained in the USDA's Farm Bill Proposal is Supplemental Deductible Coverage (SDC). SDC would allow farmers who purchase individual crop insurance coverage to purchase GRP in the amount of the individual policy deductible. GRP indemnities would be accelerated compared with the current GRP policy. Analysis indicates that SDC provides substantial benefits in terms of certainty equivalent gains. The largest benefits are realized by low risk farmers, compared to others in the county, and farmers whose yields are highly correlated with the county yield. Optimal individual policy coverage levels generally decrease when SDC is taken.

Keywords: Crop Insurance, Supplemental Deductible Coverage, Farm Bill

Economic Analysis of Supplemental Deductible Coverage as Recommended in the USDA's 2007 Farm Bill Proposal

The Administration recently released the USDA 2007 Farm Bill Proposal (USDA 2007a). Among its recommendations are several proposed modifications of current crop insurance programs under Title X (USDA 2007b). The first recommendation presented under these is Crop Insurance Supplemental Deductible Coverage. This proposed Supplemental Deductible Coverage would "Allow farmers to purchase supplemental insurance that would cover all or part of their individual policy deductible in the event of a county or area wide loss" (USDA 2007b, p. 151).

Supplemental Deductible Coverage (SDC) would improve the safety net for producers by offering full coverage (100% of the value of expected yield) in the event of a more widespread disaster. Buying the highest currently available coverage level (85%) is relatively expensive, especially in high risk areas, and still requires the farmer to bear the first 15% of any loss, which for some farmers exceeds their profit margin. The hope is that offering SDC will increase the effective coverage taken by Federal Crop Insurance Program participants and thus reduce the need for disaster assistance.

Offering SDC raises several questions. Farmers would likely find such coverage useful, but what types of farmers and in which areas? SDC is targeted at helping "fill the gap" in available insurance coverage for farmers in high risk areas subject to multiple year losses. How effective is SDC as a risk management tool for such farmers? If SDC were offered over a wide region (e.g., the Great Plains states), would farmers in low risk areas also find it valuable or even more valuable than farmers in high risk areas? Besides farmer demand and welfare questions, how would SDC affect farmer behavior? In particular, how would optimal APH coverage levels change when APH is combined with area-wide coverage through SDC? Would offering SDC encourage farmers in high risk areas to farm land they would not otherwise farm or shift their crop allocation to favor one or more crops? If such acreage effects occur, what are the environmental consequences? In addition, SDC raises questions about program efficiency. Specifically, how would SDC affect total crop insurance subsidies, administrative and operating reimbursements to insurance companies, moral hazard, and program fraud and abuse?

To answer some of these questions surrounding SDC, we estimate changes in farmer welfare with each policy (APH alone, GRP alone, APH with SDC, APH with SDC with accelerated payout) under a variety of empirically-based assumptions regarding farm and county yields. This analysis identifies the types of farmers who would find SDC most beneficial, in particular, indicating how much such a program benefits farmers in high risk areas relative to those in low risk areas. In addition, the analysis identifies the preferred coverage level under each policy, to determine how farmers would likely adjust coverage levels if SDC became available. The analysis indicates the regions and crops where farmers would find the proposed SDC most useful, provides monetary estimates of its farmer level benefits, and indicates how farmers would likely use the policy to manage their risk.

Proposed SDC Program Structure

The description of the proposed SDC program structure (USDA 2007b) indicates that the program would be an option to the existing APH yield insurance policy. For this policy, farmers choose an APH coverage level as a percentage of the insured unit's historical average yield, with available coverage levels range from 50% to as high as 85%

in 5% intervals. Under this policy, 100% minus the chosen APH coverage level serves as a deductible to ensure that farmers share in the risk of loss so as to have incentives to use appropriate production practices to mitigate the potential for losses. The proposed SDC would allow insured farmers to buy GRP as a supplement to their APH policy, with a maximum liability for this supplemental coverage equal to their APH deductible. Thus with APH and GRP combined under SDC, the maximum liability for the GRP component would be their APH deductible, which is equal to one minus their APH coverage level multiplied by the product of their APH yield and chosen insurance price guarantee. Thus, the total liability (maximum indemnity) with APH under the SDC option would be 100% of the crop's expected value.

We use the following language from the Farm Bill proposal to construct the specifics regarding the SDC proposal:

> "[I]f the county yield is at or below 70 percent of the county average, producers would receive a payment equal to 100 percent of the loss not covered by the crop insurance payment under their individual policy. If the county yield is between 90 and 70 percent of the county average, the producer would receive a proportional amount of the loss not covered by the crop insurance payment. And if the countywide loss is less than 90 percent, no deductible payment would be triggered." (USDA 2007b, p. 154)

This language implies that a 90% GRP coverage level will be used for SDC; that is the county yield would have to be less than 90% of the GRP expected county yield before an SDC indemnity will be paid. In addition, a more rapid payout of indemnities will be used than is the case for GRP. GRP pays indemnities proportional to the county yield loss, with 100% of the coverage only paid when the county yield is 0, which is a highly unlikely event for most crops in most counties. To improve the effectiveness of SDC coverage, this language indicates that 100% of the SDC liability (the APH deductible) will be paid when the county yield is 70% of the expected county yield (as opposed to 0% for GRP). Figure 1 graphically illustrates the difference between the two indemnity payment schedules—both have the same maximum payout, but this maximum is reached more quickly with the accelerated payment rate.

Indemnities

To clarify the structure of the proposed SDC program, we report equations for farmer indemnities under the different policies analyzed. The farmer indemnity ($/ac) with APH ($I_{aph}$) is

(1) $$I_{aph}(CL_{aph}) = \max(CL_{aph}\mu_f - y_f, 0)P_{aph},$$

where CL_{aph} is the chosen APH coverage level, μ_f is the farm unit's mean yield as determined from the unit's actual production history, y_f is the realized farm unit yield, and P_{aph} is the APH price determined by the RMA and used to value yield losses.[1] The APH coverage level CL_{aph} is a percentage of the farm unit's average yield (μ_f) chosen by the farmer as the unit's yield guarantee. Available coverage level options are 50% to 85% in 5% increments. Hence, $CL_{aph}\mu_f$ in equation (1) is the farm unit's per acre yield guarantee and the expression in the max(·) operator determines the unit's per acre yield loss relative to this guarantee. Finally, this loss is valued at the established price P_{aph} for paying indemnities.

The farmer indemnity ($/ac) with GRP ($I_{grp}$) is

(2) $$I_{grp}(CL_{grp}) = MaxProt_{grp} \max\left(\frac{CL_{grp}\mu_c - y_c}{CL_{grp}\mu_c}, 0\right),$$

where $MaxProt_{grp}$ is the GRP maximum protection per acre ($/ac) established by the RMA (equal to the policy's maximum liability), CL_{grp} is the GRP coverage level, μ_c is the county mean yield, and y_c is the realized county yield. The GRP coverage level CL_{grp} is a percentage of the county average yield (μ_c) chosen by the farmer as the yield guarantee or trigger for paying indemnities. For GRP, multiple coverage level options are available, but SDC will use an indemnity trigger equivalent to the 90% GRP coverage level. In equation (2), $CL_{grp}\mu_c$ is the GRP per acre county yield guarantee based on the coverage level chosen, the expression in the max(·) operator is the percentage yield loss (i.e., the percentage that the observed county yield falls below the county yield guarantee), and the indemnity is the product of this percentage loss and the total liability $MaxProt_{grp}$.[2]

The per acre farmer indemnity for APH combined with SDC coverage with a standard GRP payment rate (I_{sdc_stnd}) is

$$(3) \qquad I_{sdc\_stnd}(CL_{aph}) = I_{aph}(CL_{aph}) + D_{aph}(CL_{aph})\max\left(\frac{0.9\mu_c - y_c}{0.9\mu_c}, 0\right),$$

where $D_{aph}(CL_{aph}) = (1 - CL_{aph})\mu_f P_{aph}$ is the APH deductible (\$/ac) as a function of the APH coverage level. Equation (3) is the APH indemnity plus a GRP-based indemnity using a 90% GRP coverage level trigger, but with the APH deducible (D_{aph}) replacing the GRP maximum protection per acre ($MaxProt_{grp}$). APH combined with SDC coverage with a standard GRP payment rate is not the policy proposed in the USDA's 2007 Farm Bill, but is analyzed here as a useful counterfactual for comparison.

The per acre farmer indemnity for APH combined with SDC coverage with an accelerated GRP payment rate (I_{sdc_accl}) is

$$(4) \qquad I_{sdc\_accl}(CL_{aph}) = I_{aph}(CL_{aph}) + D_{aph}(CL_{aph})\min\left(\max\left(\frac{0.9\mu_c - y_c}{0.9\mu_c - 0.7\mu_c}, 0\right), 1.0\right),$$

where all variables are as previously defined. Equation (4) is the APH indemnity plus a modified GRP indemnity. Again, a 90% GRP coverage level is used and the APH deducible replaces the GRP maximum protection per acre. However, the GRP percentage yield loss (the term in the max(·) operator) is calculated as a percentage of $0.9\mu_c - 0.7\mu_c$, not the county yield guarantee of $0.9\mu_c$. Since the term in the denominator in equation (4) is smaller than in equation (3), the percentage yield loss in equation (4) is larger than in equation (3), so indemnities are larger. However, the percentage yield loss is no longer limited to be less than 100%, so the min(·) operator limits the percentage yield loss used to pay indemnities to 100%. Figure 1 illustrates the difference between the GRP-based components of the SDC indemnity in equation (3) and equation (4). Also, to follow the USDA's 2007 Farm Bill proposal, equation (4) uses 70% of the county expected yield as the level at which the GRP component pays 100% of the APH deductible; other percentages are possible, but not examined here.

Conceptual Framework and Analytical Methods

The analysis goal is to determine how combining SDC with APH affects farmer welfare as measured by changes in certainty equivalents ($/ac) and farmer behavior as indicated by changes in optimal APH coverage levels. Here we explain our modeling approach and its empirical implementation. We first specify a parametric model of correlated county and farm yields, as well as farmer revenue and utility. Next, we describe empirical implementation of Monte Carlo integration for calculating expected utility and actuarially fair premiums. Finally, we specify the farmer's optimization problem—choosing the APH coverage level to maximize the expected utility of revenue from crop production, and then explain how the solutions will be used to examine the effects of SDC on farmer welfare and optimal APH coverage levels.

County and Farm Yields

An important aspect of this analysis is how farm yields related to county yields, since the GRP-based component of SDC is based on the county yield. The overall goal is to understand what portion of the farm variability is due to idiosyncratic effects and what portion is systemic. Several approaches have been developed for modeling the connection between county and farm yields. Recently, Deng et al. (2007) describe a multiplicative model in which the farm yield is some random proportion of the realized county yield. In this case, the mean of this random proportion determines the farm mean yield relative to the county yield while the variance of this random proportion partially determines the proportion of the farm variability due to idiosyncratic effects. More commonly used is an additive model in which the farm yield is the product of a constant factor and the realized county yield plus some random idiosyncratic error. Originally described by Miranda (1991) to examine area yield crop insurance (e.g., GRP), Atwood et al. (1996) used the model to develop premiums for income protection, Carriquiry et al. (2005) used it to propose improvements for making APH premiums, and Ramaswami and Roe (2004) derived its micro-production function foundations.

Without actual farm unit yield histories from crop insurance policies available for use, we did not pursue a multiplicative or additive model to connect farm and county yields. Rather, we used a parametric approach, specifying commonly used probability distributions for county and farm yields (Goodwin and Ker, 2002), and captured different relative levels of systemic and idiosyncratic yield variability by varying the correlation between county and farmer yields. The implication is that farm and county yields have a joint distribution in which the two marginal distributions and their correlation are known. Hence, the final stochastic model of farm and county yields is specified by five parameters—the mean and standard deviation of both farm and county yields and the correlation (or covariance) between farm and county yield.

For empirical analysis, we use a lognormal distribution for county yield, an assumption consistent with the analysis of Deng et al. (2007). An important advantage of the lognormal distribution is that when simulating county yields, negative realizations are not possible. In high risk counties with relatively low mean county yields and high standard deviations, the likelihood of negative county yields is not negligible for a normal distribution, so that ad hoc fixes would be required for simulated yields. For each county examined, the mean county yield is set equal to the 2007 expected county yield for GRP as published in the official actuarial documents for each county (USDA-RMA 2007a). The standard deviation for each county was calibrated so that the actuarially fair premium rate for the simulated county yields with 90% GRP coverage matched the published unsubsidized GRP rate for 90% coverage as published in the official actuarial documents for each county (USDA-RMA 2007a). Table 1 lists the resulting means and standard deviations of county yield for the four counties examined here (as well as the APH price and GRP maximum protection per acre). Tripp County, South Dakota and Hamilton County, Iowa respectively represent a high risk and a low risk county for producing corn, while Andrews County, Texas and Coahoma County, Mississippi respectively represent a high risk and a low risk county for producing cotton.

For empirical analysis, we use a beta distribution for farm unit yields, a common assumption (Goodwin and Ker (2002) review several examples). For each county, we examine results for two types of producers—farmers with mean yield 25% below the county average yield and farmers with mean yield 25% above the county average yield. The standard deviations for farm yield were calculated so that the implied coefficient of variation for the farm yield was 150% of the coefficient of variation for county yield. Finally, since the beta distribution requires specifying the minimum and maximum, we follow Babcock et al. (2004) and set minimum yield to zero and maximum yield to the mean plus two standard deviations. Table 1 reports the resulting means and standard deviations of farm yield for farms with below average and with above average yields in the four counties examined here. The resulting distributions of farm yield are generally consistent with published results for dryland production of corn and cotton (e.g., Coble, Heifner and Zuniga 2000; Coble, Zuniga, and Heifner 2003; Hennessy et al. 1997).

The final parameter needed to specify the relationship between farm and county yields is their covariance. Little published data regarding observed farm and county yield covariances for a range of crops and counties exists (e.g., Hennessy et al. (1997) report 0.8 as the average correlation for ten farms for a single crop in a single county). As a result, we selected three levels for Pearson's correlation coefficient between farm and county yields (0.3, 0.6, 0.9) as examples of farms with low, moderate and high yield correlation with the county yield to capture a wide range of correlations.

Farmer Revenue and Insurance Premiums

For this analysis, farm revenue is crop revenue (the product of the non-random price and random yield) plus the indemnity minus the premium, where both the indemnity and premium depend on the chosen APH coverage level. We do not include non-random production costs given the difficulty in consistent estimation of such costs for different types of producers in different counties across states. However, the empirical analysis is constructed so that results can be easily adjusted to include cost differences for those who wish to do so. Thus, farmer returns ($/ac) for insurance program $i \in \{none, aph, grp, sdc\_stnd, sdc\_accl\}$ are

$$(5) \qquad \pi_i(CL_{aph}) = P_{aph}y_f + I_i(CL_{aph}) - M_i(CL_{aph}),$$

where $M_i(CL_{aph})$ is the per acre farmer premium for insurance program i as a function of the APH coverage level. The subscript *none* implies no insurance with I_{none} and M_{none} equal zero. The analysis uses a non-random price to focus only on yield risk and uses the published APH price for all crops and policies as an easily available estimate of the expected crop price at harvest. Indemnities for each insurance policy are as defined by equation (1)-(4), but premiums remain undefined.

For farmer premiums, we analyze these insurance policies using actuarially fair premium rates generated as the expected value of the indemnity derived through the Monte Carlo integration process. Premiums currently include subsidies so that farmers pay less than what the RMA considers actuarially fair. Table 2 reports the current premium subsidy rates for all APH and GRP coverage levels. Since these premium subsidies are included in all current actual premiums, we use these same subsidy rates in our analysis. Since indemnities for SDC combined with APH are a combination of APH and GRP-based indemnities, premiums for APH combined with SDC use the APH subsidy rate for the APH portion of the premium and the 90% GRP subsidy rate for the

SDC portion of the premium. Since all crop insurance premiums are currently subsidized, we do not report results for unsubsidized premiums.

As previously explained, the county yield standard deviations were calibrated so that the simulated fair GRP premium rate matched the actual GRP rate. Thus by construction, our subsidized SDC premiums are equal to actual 90% coverage GRP premiums with the maximum protection per acre equal to the APH deductible. However, for SDC with an accelerated payment rate, the available GRP premium information does not allow calibration of simulated premiums to equal published premiums. Therefore, premium rates for the accelerated coverage were derived through Monte Carlo integration using the modified accelerated indemnity function reported in equation (4). APH premiums used in the analysis were also derived through the Monte Carlo integration, based on the assumption that the farm yield coefficient of variation is equal to 150% of the county yield coefficient of variation derived from the unsubsidized GRP premium rate for 90% coverage.

Farmer Utility

As an approximation of farmer risk preferences, we use a negative exponential utility function. Because negative exponential utility implies constant absolute risk aversion (CARA), the analysis does not require assumptions concerning farmer wealth or income from outside activities. Thus, farmer utility from per acre returns for insurance program $i \in \{none, aph, grp, sdc\_stnd, sdc\_accl\}$ is

(6) $U_i(CL_{aph}) = 1 - \exp(-R\pi_i(CL_{aph}))$,

where R is the coefficient of absolute risk aversion and π_i is as defined by equation (5). Following the lead of Babcock et al. (1993), the coefficient R for the empirical analysis was calibrated for each parameter set examined so that the implied farmer risk premium with no insurance was equal to 30% of the returns standard deviation. The resulting values for R are reported in Table 1 for farms with mean yields 25% above and 25% below the county mean.

Farmer expected utility for each policy is the expected value of equation (6):

$$EU_i(CL_{aph}) = \text{E}[1 - \exp(-R\pi_i(CL_{aph}))] = \int_{\pi} 1 - \exp(-R\pi_i(CL_{aph}))dF(\pi_i \,|\, CL_{aph}), \tag{7}$$

where $F(\pi_i|CL_{aph})$ is the cumulative distribution function of random farmer returns for the given APH coverage level. As equation (5) indicates, π_i is a transformation of farm yield y_f both directly through $P_{aph}y_f$ and indirectly through the indemnity, so that for most of the polices analyzed, the actual conditional distribution function $F(\pi_i|CL_{aph})$ is generally difficult to express due to the farm and county yield distributions used and the truncated nature of insurance indemnities. Furthermore, the transformation of returns π_i by the utility function creates additional nonlinearity so that closed-form analytical solutions for expected utility do not exist for any of the policies analyzed. As a result, numerical methods are needed to calculate expected utility; for the analysis here, we use Monte Carlo integration.

Empirical Implementation

Monte Carlo integration is a widely used technique to approximate multiple integrals of complex functions. Greene (2003) provides an overview of the methodology, with numerous applications in agriculture and crop insurance available (e.g., Hennessy et al. 1997; Hurley et al. 2004; Mitchell et al. 2004; Seo et al. 2005). Here we use Monte Carlo integration to approximate the integration required to calculate the expected utility as expressed in equation (7) and to calculate actuarially fair premiums equal to the expected value of the appropriate indemnities.

The basic intuition of the method is that the expected value of a complex function of random variables is approximated by drawing pseudo-random numbers from the appropriate distributions, transforming these draws with the same function, and then calculating the sample average. More formally, if x is a vector of random variables from some joint distribution and $g(\cdot)$ is a vector valued function, then the expected value of $g(x)$ is approximately $E[g(x)] \cong \sum_{k=1}^{K} g(x_k)/K$, where x_k is a pseudo-random draw of x and K is the total number of such pseudo-random draws. As K becomes large, the approximation converges. The key for empirical implementation is generating pseudo-random variables from the appropriate distributions.

For the empirical analysis here, the fundamental random variables are county and farm unit yields; all other random variables are functions of these two random variables and other parameters. A set of pseudo-random draws for a single variable can be generated using the inverse distribution function technique, which begins with a set of uniform random draws and transforms each draw through the inverse of the cumulative distribution function. Random draws for multiple random variables from different distributions can be generated by beginning with separate sets of uniform random variables. For the application here, the inverse of the lognormal and the beta distribution functions are needed to generate yields. The empirical problem for the analysis here is that county and farm yields need to be appropriately correlated.

For the analysis here, we use the method of Richardson and Condra (1981) explained in more detail by Fackler (1991), to draw vectors of county and farm yields with the desired correlation. In brief, the method begins with two vectors of independent standard normal random variables. Multiplying these by the Cholesky decomposition of the desired variance-covariance matrix gives correlated normal random variables, which are transformed to correlated uniform random variables using the normal cumulative distribution function. Finally, these correlated uniform random variables are transformed to yields with the correlation implied by the original variance-covariance matrix using the appropriately parameterized inverse of the required cumulative distribution function (lognormal for county yield, beta for farm yield). See Goodwin and Ker (2002) for an overview of empirical methods used for generating correlated random variables, including a discussion of the merits and weaknesses with the method used here.

The Monte Carlo integration for this analysis was implemented in Microsoft Excel 2003. Standard normal random variables were generated using the data analysis tool provided with the software and transformations were calculated using the software's distribution and inverse distribution functions. Experimentation indicated that 10,000 random draws were sufficient for results to converge.

Analyzing Supplemental Deductible Coverage

The analysis assumes farmers behave optimally and choose the APH coverage level that maximizes their expected utility. Mathematically, the farmer's problem is:

(8) $$\max_{CL_{pah}} EU_i(CL_{aph}) = \max_{CL_{aph}} \int_{\pi} 1 - \exp(-R\pi_i(CL_{aph}))dF(\pi_i \mid CL_{aph}),$$

where $CL_{aph} \in$ {0%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%} is the farmer's choice variable. CL_{aph} = 0% is no insurance (i = *none*) when examining the current APH policy alone (i = *aph*) and is 90% GRP coverage (i = *grp*) when examining either of the SDC policies (i = *sdc_stnd* or i = *sdc_accl*). This choice set for CL_{aph} collapses the five insurance policies into three scenarios to analyze: APH alone (i = *aph*), APH combined with SDC using a standard GRP payment rate (i = *sdc_stnd*), and APH combined with SDC using an accelerated GRP payment rate (i = *sdc_accl*). Simulations were conducted for all possible APH coverage levels and a simple search identified the optimal APH coverage level ($CL^*_{aph\_i}$) and associated optimal expected utility (EU^*_i) for each of these three scenarios. Next, these optimal expected utilities were converted into the associated optimal certainty equivalents ($/ac) for each scenario:

(9) $$CE^*_i = -\ln(1 - EU^*_i)/R.$$

Figure 2 illustrates sample results for Tripp County South Dakota and Hamilton County Iowa under the specifics indicated by the figure legend. The three lines in each plot indicate farmer certainty equivalents for all APH coverage levels for each scenario as labeled. From the data used to generate these plots, the optimal APH coverage level ($CL^*_{aph\_i}$) and associated optimal certainty equivalent (CE^*_i) was identified for the three scenarios for each parameterization. The vertical gap between the three lines is the increase in farmer certainty equivalents when a farmer switches from APH alone to APH with SDC with a standard or with an accelerated payment rate. Because so many parameterizations were analyzed, to conserve space, the optimal coverage levels and certainty equivalents for each parameterization are not reported, but are available on request from the authors.

The presentation of results focuses on changes in optimal coverage levels and certainty equivalents between the scenarios to provide monetary estimates of the farmer level benefits of SDC and to determine how farmers would likely adjust APH coverage levels if SDC became available. Changes in optimal certainty equivalents between using the current APH policy alone and either APH combined with SDC using a standard GRP payment rate or with SDC using an accelerated GRP payment rate are estimates of the farm level benefits of the proposed SDC policy. Changes in the optimal APH coverage levels between the current APH policy alone and either APH combined with SDC using a standard GRP payment rate or with SDC using an accelerated GRP payment rate indicate how farmers would likely adjust APH coverage levels if SDC became available.

Results

Table 3 reports the increase in farmer certainty equivalents (as $/ac and as a percentage) when switching from using APH alone to using APH combined with either SDC using the standard GRP payment rate or the accelerated payment rate. Table 4 reports the decrease in the optimal APH coverage level associated with switching from APH alone to APH combined with either type of SDC examined. Based on the results in these tables, we draw several generalizations regarding the effect of SDC as proposed in the USDA's 2007 Farm Bill.

Farmer Benefits from SDC

For all cases in Table 3, SDC generates positive benefits relative to APH alone, implying that all farmers would find some benefit from SDC. We focus initially on results with the accelerated payment rate, as this is the proposed program. In Tripp County, SDC generates a substantial benefit for corn farmers, with benefits ranging from over $6/ac to almost $19/ac with the accelerated payment rate; benefits in Hamilton County are smaller, ranging $5/ac to $16/ac. The relative benefit of SDC in Tripp County is also much larger, since Tripp County is less productive; SDC increases farmer certainty equivalents 4% to almost 8% there, but only 1% to 2% in Hamilton County. SDC with the accelerated payment rate generates benefits ranging about $8/ac to $24/ac in Andrews County and Coahoma County, with comparable benefits essentially equal in both counties. However, since Andrews County is less productive, the relative benefit is larger, implying a 7% to 12% increase in certainty equivalents, versus a 2% to 4% increase in Coahoma County. Farmer benefits from SDC with the standard payment rate are lower, indicating the essential nature of the accelerated payment rate in order for SDC to generate a significant farmer benefit. Farmer benefits with the standard payment rate are less than $3.50/ac for the corn cases examined and less than $7.40/ac for the cotton cases examined.

In Table 3, high risk farmers (those with a mean yield 25% below the county mean) receive smaller benefits than low risk farmers (those with a mean yield 25% above the county mean) in the same county. This generalization holds for all cases examined with the accelerated payment rate, with the $/ac benefit decreasing for high risk farmers enough so that the percentage increase in farmer certainty equivalents is essentially the same for low and high risk farmers with the same farm-county yield correlation in the same county. However, exceptions to this generalization occur in Table 3 for farmers with yields highly correlated with the county yield (ρ_{fc} = 0.90); in these cases, low risk farmers tend to realize larger percentage increases in certainty equivalents.

In Table 3, as the farm-county yield correlation increases, the benefits from SDC increase, since SDC indemnities are more likely to coincide with poor farm yield performance. As the yield correlation increases, farmers with higher mean yields receive greater benefits than those with lower mean yields, since the overall value of production increases. Finally, with the accelerated payment rate, benefits for cotton farmers are larger than for comparable corn farmers, ranging $2 to $8 more per acre. With the standard payment rate, benefits for corn and cotton farmers are generally similar, though benefits for cotton farmers always exceed those for comparable corn farmers.

Effect of SDC on Optimal APH Coverage Levels

The coverage offered by SDC not only complements APH coverage, which increases the farmer's certainty equivalent as seen in Table 3, but SDC also substitutes for APH, which can imply a reduction in the optimal APH coverage level. Thus, for all cases in Table 4, the optimal APH coverage with SDC either decreases or remains unchanged—the optimal APH coverage level never increases when APH is combined with SDC. The decrease is as large as 35 percentage points with the accelerated payment rate (i.e., a shift from the 85% to the 50% coverage level). With the standard payment rate, the optimal coverage level generally decreases no more than 5 percentage points, except for a few cases when it becomes optimal to discontinue APH (0% APH coverage level) and use GRP.

With the accelerated payment rate, a farm's mean yield has no effect on the decrease in the optimal APH coverage level for all cases in Table 4 within the same county with the same farm-county yield correlation. Indeed, though not reported here, with the accelerated payment rate the optimal APH coverage level in a county does not change with the farm's mean yield. Comparing across crops and counties, the coverage level decrease in Tripp and Hamilton counties shows a larger decrease in Tripp, while the decrease is about the same in Andrews and Coahoma counties.

As the farm yield becomes more correlated with the county yield, the effectiveness of SDC as a substitute for APH increases and so the optimal APH coverage level with SDC should decrease or remain unchanged. This shift in optimal APH coverage occurs for all cases examined in Table 4. With the accelerated payment rate, the optimal coverage level decreases 25 to 35 percentage points for a farm with a farm-county yield correlation of 0.9 compared to 0.3. Indeed, though not reported, for all cases examined, the optimal APH coverage level for SDC with the accelerated payment rate is 50% if the yield correlation is 0.9.

Discussion and Conclusions

Our results indicate that SDC, as structured under the USDA Farm Bill Proposal, has substantial welfare benefits for all of the farms analyzed. A key provision of the proposal giving rise to those benefits is the accelerated indemnity schedule for the supplemental GRP portion of the coverage. Benefits are positive but modest in magnitude under standard GRP but are much larger with the accelerated indemnity function. Other primary results can be summarized as follows.

- Within a county, benefits of SDC are larger for low risk farmers than for high risk farmers. This might be viewed as a positive attribute of SDC since some other aspects of the crop insurance program, such as proportional premium subsidies, can be viewed as more beneficial to high risk farmers.
- SDC offers larger benefits for farms with yields that are highly correlated with the county yield. Thus, the demand for the coverage would likely be

greater in regions where systemic risks account for a large proportion of total yield risk.

- In most cases, with the accelerated payment rate, optimal APH coverage levels decrease modestly — 5% to 10% — when SDC is taken. However, the decrease in APH coverage is in the 30% to 35% range for farms with yields that are highly correlated with the county yield.

The results of our analysis should prove useful to policy makers in understanding the potential contribution of SDC to the overall effectiveness of the Federal Crop Insurance Program. One other beneficial aspect of SDC that should be noted is that the shift from individual coverage to area coverage would reduce the potential for moral hazard, fraud, and program abuse because a smaller proportion of total program liability would be for individual coverage and because these problems are believed to be less serious when coverage levels on individual coverage are lower.

Endnotes

1. Farmers have the option of insuring at less than 100% of the RMA determined expected price but insurance program experience has shown that the vast majority of participants choose coverage based on the maximum available price election.

2. Here we assume that the producer takes the GRP maximum protection per acre published in the RMA county actuarial documents. Producers are allowed to choose amounts of coverage per acre less than this value, but most GRP participants choose to insure the maximum protection per acre.

Table 1. Parameters used for empirical analysis of supplemental deductible coverage.

Parameter	---------- Corn ---------- Tripp, SD	Hamilton, IA	---------- Cotton ---------- Andrews, TX	Coahoma, MS
County Mean μ_c	56.9	176.4	302	852
County St. Dev. σ_c	18.60	28.28	132.0	212.1
County CV	32.7%	16.0%	43.7%	24.9%
APH Price P_{aph}	$3.50/bu	$3.50/bu	$0.52/lb	$0/53/lb
GRP Maximum Protection per acre $MaxProt_{grp}$	$251.78	$780.57	$244.62	$690.12
Farm Mean 25% Below County Mean				
Farm Mean μ_c	43.0	132.0	227.0	639.0
Farm St. Dev. σ_c	21.1	31.7	148.8	238.6
Farm CV	49.1%	24.0%	65.6%	37.3%
Coefficient of Absolute Risk Aversion R	0.00833	0.00497	0.00843	0.00466
Farm Mean 25% Above County Mean				
Farm Mean μ_c	71.0	221.0	378.0	1065.0
Farm St. Dev. σ_c	34.8	53.1	247.8	397.7
Farm CV	49.0%	24.0%	65.6%	37.3%
Coefficient of Absolute Risk Aversion R	0.00505	0.00297	0.00506	0.00279

Table 2. Current premium subsidy rates for federal crop insurance policies.

Coverage Level	APH Subsidy Rate	GRP Subsidy Rate
50%	67%	---
55%	64%	---
60%	64%	---
65%	59%	---
70%	59%	64%
75%	55%	64%
80%	48%	59%
85%	38%	59%
90%	---	55%

Table 3. Net benefit of SDC with a standard and with an accelerated payment rate, measured as the increase in farmer certainty equivalents ($/ac) relative to APH alone.

County	Mean Yield*	ρ_{fc}	Standard Rate		Accelerated Rate	
Tripp	25% Below	0.3	1.37	0.9%	6.27	4.2%
		0.6	1.68	1.1%	7.99	5.3%
		0.9	1.92	1.3%	11.13	7.4%
	25% Above	0.3	2.28	0.9%	10.38	4.2%
		0.6	2.75	1.1%	13.17	5.3%
		0.9	3.21	1.3%	18.73	7.6%
Hamilton	25% Below	0.3	1.25	0.3%	5.00	1.1%
		0.6	1.53	0.3%	6.24	1.3%
		0.9	3.36	0.7%	9.87	2.1%
	25% Above	0.3	2.09	0.3%	8.38	1.1%
		0.6	2.59	0.3%	10.46	1.3%
		0.9	3.02	0.4%	16.19	2.1%
Andrews	25% Below	0.3	1.89	1.6%	8.23	7.0%
		0.6	2.21	1.9%	10.36	8.8%
		0.9	5.59	4.8%	14.33	12.2%
	25% Above	0.3	3.15	1.6%	13.69	7.0%
		0.6	3.66	1.9%	17.25	8.8%
		0.9	4.13	2.1%	24.10	12.3%
Coahoma	25% Below	0.3	1.90	0.6%	8.16	2.4%
		0.6	2.23	0.7%	10.32	3.1%
		0.9	7.39	2.2%	14.48	4.3%
	25% Above	0.3	3.17	0.6%	13.62	2.4%
		0.6	3.72	0.7%	17.18	3.1%
		0.9	4.19	0.7%	24.28	4.3%

*Relative to county mean.

Table 4. Percentage point decrease in the optimal APH coverage level with SDC relative to APH alone with the standard and with an accelerated SDC payment rate.

County	Mean Yield*	ρ_{fc}	Standard Rate	Accelerated Rate
Tripp	25% Below	0.3	5%	10%
		0.6	5%	10%
		0.9	5%	35%
	25% Above	0.3	5%	10%
		0.6	5%	10%
		0.9	5%	35%
Hamilton	25% Below	0.3	0%	0%
		0.6	0%	0%
		0.9	85%	35%
	25% Above	0.3	0%	0%
		0.6	0%	0%
		0.9	0%	35%
Andrews	25% Below	0.3	0%	5%
		0.6	0%	10%
		0.9	80%	30%
	25% Above	0.3	0%	5%
		0.6	0%	10%
		0.9	0%	30%
Coahoma	25% Below	0.3	0%	5%
		0.6	0%	5%
		0.9	85%	35%
	25% Above	0.3	0%	5%
		0.6	0%	5%
		0.9	0%	35%

*Relative to county mean.

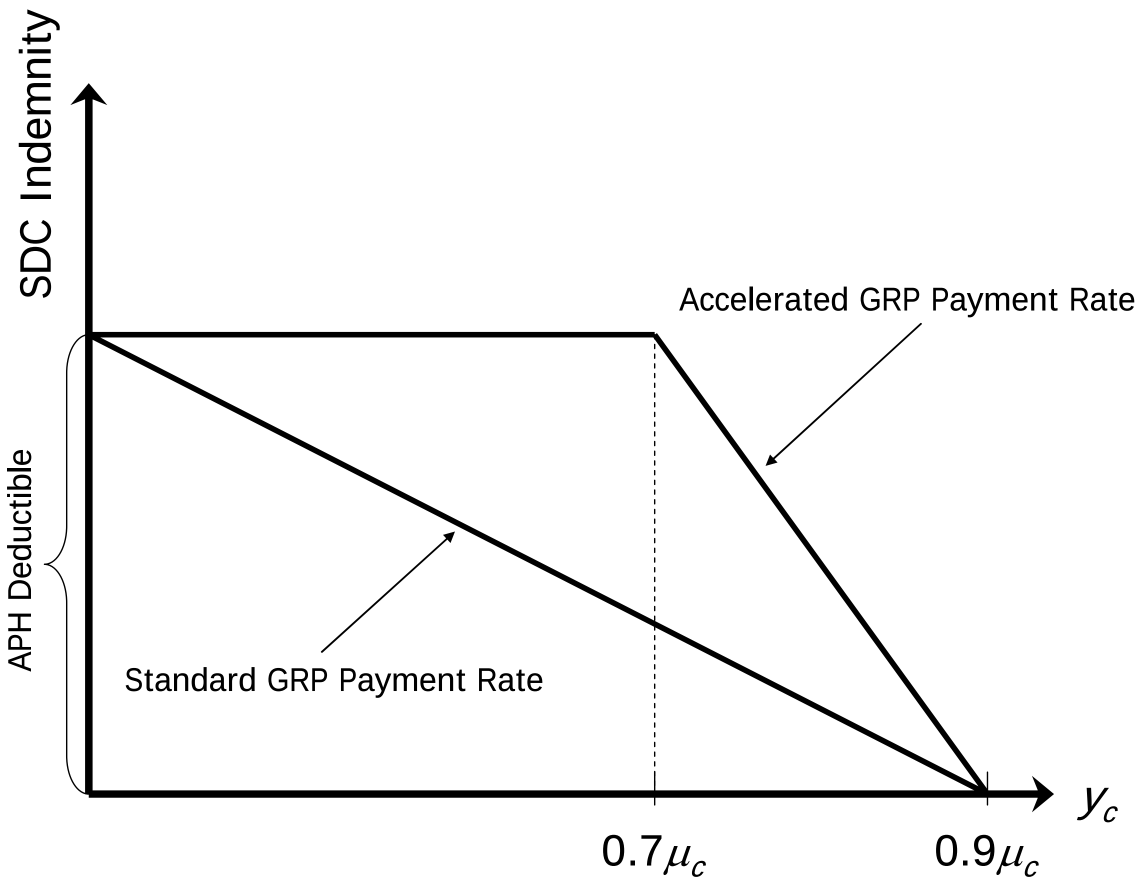

Figure 1. SDC indemnities plotted versus county yield with a standard GRP payment rate and with an accelerated payment rate.

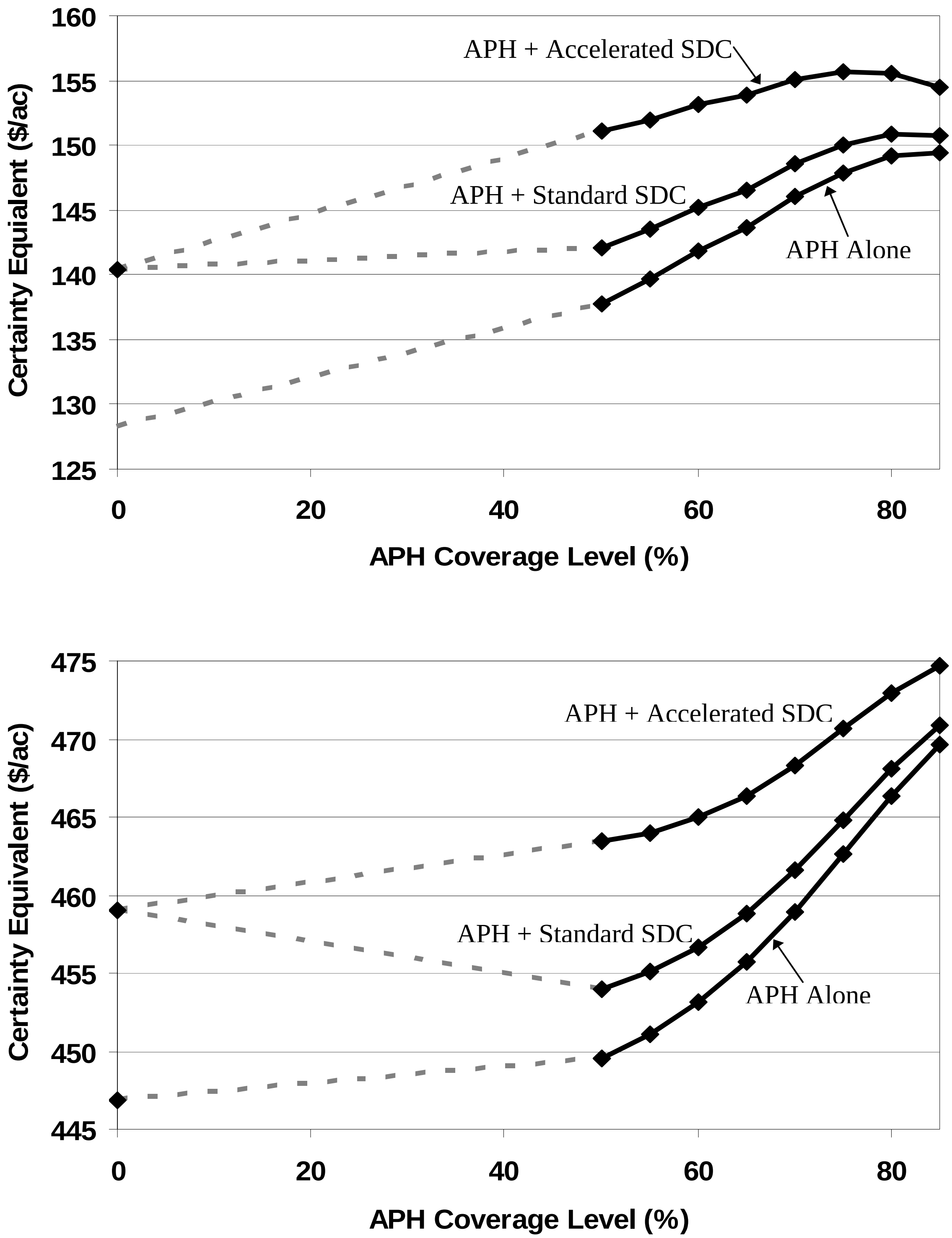

Figure 2. Certainty equivalent returns for corn in Tripp County South Dakota (top) and Hamilton County Iowa (bottom) for the three insurance scenarios (with fair subsidized premiums, farm mean 25% below county average, and county-farm correlation of 0.3).

References

Atwood, J., A. Baquet, and M. Watts. 1996. Income Protection. Technical Report, Montana State University. Submitted to the U.S. Department of Agriculture, Economic Research Service, Commercial Agricultural Division. February 16. http://www.rma.usda.gov/pilots/miscproj/techsum.pdf.

Babcock, B., E. Choi, and E. Feinerman. Risk and Probability Premiums for CARA Utility Functions. *Journal of Agricultural and Resource Economics* 18:17-24.

Babcock, B., C. Hart, and D. Hayes. 2004. Actuarial Fairness of Crop Insurance with Constant Rate Relativities. *American Journal of Agricultural Economics* 86:563-575.

Carriquiry, M., B. Babcock, and C. Hart. 2005. Using a Farmer's Beta for Improved Estimation of Actual Production History (APH) Yields. Working Paper 05-WP-387, Center for Agricultural and Rural Development, Iowa State University, Ames, IA. http://www.card.iastate.edu/publications/DBS/PDFFiles/05wp387.pdf.

Coble K.H., M. Zuniga, and R. Heifner. 2003. Evaluation of the Interaction of Risk Management Tools for Cotton and Soybeans. *Agricultural Systems* 75:323-340.

Coble, K., R. Heifner, and M. Zuniga. 2000. Implications of Crop Yield and Revenue Insurance for Producer Hedging. *Journal of Agricultural and Resource Economics* 25:432-452.

Deng, X., B. Barnett, and D. Vedenov. 2007. Is There a Viable Market for Area-Based Crop Insurance? *American Journal of Agricultural Economics* 89:508-519.

Fackler, P. 1991. Modeling Interdependence: An Approach to Simulation and Elicitation. *American Journal of Agricultural Economics* 73:1091-1097.

Goodwin, B.K., and A.P. Ker. 2002. Modeling Price and Yield Risk. In *A Comprehensive Assessment of the Role of Risk in U. S. Agriculture*. R. E. Just and R. D. Pope, eds., pp. 289-323. Boston, MA: Kluwer Academic Press.

Greene, W. 2003. *Econometric Analysis*, 5th ed. Upper Saddle River, NJ: Prentice Hall.

Hennessy, D., B. Babcock, and D. Hayes. 1997. Budgetary and Producer Welfare Effects of Revenue Insurance. *American Journal of Agricultural Economics* 79:1024-1034.

Hurley, T. M., P. D. Mitchell, and M. E. Rice. 2004. Risk and the Value of Bt Corn. *American Journal of Agricultural Economics* 86:345-358.

Miranda, M. 1991. Area-Yield Crop Insurance Reconsidered. *American Journal of Agricultural Economics* 73:233-242.

Mitchell, P., M. Gray, and K. Steffey. 2004. A Composed Error Model for Estimating Pest-Damage Functions and the Impact of the Western Corn Rootworm Soybean Variant in Illinois. *American Journal of Agricultural Economics* 86:332-344.

Ramaswami, B., and T. Roe. 2004. Aggregation in Area-Yield Crop Insurance: The Linear Additive Model. *American Journal of Agricultural Economics* 86:420-31.

Richardson, J., and G. Condra. 1981. Farm Size Evaluation in the El Paso Valley: A Survival/Success Approach. *American Journal of Agricultural Economics* 63:430-437.

Seo, S., P.D. Mitchell, and D. Leatham. 2005. Effects of Federal Risk Management Programs on Optimal Acreage Allocation and Nitrogen Use in a Texas Cotton-Sorghum System. *Journal of Agricultural and Applied Economics* 37:685-699.

USDA. 2007a. USDA 2007 Farm Bill Proposals by Title. Available online at http://www.usda.gov/wps/portal/usdahome?contentidonly=true&contentid=view_proposals.xml. Accessed February 14, 2007.

USDA. 2007b. USDA 2007 Farm Bill Proposal: Title X Miscellaneous: Summary of Miscellaneous Title Reform. Available online at http://www.usda.gov/documents/07title10.pdf. Accessed February 14, 2007.

USDA-Risk Management Agency. 2007a. Actuarial Documents Browser. Online. Available at http://www.rma.usda.gov/tools/adb.html.