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# The SURE Program and Its Interaction with Other Federal Farm Programs

David Ubilava, Barry J. Barnett, Keith H. Coble, and Ardian Harri

We investigate potential effects of the Supplemental Revenue Assistance Payments (SURE) program introduced in the 2008 Farm Bill. Results suggest little impact on optimal crop insurance purchase decisions, though the SURE program does seem to provide an incentive for mid-level insurance coverage. For producers in the price counter-cyclical payment (PCCP) program, SURE payments are actually higher (lower) when commodity prices are high (low). This is not the case for producers in the Average Crop Revenue Election (ACRE) program.

*Key words:* crop insurance, disaster assistance, farm bill, SURE

## Introduction

In 1887, President Grover Cleveland vetoed an emergency appropriation of \$10,000 for drought victims in Texas. He explained his decision by saying that the federal government had no “. . . warrant in the Constitution . . . to indulge a benevolent and charitable sentiment through the appropriation of public funds . . . [for] relief of individual suffering which is in no manner properly related to the public service” (Barry, 1997, p. 369). Over time, public perceptions of the federal role in disaster relief changed considerably. By the mid-1970s the federal government provided more than 70% of disaster relief funding in the United States (Clary, 1985).

The U.S. government’s role in providing agricultural disaster relief expanded greatly in 1949 when Congress established a program that would provide low-interest loans to individual farmers and ranchers who suffered losses due to natural disasters. Later the secretary of agriculture was given the authority to make direct disaster relief payments to producers who participated in federal price and income support programs. This authority was suspended in 1981 (and by legislation adopted in subsequent years) for all situations where federal crop insurance was available. Due to the widespread availability of federal crop insurance, this implied that future federal agricultural disaster payments would require *ad hoc* authorizing legislation.

Such *ad hoc* legislation became common. Between 1987 and 1994, more than 60% of U.S. farms received federal disaster payments at least once, with many farms receiving payments every year (Barnett, 1999). In some cases the *ad hoc* legislation authorized disaster payments only for specific crops in specific areas that were affected by specific natural disasters. In other cases, the legislation authorized payments for all crops in all areas that had been affected by any disaster (including the explosion of the space shuttle Columbia over Texas in 2003). Payments were also made to livestock producers (primarily for forage losses) and to crop producers who were affected by adverse economic events (e.g. low prices) rather than natural disasters. All of these *ad hoc* payments were funded by off-budget emergency supplemental appropriations.

*Ad hoc* payments were also made in a context of increasing on-budget funding for subsidized crop insurance. Crop insurance reform legislation was adopted in 1980, 1994, and 2000; each time

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the expressed intent was to eliminate or at least reduce the need for *ad hoc* disaster payments (Glauber, 2004). These reforms generally increased crop insurance premium subsidies to stimulate higher levels of participation. As a result the cost of the program to the government (indemnities net of premiums, premium subsidies, and delivery cost) rose considerably.

Despite frequent implementation of *ad hoc* disaster payments, there was no standing program that provided disaster payments to farmers and ranchers in the U.S. after 1981. This changed with passage of the Food Conservation and Energy Act of 2008 (hereafter referred to as the 2008 farm bill) which authorized the Supplemental Agricultural Disaster Assistance (SADA) program. The SADA program is fairly comprehensive, including components to cover losses in crop production (the Supplemental Revenue Assistance or SURE program), livestock mortality due to adverse weather (Livestock Indemnity Payments), forage losses (Livestock Forage Disaster Program), orchard and nursery tree losses (Tree Assistance Program), and other production losses on livestock, honeybees, or farm-raised catfish (Emergency Assistance program).

This paper focuses on the commercial row-crop provisions of the SURE program. The SURE program differs considerably from the standing disaster program that was in place prior to 1981. For example, the pre-1981 program was based on yield losses, whereas the SURE program is based on revenue losses. Also, the pre-1981 program provided compensation for losses on individual crops, while SURE provides compensation based on shortfalls in “whole farm” revenue, including all crops produced on the farm.

To be eligible for SURE payments, farms are required to purchase at least the catastrophic level of federal crop insurance. SURE payments are triggered if the farm is located in or adjacent to a county declared a disaster area (or the farm has a 50% loss) and one crop has a loss of at least 10%. The program will compensate farms for 60% of the difference between their disaster payment program guarantee and their realized total farm revenue. For purposes of this program, realized farm revenue includes market revenue, any crop insurance indemnities, 15% of any federal direct fixed payments, any loan deficiency payments or marketing loan gains, and any federal price-based counter-cyclical payments (PCCP) or revenue-based Average Crop Revenue Election (ACRE) payments.

The research presented here analyzes the impact of the SURE program at the farm level under participation in either the PCCP program or the ACRE program. Specifically, we:

1. Investigate the impact of the SURE program on federal crop insurance purchase decisions;
2. Analyze expected disaster payment benefits for different crops and regions;
3. Analyze expected disaster payment benefits for different degrees of on-farm crop diversification; and
4. Analyze effects of moral hazard behavior on crop insurance purchase decisions.

We hypothesize that expected SURE payments will be lower in regions with lower production risk and lower for more diversified farms (since the payment trigger is based on whole farm revenue, which should be less variable on a diversified operation). Finally, we expect that moral hazard incentives will increase SURE payments. However, the primary question that we intend to answer is whether or not participation in the SURE program will affect optimal crop insurance coverage levels.

### Conceptual Framework

When farmers plant crops, they are making financial investments in a portfolio of enterprises that they hope will generate positive net income. In this sense, farmers are no different than those who invest in stocks, bonds, or other financial assets.

Consider a portfolio consisting of  $n$  different crop enterprises. The expected return on the portfolio is:

$$(1) \quad E(r_{portfolio}) = \sum_{i=1}^n s_i E(r_i),$$

where  $E(r_i)$  is the expected return for crop  $i$ ,  $s_i$  is the proportion of the total value of the portfolio that is in crop  $i$ , and  $\sum_{i=1}^n s_i = 1$ .

For a portfolio consisting of two crops,  $j$  and  $k$ , the variance in returns for the portfolio would be measured as:

$$(2) \quad \sigma_{portfolio}^2 = s_j^2 \sigma_j^2 + s_k^2 \sigma_k^2 + 2s_j s_k \sigma_j \sigma_k \rho_{j,k},$$

where  $\rho_{j,k}$  is the correlation coefficient between returns on crop  $j$  and crop  $k$ . By changing the notation for variance from  $\sigma_{crop}^2$  to  $\sigma_{crop,crop}$ , equation (2) can be generalized to allow for portfolios of  $n$  crops:

$$(3) \quad \sigma_{portfolio}^2 = \sum_{g=1}^n \sum_{h=1}^n s_g s_h \sigma_g \sigma_h \rho_{g,h}.$$

In addition, the farm participates in various available federal programs so the realized stochastic whole-farm annual return,  $R_w$ , is also a function of stochastic crop returns and any payments received from the federal programs. Following standard financial theory, we assume that farmers manage their portfolios by making decisions that weigh expected returns against risk. Specifically, it is assumed that farmers maximize a constant relative risk aversion (CRRA) utility function, which is represented mathematically as:

$$(4) \quad U = \begin{cases} \frac{R_w^{1-\phi}}{1-\phi} & \text{if } \phi \neq 1 \\ \ln(R_w) & \text{if } \phi = 1. \end{cases}$$

The farmer's expected utility is:

$$(5) \quad E(U) = \begin{cases} \sum_{w=1}^n \omega_w \frac{R_w^{1-\phi}}{1-\phi} & \text{if } \phi \neq 1 \\ \sum_{w=1}^n \omega_w \ln(R_w) & \text{if } \phi = 1, \end{cases}$$

where  $\phi$  is the relative risk aversion coefficient and  $\omega_w$  is the probability weight associated with each possible outcome,  $R_w$ .

Federal commodity program payments included in the analysis are Direct Payments (DPs), Loan Deficiency Payments (LDPs), and either Price Counter-Cyclical Payments (PCCPs) or Average Crop Revenue Election (ACRE) revenue counter-cyclical payments. For each program crop, commodity program payments, crop insurance indemnities, and disaster program payments are modeled as follows. The LDP is calculated as:

$$(6) \quad LDP_i = \max\{0, (LR_i - HP_i)\} \times HA_i \times FY_i,$$

Where  $LR_i$  is the loan rate,  $HP_i$  is the harvest time cash price,  $HA_i$  is harvested acres,  $FY_i$  is the realized farm yield, and the subscript  $i$  indicates a specific crop. Consistent with the ACRE program authorizing legislation, the loan rate is reduced by 30% when calculating LDPs for farms enrolled in ACRE. The DP is calculated as:

$$(7) \quad DP_i = DPR_i \times 83.3\% \times BA_i \times BY_i,$$

where  $DPR_i$  is the direct payment rate (specified in the authorizing legislation),  $BA_i$  is the base acreage, and  $BY_i$  is the base yield. For farms enrolled in ACRE, direct payments are reduced by 20% from the value calculated in equation (7). The PCCP is calculated as:

$$(8) \quad PCCP_i = \max\{0, (TP_i - DPR_i - \max(LR_i, MYA_i))\} \times 85\% \times BA_i \times BY_i,$$

where  $TP_i$  is the target price,  $MYA_i$  is the national marketing year average price, and all other variables are as defined previously.<sup>1</sup> ACRE payments are calculated as:

$$(9) \quad ACRE_i = \phi \times 83.3\% \times \left[ \max\{0, (\min\{(0.25 \times SREVB_i), (SREVB_i - SREVA_i)\})\} \times \frac{\overline{FY}_i}{\overline{SY}_i} \times PA_i \right],$$

where  $\phi$  is a dummy variable with a value of one if realized farm revenue is below the farm-level benchmark revenue (which is a product of the Olympic average farm yield over the previous five years and the average marketing year average price over the previous two years plus any crop insurance premium paid) and a value of zero otherwise;  $SREVB_i$  is the benchmark state revenue calculated according to ACRE provisions (note, that ACRE payment is capped at 25% of the state benchmark guarantee);  $SREVA_i$  is actual state revenue to count under ACRE provisions;  $\overline{FY}_i$  is the farm-level benchmark yield;  $\overline{SY}_i$  is the state level benchmark yield; and  $PA_i$  is planted acres.<sup>2</sup>

Crop revenue insurance is modeled at coverage levels ranging from 50 to 85% in 5% increments, as in the actual crop insurance program. Indemnities are computed as:

$$(10) \quad IND_i = \max\{0, [(CL_i \times APH_i \times \max\{EP_i, FP_i\}) - FY_i \times FP_i]\} \times IA_i,$$

where  $EP_i$  is the crop insurance pre-planting expected price,  $FP_i$  is the harvest time futures price,  $CL_i$  is the coverage level selected,  $APH_i$  is the farm's crop insurance actual production history (APH) yield, and  $IA_i$  is the insured acreage. Crop insurance is assumed to be priced at the actuarially-fair rate adjusted by a 25% multiplicative load.<sup>3</sup> The current enterprise unit federal premium subsidy structure is imposed, which ranges from an 80% subsidy for the 50% coverage level to a 53% subsidy for the 85% coverage level.<sup>4</sup> All acreage for a particular crop is assumed to be insured as one unit.

The SURE program is designed to interface with crop insurance. This is clearly observed when one examines the SURE payment function for a farm producing  $i$  crops:

$$(11) \quad SURE = \theta \times 0.6 \times \max\{0, (G - R)\},$$

where:  $G = \max\{(115\% \times \sum_i APH_i \times CL_i \times EP_i \times IA_i), (90\% \times \sum_i APH_i \times EP_i \times IA_i)\},$

<sup>1</sup> It is technically possible for base yields for direct payments and base yields for counter-cyclical payments to differ; however, in this analysis, they are assumed to be the same.

<sup>2</sup> A full discussion of ACRE provisions is beyond the scope of this paper; however, a brief explanation of the broad outlines of the program is useful in the current context. Basically, the ACRE program provides a payment to the producer when actual state revenue (as defined in the Farm Bill) falls below a benchmark level based on past state-level yields (five-year Olympic average) and national marketing year average prices. This state-level payment rate is scaled by the ratio of average farm yields to average state yields in order to determine the farm-specific payment rate. The payment is based on planted acres where sum of payment across crops cannot exceed total base acres on a farm. It is notable that due to a very nature of the benchmark calculation, the ACRE program is "time dependent" and payments may vary across different years depending on yield and price realizations during previous years. For a more detailed explanation of ACRE provisions see Zulauf (2008).

<sup>3</sup> This load factor is somewhat arbitrary; however, some load is required to account for the load that is applied to actual crop insurance rates as well as for other subjective factors that influence producers to purchase lower crop insurance coverage levels (e.g., downward-biased estimates of yield and/or price risk, perceived presence of yield trends, perception of moral hazard influencing rates, etc.). Along with the 25% load, we also considered 35% and 10% loads. There were no apparent qualitative changes. The sensitivity analysis results are available in the technical appendix. For a more detailed discussion of subjective issues affecting crop insurance coverage level decisions see, Pease (1992), Eales et al. (1990) and Egelkraut et al. (2006).

<sup>4</sup> Free catastrophic coverage crop yield insurance is available with a 50% guarantee and the crop value capped at 55% of the expected price.

$R = \sum_i FY_i \times MYA_i \times HA_i + \sum_i 0.15DP_i + \delta \sum_i PCCP_i + (1 - \delta) \sum_i ACRE_i + \sum_i LDP_i + \sum_i IND_i$ ,  
and  $\theta$  is a dummy variable taking a value of 1 if the SURE payment is triggered and zero otherwise.

SURE regulations state that  $\theta$  will be equal to 1 if the following three conditions are met: 1) the farmer has purchased crop insurance on all acres; 2) the farm has a 50% loss (or is in, or adjacent to, a county declared a disaster area); and 3) one crop has a loss of at least 10%. For this analysis, the first and third conditions are incorporated, as is the 50% farm-level loss trigger for the second condition. As a proxy for the political decision of a county being declared a disaster area (in the second condition) we assume that a disaster declaration will be made only if the simple average yield shortfall across all crops considered for the county is greater than 35%. No attempt is made to include the adjacent county trigger for the second condition due to the large number of *ad hoc* assumptions that would be required and the low probability that this trigger would be met when neither of the other triggers for the second condition are met.

$G$  on the right-hand side of equation (11) is the guarantee equal to 115% of the insured value of all crops. The guarantee is capped at 90% of the expected crop revenue, so only for crop insurance coverage levels up to 80%, choosing higher crop insurance coverage levels results in a higher SURE guarantee. For crop insurance coverage levels higher than 80%, the 90% SURE guarantee becomes binding.  $R$  on the right-hand side is the sum across crops of crop revenue, 15% of all direct payments per acre, all PCCP or ACRE payments, all LDPs, and all crop insurance indemnities. Finally,  $\delta$  is a dummy variable taking a value of 1 if the farm is enrolled in the current PCCP program and a value of 0 if the farm is enrolled in the new ACRE program.

### Data and Modeling

A stochastic simulation model is developed to evaluate SURE program payments, crop insurance indemnities, and other farm program payments for a representative Illinois soybean-corn farm in McLean county, a representative Kansas wheat-corn farm in Sheridan county, a representative Mississippi cotton-soybean-corn farm in Yazoo county, and a representative North Dakota wheat-corn farm in Barnes county. These counties were selected because they are representative of major production regions with each having different crop mix, production risk, and price-yield correlation characteristics. McLean County, Illinois is representative of Midwestern corn-soybean production where yield risk is relatively low and price and yield tend to be highly negatively correlated. Sheridan County Kansas, is representative of plains winter wheat and corn production. Production risk in this region is higher than in the Midwest and price-yield correlation is lower (in absolute value terms). Yazoo County, Mississippi is typical of the mid-south where farms often produce several commodities, production risk for cotton, soybeans, and corn is relatively high, and price and yield are largely uncorrelated. Barnes County, North Dakota is representative of a northern plains spring wheat and corn production region with relatively high yield risk. Yields and prices are not highly correlated for corn in this region but are highly negatively correlated for spring wheat.

Certainty equivalents of gross revenue are calculated for each crop insurance coverage level from 50 to 85%, both with and without SURE to determine any impact of SURE on optimal crop insurance purchase decisions. SURE payments were calculated assuming enrollment in the PCCP program and the ACRE program to see what effect this enrollment decision would have on SURE program outcomes.

As equation (11) makes clear, to accurately assess the potential impacts of the SURE program, it is necessary also to model returns from crop production, other government programs, and crop insurance. Simulating outcomes for these different revenue streams requires a relatively large number of variables, including futures prices, cash prices, farm-level yields, county-level yields, and state-level yields for each of the crops considered.

The price data used in the model consist of beginning and ending prices as defined in the crop revenue coverage (CRC) insurance product provisions as well as harvest time cash prices and marketing year average prices.<sup>5</sup> State-level, county-level, and farm-level yields are simulated in the model. Clearly, farm-level yields are required to calculate crop returns, crop insurance indemnities, and loan deficiency payments. Farm-level yields are also used to calculate production loss, which is one of the necessary conditions for a SURE program payment. As well, farm-level yields are required to assess a farm trigger under the ACRE program. County-level yields are simulated in order to define an event triggering a disaster program payment. If county-level yields for any crop fall below a defined threshold, a disaster declaration is assumed, which is one of the necessary conditions for producers in the county to be eligible for SURE payments. State-level yields are necessary to assess a state trigger under the ACRE program.

To simulate price outcomes, beginning prices were set to 2010 ACRE guarantee prices (simple average of 2008 and 2009 marketing year prices) for each crop.<sup>6</sup> Futures price changes over the production season and harvest time basis values were simulated using parameters calculated from historic data obtained from the Commodity Research Bureau (CRB) database and the U.S. Department of Agriculture's National Agricultural Statistical Service (NASS). This information was used to simulate harvest time futures and cash prices for each crop and location, as well as national level MYA prices.

Yields were simulated from a Beta distribution, with parameters of the distribution for each crop derived from historic data. State and county yields were obtained from NASS. Farm yields were simulated from the county-level series using the method described in Coble and Barnett (2007) to increase county-level yield variability to a level consistent with APH crop insurance rates for that county. The farm yield series was further calibrated to have a correlation of 0.85 with the county yield series using the procedure described in Iman and Conover (1982).<sup>7</sup> Correlated yields, futures price changes, and basis values were simulated (correlation tables are provided in the Technical Appendix). Data covered the period from 1980 through 2009. Table 1 provides descriptive statistics for the yield and price data used in the simulation.

A total of 100,005 correlated price changes, basis values, and yields were simulated for each representative farm.<sup>8</sup> Correlated price variables were simulated using the procedure described by (Anderson, Harri, and Coble, 2009). In this procedure, a rank correlation matrix,  $\rho_s$ , is calculated. An eigen decomposition of  $\rho_s$  results in a matrix of eigen values,  $\epsilon$ , and eigen vectors,  $\hat{\epsilon}$ . Correlated standard normal deviates ( $\hat{Z}$ ) are generated using:

$$(12) \quad \hat{Z} = \sqrt{\epsilon}Z\hat{\epsilon},$$

where  $Z$  is a vector of independent standard normal deviates. These correlated standard normal deviates are converted to correlated uniform deviates on the (0, 1) interval by a transformation on the standard normal cumulative distribution function. The uniform deviates are used as probabilities

<sup>5</sup> The CRC Commodity Exchange Endorsement describes how base (i.e., beginning) and harvest (i.e., ending) prices are to be established for each crop and location. For example, the base price for corn in counties with a March 15 cancellation date for CRC policies is the average daily settlement price on the Chicago Board of Trade's December corn contract during the month of February. The harvest price is the average daily settlement price on that same contract during the month of October. Additional details about the beginning and ending prices used in this study can be found in the CRC Commodity Exchange Endorsement (USDA/RMA, 2003).

<sup>6</sup> The choice of price level does affect the results (especially for PCCP and ACRE payments). Current levels are assumed here to represent the most "realistic" scenario.

<sup>7</sup> The Iman and Conover procedure permits simulation of a data series that is correlated at the specified level with some existing series. Thus, a farm-level yield series matching the length of the original county yield series was simulated using parameters based on the expanded variance of the county-level series. These farm-level series are used in all subsequent analysis. Sensitivity analysis using farm yields correlated to the county yield at 0.50 and 0.25 was conducted. The results of the sensitivity analysis are presented in the Technical Appendix.

<sup>8</sup> Results are based on 100,000 simulated observations. The additional 5 observations are required to calculate 5-year Olympic averages of farm- and state-level yields used to establish the ACRE guarantee.

in an inverse transformation on each of the marginal distributions for the variables being simulated (in this case, price changes, basis values, and yields).<sup>9</sup>

Simulated prices and yields are used to calculate crop returns, crop insurance indemnities, government payments (e.g., LDPs, PCCPs and ACRE payments), and any payments under the SURE program. To calculate the direct and counter-cyclical payments, crop base acres and yields must be assumed. In this model, base acres and planted acres are assumed to be the same. All four representative farms are assumed to have 1,500 acres of cropland. Representative farm base yields are assumed equal to the county average base yield for each crop. Finally, for each representative farm we assume crop insurance APH yields that are equal to 96% of the expected county yield, where expected county yields are obtained by detrending the historical NASS county yield data.<sup>10</sup>

Returns from all sources are converted to utility values using the constant relative risk aversion (CRRA) utility function shown in equation (4). Following Lien and Hardaker (2001) and Lusk and Coble (2005) we assume a risk aversion coefficient of 2, representing a moderately risk-averse decision maker.<sup>11</sup> Certainty equivalents (CEs) for crop insurance coverage levels from 50% to 85% are then calculated to define the optimal coverage level both with and without the SURE program. The CE represents the highest certain payment a decision maker would be willing to take to avoid a risky outcome (Hardaker, Huirne, and Anderson, 1997). For any two alternatives  $l$  and  $m$ , if  $CE_l > CE_m$ , then alternative  $l$  is preferred to  $m$ .

For this investigation, the optimal crop insurance coverage level is that which results in the highest CE. Comparing optimal coverage levels with and without SURE payments will reveal what effect, if any, the SURE program is likely to have on optimal insurance purchase decisions. The equations for calculating the CE from the CRRA utility functions used here are

$$(13) \quad CE_r = \begin{cases} [E(U)(1 - \phi)]^{\frac{1}{1-\phi}} & \text{if } \phi \neq 1 \\ e^{E(U)} & \text{if } \phi = 1. \end{cases}$$

where  $E(U)$  is a value for expected utility calculated from equation (5).

## Results and Discussion

SURE, similar to ACRE, is a revenue-based program, while PCCP is a price-based program. Therefore, while there should be a positive correlation in payments from these programs, ACRE and SURE will reveal stronger complementarities than PCCP and SURE. Notably, however, SURE is a whole farm program, while ACRE is crop-specific. ACRE is triggered in relation to the state-level revenue benchmark, while SURE is triggered in relation to county- and farm-level revenue benchmarks. The latter also creates incentives for moral hazard (see Smith and Watts, 2010). The described complexity in the relationship between the SURE and ACRE programs, as well as between SURE and crop insurance programs, makes it difficult to generalize the expected outcome of SURE participation on optimal crop insurance coverage levels and motivates research on a case-by-case basis.

### *SURE Impact on Crop Insurance Coverage Levels*

Figure 1 presents calculated certainty equivalents at each insurance coverage level for each farm with a diversified crop mix. It does not appear that optimal crop insurance coverage levels are greatly

<sup>9</sup> For a more detailed description, see (Phoon, Quek, and Huang, 2004).

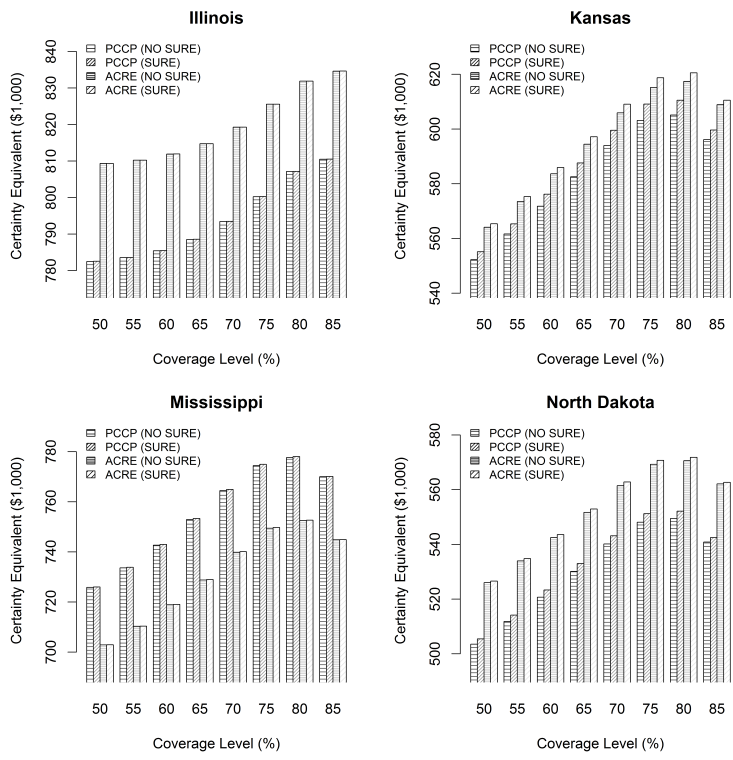
<sup>10</sup> The APH yield is a simple moving average of the most recent 4-10 years of yields on the insured unit. If there is a positive yield trend, the APH yield will be less than the expected yield.

<sup>11</sup> Additionally, we simulated scenarios with risk aversion coefficients set to 1 and 4, representing lower and higher levels of risk aversion, respectively. This sensitivity analysis did not yield qualitatively different results from those reported here. Those results are available from the authors upon request.

**Table 1. Descriptive Statistics of Data used in Representative Farm Models**

| Variable                                   | Illinois |       | Kansas |       | Mississippi |        | North Dakota |       |
|--------------------------------------------|----------|-------|--------|-------|-------------|--------|--------------|-------|
|                                            | Mean     | S.D.  | Mean   | S.D.  | Mean        | S.D.   | Mean         | S.D.  |
| <i>Farm-Level Yields</i>                   |          |       |        |       |             |        |              |       |
| Corn                                       | 177.64   | 29.67 | 158.57 | 70.59 | 149.28      | 40.46  | 140.48       | 68.65 |
| Soybeans                                   | 46.38    | 12.24 |        |       | 37.29       | 22.21  |              |       |
| Wheat                                      |          |       | 38.99  | 22.61 |             |        | 44.03        | 19.09 |
| Cotton                                     |          |       |        |       | 861.31      | 436.86 |              |       |
| <i>County-Level Yields</i>                 |          |       |        |       |             |        |              |       |
| Corn                                       | 177.93   | 22.13 | 140.69 | 19.43 | 147.87      | 12.41  | 118.10       | 22.24 |
| Soybeans                                   | 52.15    | 5.35  |        |       | 32.02       | 6.40   |              |       |
| Wheat                                      |          |       | 35.56  | 11.87 |             |        | 44.81        | 8.67  |
| Cotton                                     |          |       |        |       | 846.19      | 126.65 |              |       |
| <i>State-Level Yields</i>                  |          |       |        |       |             |        |              |       |
| Corn                                       | 165.31   | 17.79 | 144.54 | 15.16 | 138.74      | 11.46  | 116.15       | 15.98 |
| Soybeans                                   | 46.44    | 3.74  |        |       | 33.94       | 5.02   |              |       |
| Wheat                                      |          |       | 37.08  | 6.60  |             |        | 34.97        | 5.98  |
| Cotton                                     |          |       |        |       | 901.64      | 113.29 |              |       |
| <i>Benchmark Farm-Level Yields (ACRE)</i>  |          |       |        |       |             |        |              |       |
| Corn                                       | 177.55   | 14.98 | 155.65 | 35.58 | 149.00      | 20.76  | 139.83       | 36.66 |
| Soybeans                                   | 46.16    | 6.27  |        |       | 35.63       | 11.07  |              |       |
| Wheat                                      |          |       | 37.66  | 12.17 |             |        | 43.12        | 9.70  |
| Cotton                                     |          |       |        |       | 842.26      | 226.74 |              |       |
| <i>Benchmark State-Level Yields (ACRE)</i> |          |       |        |       |             |        |              |       |
| Corn                                       | 165.54   | 8.79  | 144.54 | 7.50  | 138.71      | 5.65   | 116.51       | 7.96  |
| Soybeans                                   | 46.48    | 1.82  |        |       | 33.89       | 2.55   |              |       |
| Wheat                                      |          |       | 37.03  | 3.33  |             |        | 35.00        | 2.96  |
| Cotton                                     |          |       |        |       | 900.78      | 56.10  |              |       |
| <i>Harvest Time Futures Prices</i>         |          |       |        |       |             |        |              |       |
| Corn                                       | 3.56     | 0.63  | 3.56   | 0.63  | 3.56        | 0.63   | 3.56         | 0.63  |
| Soybeans                                   | 9.68     | 1.74  |        |       | 9.68        | 1.74   |              |       |
| Wheat                                      |          |       | 5.68   | 1.08  |             |        | 5.62         | 0.90  |
| Cotton                                     |          |       |        |       | 0.54        | 0.11   |              |       |
| <i>Harvest Time Cash Prices</i>            |          |       |        |       |             |        |              |       |
| Corn                                       | 3.38     | 0.56  | 3.50   | 0.57  | 3.71        | 0.57   | 3.21         | 0.55  |
| Soybeans                                   | 9.49     | 1.54  |        |       | 9.58        | 1.5    |              |       |
| Wheat                                      |          |       | 5.42   | 1.06  |             |        | 5.57         | 0.75  |
| Cotton                                     |          |       |        |       | 0.48        | 0.09   |              |       |
| <i>Benchmark Prices (ACRE)</i>             |          |       |        |       |             |        |              |       |
| Corn                                       | 3.92     | 0.57  |        |       |             |        |              |       |
| Soybeans                                   | 10.12    | 1.41  |        |       |             |        |              |       |
| Wheat                                      | 5.94     | 0.79  |        |       |             |        |              |       |
| Cotton                                     | 0.56     | 0.08  |        |       |             |        |              |       |

Notes: Cotton prices given in \$/lb; corn, soybean, and wheat prices are given in \$/bushel.



**Figure 1. SURE Program Effects on Optimal Crop Insurance Coverage Levels for a Diversified Crop Mix**

influenced by the availability of the SURE program. This is partly due to the fact that expected SURE payments constitute a very small share of total farm revenue (see table 2). SURE payments are a small portion of total revenue when compared to crop returns and even other program payments (such as the direct payment, ACRE payments, and PCCP payments). Certainly, the calculation of the SURE revenue guarantee—guaranteeing 115% of insured value but with a cap at 90% of expected revenue—suggests that the SURE program makes the highest crop insurance coverage levels less attractive. Otherwise, it appears that differences in SURE payments across insurance coverage levels are not sufficient to have a significant influence on coverage level decisions. To be more precise, the SURE program guarantee encourages crop insurance at up to the 80% coverage level. Above this level, the cap on SURE payments at 90% of expected revenue becomes binding; below this level, SURE payments are reduced by the lower SURE benchmark revenue. But these coverage levels (except for the Illinois representative farm) seem to be preferred even without SURE. So, if anything, SURE participation only further encourages producers to select mid-level crop insurance coverage.

*Relationship between SURE Payments and Other Program Payments*

Figure 2 presents results related to the interaction between the SURE program and other farm programs. Results vary substantially across the different locations. In particular, SURE payments are higher for a single crop compared to the diversified crop situation for the Kansas representative farm. However, at optimal crop insurance coverage levels, SURE payments are higher for a diversified crop mix scenario as compared to the corn-only situation in Illinois and wheat-only situation in North Dakota. Interestingly, in North Dakota, at lower crop insurance coverage levels single crop

**Table 2. SURE Payments as a Percentage of Expected Crop Revenues**

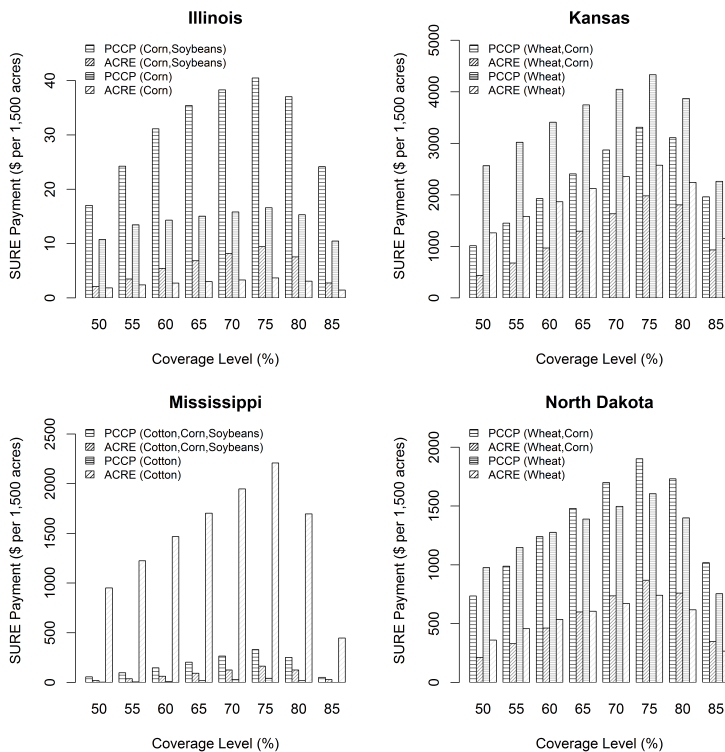
| Coverage<br>Level | Illinois |         | Kansas |       | Mississippi |         | North Dakota |       |
|-------------------|----------|---------|--------|-------|-------------|---------|--------------|-------|
|                   | PCCP     | ACRE    | PCCP   | ACRE  | PCCP        | ACRE    | PCCP         | ACRE  |
| CL50              | < 0.01%  | < 0.01% | 0.17%  | 0.07% | 0.01%       | < 0.01% | 0.14%        | 0.04% |
| CL55              | < 0.01%  | < 0.01% | 0.24%  | 0.11% | 0.01%       | 0.01%   | 0.18%        | 0.06% |
| CL60              | < 0.01%  | < 0.01% | 0.31%  | 0.15% | 0.02%       | 0.01%   | 0.22%        | 0.08% |
| CL65              | < 0.01%  | < 0.01% | 0.38%  | 0.20% | 0.03%       | 0.01%   | 0.27%        | 0.10% |
| CL70              | 0.01%    | < 0.01% | 0.45%  | 0.25% | 0.03%       | 0.02%   | 0.30%        | 0.13% |
| CL75              | 0.01%    | < 0.01% | 0.52%  | 0.30% | 0.04%       | 0.02%   | 0.33%        | 0.15% |
| CL80              | 0.01%    | < 0.01% | 0.48%  | 0.28% | 0.03%       | 0.02%   | 0.30%        | 0.13% |
| CL85              | < 0.01%  | < 0.01% | 0.31%  | 0.15% | 0.01%       | < 0.01% | 0.18%        | 0.06% |

production generates higher SURE payments as compared to the diversified crop scenario. Finally, in the Mississippi PCCP scenario cotton-only SURE payments are substantially lower than multi-crop SURE payments, but the opposite is true for the ACRE scenario. These results map back to SURE payments being triggered by whole farm revenue so that not only does the risk associated with each crop matter, but also the overall relative risk associated with all the crops produced. For example, in the case of the North Dakota farm, the underlying production risk of corn is higher compared to the wheat production risk. Therefore, when corn is added to the production mix, the likelihood of SURE payments being triggered increases relative to the wheat-only production scenario.

Additionally, the cotton-only SURE payment with PCCP is much lower than the cotton-only SURE payment under ACRE participation. This result points to a rather curious feature of the SURE program as it relates to other farm programs, particularly the PCCP and the marketing loan programs. Under SURE, the farm's payment trigger is essentially 115% of the farm's total insurance liability. Expectations of government program payments are not included in this benchmark revenue. However, program payments are included in revenue to count at the end of the year. When prices are low (as was the case with cotton during the time period used to initialize the simulation), the SURE benchmark revenue is also low. However, the likelihood of receiving substantial PCCPs and LDPs is high. Thus, it becomes much more likely that revenue to count will exceed the SURE benchmark revenue, resulting in no SURE payment. When prices are high, the correspondence between benchmark revenue and revenue to count will be greater because PCCPs and LDPs will be a much less significant component of revenue. The interesting result is that for producers in the PCCP program, SURE will be expected to pay out more when prices are high than when prices are low. The effect noted above should be reduced for producers enrolled in the ACRE program because ACRE price guarantees are not fixed. In general, the likelihood of an ACRE payment should be about the same whether prices are high or low. This is reflected in the results in figure 2. Except for the case of cotton-only in Mississippi, SURE payments are much higher under PCCP enrollment than under ACRE enrollment. This suggests that ACRE and SURE payments are largely offsetting. That is, when SURE pays out, ACRE is also generally paying out, thus reducing the amount of the SURE payment. This is not necessarily true under the PCCP program, since PCCP programs are based only on price and the target price for PCCP payments is fixed.

#### *SURE Program Experience Across Regions*

Results in figure 2 clearly demonstrate substantial differences in expected SURE payments across geographic regions. Because of differences in expected revenue per acre across states, mainly reflecting differences in expected yield, it is somewhat difficult to compare whole-farm SURE payment levels. To better illustrate differences in payment levels across geographic regions, table 2 shows SURE payments with PCCP and ACRE participation as a percentage of expected whole-



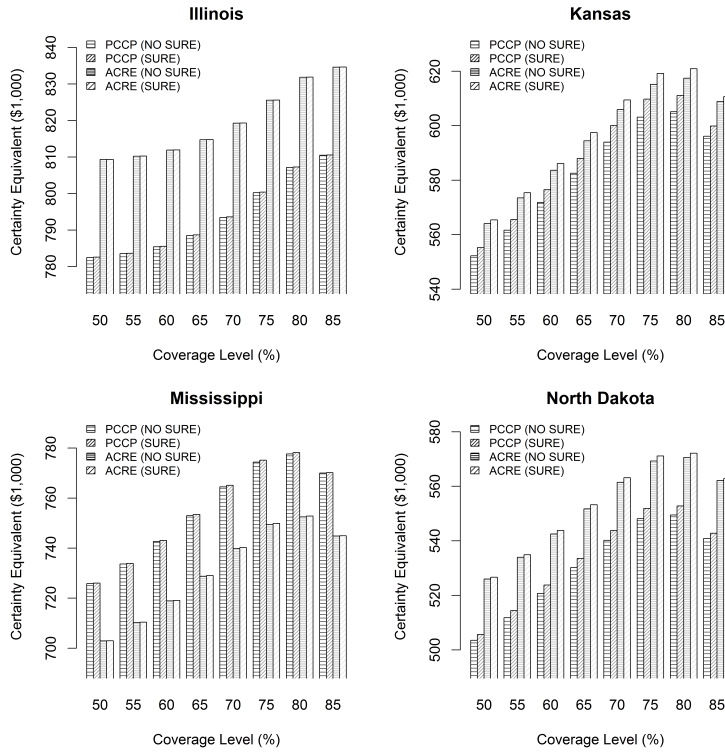
**Figure 2. SURE Payments at Different Crop Insurance Coverage Levels for a Mono-Crop and a Diversified Crop Mix**

farm revenue. In these terms, SURE payments are smallest in Illinois and largest in Kansas, with Mississippi and North Dakota payments falling between these two. Differences in SURE payments are by no means trivial and largely reflect differences in production risk across the different regions (shown in table 1).

*SURE Program and Moral Hazard*

As noted by Smith and Watts (2010), the SURE program creates incentives for moral hazard. This is mostly due to one of the necessary conditions, that SURE will be triggered if a farm production loss exceeds 50% of the average production. Smith and Watts (2010) present peculiarities of this incentive (with a number of alternative price scenarios). We examine whether SURE-induced moral hazard behavior affects optimal crop insurance coverage levels. In order to illustrate the moral hazard behavior, we assume that during the growing season the farmer would take actions, or fail to take actions, that further reduce production if the simulated average yield shortfall, relative to historical average yields, across all crops produced on the farm exceeds 40%. When this occurs, we assume that moral hazard behavior will further reduce the realized yield by an additional 20% (relative to the initial simulated level).<sup>12</sup> Additionally, we use average yield shortfalls across all crops when modeling opportunities for SURE-induced moral hazard behavior, because SURE payments are

<sup>12</sup> These values are, of course, somewhat arbitrary due to the difficulty of quantifying moral hazard behavior. The assumed 20% reduction in crop yield, due to moral hazard behavior is motivated, in part, by estimates of the yield impacts of delayed or reduced use of fertilizers (e.g., Scharf, Wiebold, and Lory, 2002; Stewart et al., 2005). While we consider the assumptions to be reasonable, the findings from this exercise should be interpreted as illustrative rather than definitive.



**Figure 3. SURE Program Effects on Optimal Crop Insurance Coverage Levels for a Diversified Crop Mix Assuming Moral Hazard**

based on whole farm outcomes. Note that this moral hazard behavior does not necessarily guarantee that a SURE payment will occur or that realized crop insurance revenue will be less than 75% of the revenue guarantee, because realized revenue is also a function of price, over which the farmer has no control.

As shown in table 3, the assumed SURE-induced moral hazard behavior increases SURE payments. In particular, SURE payment increases due to moral hazard range from 5% to 80% in Kansas, Mississippi and North Dakota. The percentage increase in Illinois is much larger (up to 331%), but these large percentage increases reflect the fact that the expected level of SURE payments is low (see table 2). The change in absolute terms is rather modest. For all four states, these changes in SURE payments have little effect on optimal crop insurance coverage levels, which can be seen by comparing figure 3 to figure 1. This is not unexpected, given that SURE payments constitute such a small share of expected revenue. Finally, these effects would be even further mitigated if farmers were less successful in implementing the SURE-induced moral hazard behavior than is assumed here.

**Summary and Conclusions**

The SURE standing disaster payment program represents an attempt by policy-makers to provide a systematic means of compensating crop producers for revenue shortfalls. Because the revenue trigger established under this proposed program is tied to the producer’s crop insurance coverage level and because the program would function in much the same way as a crop insurance product, it is feasible that the program could influence crop insurance purchase decisions.

**Table 3. Percentage Change in SURE Payments as a Result of Moral Hazard**

| Coverage Level | Illinois |        | Kansas |       | Mississippi |       | North Dakota |       |
|----------------|----------|--------|--------|-------|-------------|-------|--------------|-------|
|                | PCCP     | ACRE   | PCCP   | ACRE  | PCCP        | ACRE  | PCCP         | ACRE  |
| CL50           | 123.6%   | 75.8%  | 4.7%   | 5.8%  | 11.8%       | 14.8% | 12.2%        | 11.4% |
| CL55           | 160.3%   | 137.1% | 6.8%   | 8.6%  | 20.3%       | 28.3% | 16.2%        | 16.5% |
| CL60           | 192.2%   | 210.8% | 8.3%   | 10.6% | 27.7%       | 43.3% | 19.5%        | 20.8% |
| CL65           | 222.5%   | 294.2% | 9.8%   | 12.0% | 35.2%       | 54.5% | 22.1%        | 23.9% |
| CL70           | 233.3%   | 331.2% | 11.2%  | 13.4% | 41.3%       | 62.5% | 24.3%        | 26.2% |
| CL75           | 230.1%   | 317.1% | 12.5%  | 14.7% | 45.3%       | 66.7% | 26.0%        | 27.7% |
| CL80           | 220.2%   | 307.1% | 12.5%  | 14.7% | 48.5%       | 72.2% | 25.7%        | 27.2% |
| CL85           | 195.9%   | 303.3% | 10.0%  | 12.2% | 54.2%       | 83.5% | 21.9%        | 23.1% |

Simulation results suggest that SURE payments could have some effect on the optimal crop insurance coverage level, moving producers toward mid-level coverage from either lower or higher levels. However, SURE payments are, on average, small relative to crop revenues, other program payments, and insurance indemnities. Thus, the actual impact of SURE payments on producer decisions is not likely to be that great.

Results also demonstrate interesting interactions between the SURE program and other federal commodity programs. Surprisingly, for producers who participate in the PCCP program, the method of establishing SURE benchmark revenue (which ignores expected PCCP and marketing loan program payments) will result in lower SURE payments when prices are low and higher SURE payments when prices are high. For producers participating in the ACRE program, SURE and ACRE payments will overlap to a substantial degree, generally resulting in small expected SURE payments. These results provide a useful illustration of the complex inter-relationships that now exist between the various farm programs.

Finally, results illustrate the influence of crop diversification and production risk on SURE payments. In general, the program will pay more to less diversified operations in areas characterized by greater production risk. This may seem an intuitively obvious finding, but it is often overlooked by policy-makers. The SURE program implicitly establishes fixed coverage levels across very diverse production regions, resulting in considerable inequities in the distribution of SURE payments, with areas of relatively less (more) risky production receiving relatively lower (higher) SURE payments.

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**Technical Appendix**

This technical appendix contains correlation matrices for variables used in the simulation analysis (tables A1 - A3) and certainty equivalent measures for different scenarios of farm-county yield correlations, multiplicative crop insurance premium loads and risk aversion coefficients (tables A5 - A7). In the tables that follow  $\Delta P$  is the percentage change in price between planting and harvest of a harvest-time futures contract,  $B$  is harvest-time basis (cash price relative to futures price),  $Y$  is yield, and the subscripts  $C$ ,  $S$ , and  $CT$  indicate corn, soybeans, and cotton, respectively.

**Table A1. Matrix of Variables Used in Simulations for a Representative Farm of Illinois**

|              | $\Delta P_C$ | $\Delta P_S$ | $B_C$ | $B_S$ | $Y_C(F)$ | $Y_S(F)$ | $Y_C(C)$ | $Y_S(C)$ | $Y_C(S)$ | $Y_S(S)$ |
|--------------|--------------|--------------|-------|-------|----------|----------|----------|----------|----------|----------|
| $\Delta P_C$ | 1.00         |              |       |       |          |          |          |          |          |          |
| $\Delta P_S$ | 0.69         | 1.00         |       |       |          |          |          |          |          |          |
| $B_C$        | -0.49        | -0.40        | 1.00  |       |          |          |          |          |          |          |
| $B_S$        | -0.34        | -0.63        | 0.70  | 1.00  |          |          |          |          |          |          |
| $Y_C(F)$     | -0.64        | -0.41        | 0.32  | 0.08  | 1.00     |          |          |          |          |          |
| $Y_S(F)$     | -0.33        | -0.24        | 0.14  | 0.12  | 0.43     | 1.00     |          |          |          |          |
| $Y_C(C)$     | -0.78        | -0.50        | 0.41  | 0.17  | 0.82     | 0.56     | 1.00     |          |          |          |
| $Y_S(C)$     | -0.42        | -0.43        | 0.17  | 0.23  | 0.49     | 0.82     | 0.60     | 1.00     |          |          |
| $Y_C(S)$     | -0.79        | -0.52        | 0.35  | 0.18  | 0.78     | 0.45     | 0.94     | 0.49     | 1.00     |          |
| $Y_S(S)$     | -0.64        | -0.69        | 0.22  | 0.35  | 0.56     | 0.66     | 0.71     | 0.83     | 0.69     | 1.00     |

**Table A2. Correlation Matrix of Variables Used in Simulations for a Representative Farm of Kansas**

|              | $\Delta P_C$ | $\Delta P_W$ | $B_C$ | $B_W$ | $Y_C(F)$ | $Y_W(F)$ | $Y_C(C)$ | $Y_W(C)$ | $Y_C(S)$ | $Y_W(S)$ |
|--------------|--------------|--------------|-------|-------|----------|----------|----------|----------|----------|----------|
| $\Delta P_C$ | 1.00         |              |       |       |          |          |          |          |          |          |
| $\Delta P_W$ | 0.41         | 1.00         |       |       |          |          |          |          |          |          |
| $B_C$        | -0.42        | 0.31         | 1.00  |       |          |          |          |          |          |          |
| $B_W$        | 0.00         | -0.18        | 0.01  | 1.00  |          |          |          |          |          |          |
| $Y_C(F)$     | -0.22        | -0.20        | -0.13 | -0.16 | 1.00     |          |          |          |          |          |
| $Y_W(F)$     | -0.03        | -0.29        | -0.13 | -0.28 | 0.15     | 1.00     |          |          |          |          |
| $Y_C(C)$     | -0.29        | -0.32        | -0.14 | -0.10 | 0.81     | 0.32     | 1.00     |          |          |          |
| $Y_W(C)$     | -0.09        | -0.29        | -0.06 | -0.38 | 0.22     | 0.80     | 0.35     | 1.00     |          |          |
| $Y_C(S)$     | -0.50        | -0.19        | 0.00  | 0.03  | 0.54     | 0.07     | 0.72     | 0.14     | 1.00     |          |
| $Y_W(S)$     | -0.09        | -0.51        | 0.03  | -0.26 | 0.11     | 0.56     | 0.25     | 0.67     | 0.05     | 1.00     |

**Table A3. Correlation Matrix of Variables Used in Simulations for a Representative Farm of North Dakota**

|              | $\Delta P_C$ | $\Delta P_W$ | $B_C$ | $B_W$ | $Y_C(F)$ | $Y_W(F)$ | $Y_C(C)$ | $Y_W(C)$ | $Y_C(S)$ | $Y_W(S)$ |
|--------------|--------------|--------------|-------|-------|----------|----------|----------|----------|----------|----------|
| $\Delta P_C$ | 1.00         |              |       |       |          |          |          |          |          |          |
| $\Delta P_W$ | 0.59         | 1.00         |       |       |          |          |          |          |          |          |
| $B_C$        | -0.47        | -0.28        | 1.00  |       |          |          |          |          |          |          |
| $B_W$        | -0.06        | -0.54        | 0.19  | 1.00  |          |          |          |          |          |          |
| $Y_C(F)$     | -0.23        | 0.16         | -0.08 | -0.50 | 1.00     |          |          |          |          |          |
| $Y_W(F)$     | -0.43        | -0.45        | 0.34  | 0.03  | 0.03     | 1.00     |          |          |          |          |
| $Y_C(C)$     | -0.21        | 0.12         | -0.16 | -0.28 | 0.83     | -0.06    | 1.00     |          |          |          |
| $Y_W(C)$     | -0.53        | -0.45        | 0.49  | 0.06  | 0.07     | 0.83     | 0.03     | 1.00     |          |          |
| $Y_C(S)$     | -0.34        | -0.03        | -0.10 | -0.21 | 0.69     | -0.03    | 0.92     | 0.08     | 1.00     |          |
| $Y_W(S)$     | -0.63        | -0.42        | 0.39  | 0.10  | 0.01     | 0.66     | 0.02     | 0.86     | 0.08     | 1.00     |

**Table A4. Correlation Matrix of Variables Used in Simulations for a Representative Farm of Mississippi**

|                 | $\Delta P_C$ | $\Delta P_{CT}$ | $\Delta P_S$ | $B_C$ | $B_{CT}$ | $B_S$ | $Y_C(F)$ | $Y_{CT}(F)$ | $Y_S(F)$ | $Y_C(C)$ | $Y_{CT}(C)$ | $Y_S(C)$ | $Y_C(S)$ | $Y_{CT}(S)$ | $Y_S(S)$ |
|-----------------|--------------|-----------------|--------------|-------|----------|-------|----------|-------------|----------|----------|-------------|----------|----------|-------------|----------|
| $\Delta P_C$    | 1.00         |                 |              |       |          |       |          |             |          |          |             |          |          |             |          |
| $\Delta P_{CT}$ | 0.37         | 1.00            |              |       |          |       |          |             |          |          |             |          |          |             |          |
| $\Delta P_S$    | 0.69         | 0.62            | 1.00         |       |          |       |          |             |          |          |             |          |          |             |          |
| $B_C$           | -0.43        | -0.23           | -0.47        | 1.00  |          |       |          |             |          |          |             |          |          |             |          |
| $B_{CT}$        | -0.33        | -0.50           | -0.41        | 0.37  | 1.00     |       |          |             |          |          |             |          |          |             |          |
| $B_S$           | -0.32        | -0.34           | -0.66        | 0.26  | 0.24     | 1.00  |          |             |          |          |             |          |          |             |          |
| $Y_C(F)$        | -0.02        | -0.07           | 0.18         | -0.24 | -0.09    | -0.11 | 1.00     |             |          |          |             |          |          |             |          |
| $Y_{CT}(F)$     | 0.08         | -0.03           | 0.07         | 0.29  | 0.19     | 0.06  | 0.04     | 1.00        |          |          |             |          |          |             |          |
| $Y_S(F)$        | -0.27        | -0.22           | -0.11        | 0.24  | 0.30     | -0.05 | -0.11    | 0.05        | 1.00     |          |             |          |          |             |          |
| $Y_C(C)$        | -0.22        | -0.16           | 0.07         | -0.11 | -0.14    | -0.02 | 0.82     | 0.17        | -0.09    | 1.00     |             |          |          |             |          |
| $Y_{CT}(C)$     | -0.14        | -0.28           | -0.13        | 0.54  | 0.31     | 0.11  | 0.14     | 0.81        | 0.28     | 0.22     | 1.00        |          |          |             |          |
| $Y_S(C)$        | -0.33        | -0.35           | -0.13        | 0.37  | 0.36     | -0.07 | -0.07    | 0.37        | 0.81     | 0.05     | 0.56        | 1.00     |          |             |          |
| $Y_C(S)$        | -0.36        | -0.23           | -0.01        | 0.30  | 0.05     | -0.09 | 0.44     | 0.02        | 0.24     | 0.64     | 0.28        | 0.38     | 1.00     |             |          |
| $Y_{CT}(S)$     | -0.19        | -0.25           | -0.19        | 0.63  | 0.31     | 0.13  | 0.20     | 0.68        | 0.35     | 0.22     | 0.92        | 0.59     | 0.39     | 1.00        |          |
| $Y_S(S)$        | -0.40        | -0.28           | -0.06        | 0.36  | 0.25     | -0.18 | 0.05     | 0.16        | 0.76     | 0.16     | 0.43        | 0.90     | 0.56     | 0.54        | 1.00     |

**Table A5. SURE Program Effects on Optimal Crop Insurance Coverage Levels with Farm-County Yield Correlations at 0.85 (base case scenario), 0.50, and 0.25 Levels**

|                           | IL             |                |                |                |                |                |                |                |                |                |                |                | KS             |                |                |                |           |      |          |           |      |          |           |      | MS       |           |      |          |           |      |          |           |  |      |  |  | ND |  |  |  |  |  |  |  |  |  |  |  |
|---------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------|------|----------|-----------|------|----------|-----------|------|----------|-----------|------|----------|-----------|------|----------|-----------|--|------|--|--|----|--|--|--|--|--|--|--|--|--|--|--|
|                           | PSSP           |                |                | ACRE           |                |                | PSSP           |                |                | ACRE           |                |                | PSSP           |                |                | ACRE           |           |      | PSSP     |           |      | ACRE     |           |      | PSSP     |           |      | ACRE     |           |      | PSSP     |           |  | ACRE |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
|                           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE | ACRE | w/o SURE | with SURE | ACRE | w/o SURE | with SURE | ACRE | w/o SURE | with SURE | ACRE | w/o SURE | with SURE | ACRE | w/o SURE | with SURE |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| <i>Correlation = 0.85</i> |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL50                      | 782,502        | 782,536        | 809,330        | 809,333        | 552,260        | 555,149        | 564,094        | 565,386        | 725,843        | 725,987        | 702,896        | 702,944        | 503,510        | 505,435        | 525,994        | 526,592        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL55                      | 783,528        | 783,573        | 810,228        | 810,233        | 561,661        | 565,352        | 573,518        | 575,282        | 733,642        | 733,861        | 710,298        | 710,382        | 511,812        | 514,128        | 533,962        | 534,788        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL60                      | 785,401        | 785,453        | 811,907        | 811,914        | 571,772        | 576,197        | 583,908        | 585,908        | 742,673        | 742,974        | 718,909        | 719,037        | 520,689        | 523,317        | 542,538        | 543,579        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL65                      | 788,504        | 788,557        | 814,729        | 814,737        | 582,550        | 587,601        | 594,456        | 597,185        | 752,962        | 753,341        | 728,783        | 728,953        | 530,154        | 533,005        | 551,725        | 552,944        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL70                      | 793,428        | 793,482        | 819,258        | 819,267        | 593,966        | 599,520        | 605,906        | 609,057        | 764,482        | 764,935        | 739,880        | 740,093        | 540,159        | 543,157        | 561,471        | 562,834        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL75                      | 800,233        | 800,282        | 825,542        | 825,551        | 603,159        | 609,124        | 615,183        | 618,717        | 774,425        | 774,948        | 749,467        | 749,725        | 548,120        | 551,213        | 569,268        | 570,749        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL80                      | 807,132        | 807,174        | 831,850        | 831,857        | <b>605,129</b> | <b>610,523</b> | <b>617,414</b> | <b>620,516</b> | <b>777,651</b> | <b>778,029</b> | <b>752,493</b> | <b>752,680</b> | <b>549,486</b> | <b>552,168</b> | <b>570,596</b> | <b>571,833</b> |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL85                      | <b>810,471</b> | <b>810,497</b> | <b>834,607</b> | <b>834,610</b> | 596,137        | 599,616        | 608,894        | 610,536        | 770,038        | 770,111        | 744,856        | 744,897        | 540,876        | 542,462        | 562,130        | 562,712        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| <i>Correlation = 0.50</i> |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL50                      | 784,938        | 785,006        | 811,986        | 811,991        | 548,851        | 554,441        | 564,416        | 566,826        | 734,292        | 734,381        | 709,683        | 709,729        | 501,562        | 504,874        | 521,468        | 522,786        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL55                      | 786,266        | 786,350        | 813,127        | 813,136        | 558,356        | 565,019        | 573,697        | 576,850        | 741,767        | 741,911        | 716,951        | 717,030        | 509,964        | 513,864        | 529,609        | 531,359        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL60                      | 788,566        | 788,660        | 815,156        | 815,169        | 568,649        | 576,229        | 583,784        | 587,644        | 750,434        | 750,636        | 725,402        | 725,520        | 519,029        | 523,367        | 538,436        | 540,564        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL65                      | 792,293        | 792,388        | 818,496        | 818,512        | 579,705        | 588,031        | 594,650        | 599,150        | 760,299        | 760,561        | 735,044        | 735,203        | 528,690        | 533,327        | 547,892        | 550,333        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL70                      | 798,044        | 798,136        | 823,737        | 823,754        | 591,424        | 600,341        | 606,203        | 611,272        | 771,375        | 771,695        | 745,909        | 746,109        | 538,874        | 543,701        | 557,880        | 560,565        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL75                      | 805,510        | 805,599        | 830,613        | 830,631        | 600,874        | 610,271        | 615,547        | 621,121        | 780,765        | 781,141        | 755,150        | 755,392        | 546,973        | 551,923        | 565,865        | 568,743        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL80                      | 812,442        | 812,516        | 836,948        | 836,961        | <b>602,896</b> | <b>611,512</b> | <b>617,645</b> | <b>622,632</b> | <b>783,262</b> | <b>783,537</b> | <b>757,648</b> | <b>757,827</b> | <b>548,366</b> | <b>552,750</b> | <b>567,308</b> | <b>569,803</b> |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL85                      | <b>814,914</b> | <b>814,959</b> | <b>838,905</b> | <b>838,909</b> | 593,772        | 599,701        | 608,809        | 611,688        | 774,786        | 774,841        | 749,365        | 749,403        | 539,639        | 542,465        | 558,857        | 560,225        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| <i>Correlation = 0.25</i> |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL50                      | 785,441        | 785,598        | 812,488        | 812,503        | 547,237        | 553,349        | 563,153        | 565,995        | 734,713        | 734,823        | 706,786        | 706,886        | 498,383        | 502,541        | 516,011        | 517,976        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL55                      | 787,235        | 787,423        | 814,030        | 814,050        | 556,587        | 563,830        | 572,271        | 575,914        | 742,450        | 742,624        | 714,421        | 714,582        | 507,054        | 511,930        | 524,495        | 527,013        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL60                      | 790,166        | 790,368        | 816,610        | 816,637        | 566,777        | 574,962        | 582,241        | 586,641        | 751,384        | 751,628        | 723,257        | 723,482        | 516,379        | 521,796        | 533,640        | 536,639        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL65                      | 794,660        | 794,860        | 820,648        | 820,679        | 577,775        | 586,700        | 593,036        | 598,092        | 761,510        | 761,824        | 733,288        | 733,581        | 526,283        | 532,081        | 543,398        | 546,789        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL70                      | 801,185        | 801,380        | 826,618        | 826,651        | 589,511        | 599,006        | 604,583        | 610,199        | 772,824        | 773,206        | 744,516        | 744,874        | 536,744        | 542,793        | 553,735        | 557,440        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL75                      | 809,218        | 809,409        | 834,058        | 834,093        | 598,994        | 608,936        | 613,950        | 620,045        | 782,404        | 782,850        | 754,067        | 754,488        | 545,081        | 551,292        | 562,010        | 565,964        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL80                      | 816,238        | 816,397        | 840,520        | 840,544        | <b>601,035</b> | <b>610,133</b> | <b>616,029</b> | <b>621,467</b> | <b>785,026</b> | <b>785,347</b> | <b>756,806</b> | <b>757,118</b> | <b>546,661</b> | <b>552,194</b> | <b>563,715</b> | <b>567,165</b> |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |
| CL85                      | <b>818,227</b> | <b>818,317</b> | <b>842,045</b> | <b>842,052</b> | 591,887        | 598,156        | 607,126        | 610,294        | 776,626        | 776,691        | 748,696        | 748,767        | 538,067        | 541,693        | 555,478        | 557,418        |           |      |          |           |      |          |           |      |          |           |      |          |           |      |          |           |  |      |  |  |    |  |  |  |  |  |  |  |  |  |  |  |

Notes: Values are certainty equivalents measured in U.S. dollars. Bold figures are the maximum values.



**Table A7. SURE Program Effects on Optimal Crop Insurance Coverage Levels with Risk Aversion at 1, 2 (base case scenario), and 4 Levels**

|                                      | IL             |                |                |                |                |                |                |                |                |                |                |                | KS             |                |                |                |           |      | MS       |           |      |          |           |      | ND       |           |      |      |  |  |
|--------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------|------|----------|-----------|------|----------|-----------|------|----------|-----------|------|------|--|--|
|                                      | PSSP           |                |                | ACRE           |                |                | PSSP           |                |                | ACRE           |                |                | PSSP           |                |                | ACRE           |           |      | PSSP     |           |      | ACRE     |           |      | PSSP     |           |      | ACRE |  |  |
|                                      | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE      | ACRE           | w/o SURE       | with SURE | ACRE | w/o SURE | with SURE | ACRE | w/o SURE | with SURE | ACRE | w/o SURE | with SURE | ACRE |      |  |  |
| <i>Risk Aversion Coefficient = 1</i> |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL50                                 | 792,145        | 792,169        | 817,271        | 817,274        | 579,637        | 581,422        | 590,160        | 590,941        | 744,090        | 744,182        | 718,657        | 718,688        | 523,575        | 524,807        | 544,246        | 544,613        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL55                                 | 792,930        | 792,964        | 818,003        | 818,007        | 586,843        | 589,247        | 597,386        | 598,519        | 750,607        | 750,756        | 725,018        | 725,075        | 530,120        | 531,679        | 550,643        | 551,179        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL60                                 | 794,418        | 794,459        | 819,407        | 819,413        | 594,874        | 597,893        | 605,437        | 606,963        | 758,304        | 758,519        | 732,545        | 732,636        | 537,361        | 539,215        | 557,751        | 558,461        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL65                                 | 796,967        | 797,011        | 821,831        | 821,839        | 603,705        | 607,297        | 614,299        | 616,231        | 767,240        | 767,523        | 741,314        | 741,441        | 545,314        | 547,416        | 565,583        | 566,454        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL70                                 | 801,149        | 801,193        | 825,833        | 825,842        | 613,322        | 617,421        | 623,956        | 626,281        | 777,420        | 777,772        | 751,318        | 751,483        | 553,951        | 556,255        | 574,103        | 575,122        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL75                                 | 807,035        | 807,080        | 831,481        | 831,491        | 620,940        | 625,488        | 631,660        | 634,362        | 786,093        | 786,515        | 759,868        | 760,076        | 560,732        | 563,201        | 580,851        | 582,002        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL80                                 | 812,932        | 812,972        | 837,118        | 837,125        | <b>621,629</b> | <b>625,811</b> | <b>632,610</b> | <b>635,023</b> | <b>788,182</b> | <b>788,494</b> | <b>761,963</b> | <b>762,117</b> | <b>561,163</b> | <b>563,353</b> | <b>581,358</b> | <b>582,341</b> |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL85                                 | <b>815,296</b> | <b>815,321</b> | <b>839,247</b> | <b>839,250</b> | 611,672        | 614,337        | 623,110        | 624,369        | 779,590        | 779,652        | 753,520        | 753,554        | 551,870        | 553,160        | 572,312        | 572,766        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| <i>Risk Aversion Coefficient = 2</i> |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL50                                 | 782,502        | 782,536        | 809,330        | 809,333        | 552,260        | 555,149        | 564,094        | 565,386        | 725,843        | 725,987        | 702,896        | 702,944        | 503,510        | 505,435        | 525,994        | 526,592        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL55                                 | 783,528        | 783,573        | 810,228        | 810,233        | 561,661        | 565,352        | 573,518        | 575,282        | 733,642        | 733,861        | 710,298        | 710,382        | 511,812        | 514,128        | 533,962        | 534,788        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL60                                 | 785,401        | 785,453        | 811,907        | 811,914        | 571,772        | 576,197        | 583,651        | 585,908        | 742,673        | 742,974        | 718,909        | 719,037        | 520,689        | 523,317        | 542,538        | 543,579        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL65                                 | 788,504        | 788,557        | 814,729        | 814,737        | 582,550        | 587,601        | 594,456        | 597,185        | 752,962        | 753,341        | 728,783        | 728,953        | 530,154        | 533,005        | 551,725        | 552,944        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL70                                 | 793,428        | 793,480        | 819,258        | 819,267        | 593,966        | 599,520        | 605,906        | 609,057        | 764,482        | 764,935        | 739,880        | 740,093        | 540,159        | 543,157        | 561,471        | 562,834        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL75                                 | 800,233        | 800,282        | 825,542        | 825,551        | 603,159        | 609,124        | 615,183        | 618,717        | 774,425        | 774,948        | 749,467        | 749,725        | 548,120        | 551,213        | 569,268        | 570,749        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL80                                 | 807,132        | 807,174        | 831,850        | 831,857        | <b>605,129</b> | <b>610,523</b> | <b>617,414</b> | <b>620,516</b> | <b>777,651</b> | <b>778,029</b> | <b>752,493</b> | <b>752,680</b> | <b>549,486</b> | <b>552,168</b> | <b>570,596</b> | <b>571,833</b> |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL85                                 | <b>810,471</b> | <b>810,497</b> | <b>834,607</b> | <b>834,610</b> | 596,137        | 599,616        | 608,894        | 610,536        | 770,038        | 770,111        | 744,856        | 744,897        | 540,876        | 542,462        | 562,130        | 562,712        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| <i>Risk Aversion Coefficient = 4</i> |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL50                                 | 763,578        | 763,640        | 793,649        | 793,653        | 503,343        | 509,326        | 517,137        | 519,951        | 691,284        | 691,593        | 673,513        | 673,618        | 466,767        | 470,639        | 491,559        | 492,899        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL55                                 | 765,200        | 765,277        | 794,936        | 794,943        | 517,021        | 524,112        | 530,950        | 534,466        | 701,833        | 702,256        | 683,060        | 683,228        | 478,502        | 482,824        | 502,718        | 504,417        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL60                                 | 767,975        | 768,057        | 797,238        | 797,247        | 530,993        | 538,962        | 545,048        | 549,216        | 713,635        | 714,165        | 693,846        | 694,078        | 490,457        | 495,035        | 514,167        | 516,146        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL65                                 | 772,314        | 772,389        | 800,918        | 800,927        | 545,255        | 553,833        | 559,410        | 564,119        | 726,651        | 727,269        | 705,884        | 706,167        | 502,694        | 507,336        | 525,932        | 528,080        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL70                                 | 778,821        | 778,887        | 806,548        | 806,557        | 559,799        | 568,731        | 574,041        | 579,155        | 740,802        | 741,490        | 719,079        | 719,406        | 515,141        | 519,710        | 537,940        | 540,173        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL75                                 | 787,501        | 787,558        | 814,121        | 814,131        | 571,665        | 580,797        | 586,043        | 591,472        | 753,186        | 753,936        | 730,617        | 730,987        | 525,160        | 529,591        | 547,626        | 549,897        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL80                                 | 796,371        | 796,417        | 821,756        | 821,763        | <b>575,765</b> | <b>583,836</b> | <b>590,447</b> | <b>595,100</b> | <b>758,577</b> | <b>759,094</b> | <b>735,378</b> | <b>735,636</b> | <b>528,123</b> | <b>531,826</b> | <b>550,393</b> | <b>552,233</b> |           |      |          |           |      |          |           |      |          |           |      |      |  |  |
| CL85                                 | <b>801,567</b> | <b>801,594</b> | <b>825,731</b> | <b>825,733</b> | 568,314        | 573,680        | 583,545        | 586,105        | 752,812        | 752,909        | 729,232        | 729,287        | 520,636        | 522,855        | 542,894        | 543,797        |           |      |          |           |      |          |           |      |          |           |      |      |  |  |

Notes: Values are certainty equivalents measured in U.S. dollars. Bold/underline figures are the maximum values.