Producer Welfare Implications of the RMA's "Shrinkage" Crop Insurance Premium Estimator

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Introduction

The federal crop insurance program provides U.S. agricultural producers risk management tools to manage crop yield and revenue losses on their farms. In 2013, the U.S. crop insurance program covered close to 296 million acres, or 90% of insurable crop land, assuming nearly $124 billion in liabilities through 1.22 million policies (USDA/RMA, 2014). The Risk Management Agency (RMA), a division of the USDA, administers this program.

The traditional product offered by the RMA, which for the purpose of simplicity is the focus of this paper, is a farm-level, multiple-peril, crop yield insurance policy (MPCI). This policy protects against low yield and crop quality losses due to adverse weather and unavoidable damage from insects and disease (Barnett, 2000). High participation has been achieved through large subsidies, with farmers as a whole now paying less than 40% of the total amount of premiums required to keep the program solvent (USDA/RMA, 2014).

The rate-setting process for the MPCI yield program can be divided into two major steps. The first step computes a county-level premium based on historical county-wide indemnities and liabilities. The second step sets farm-level rates based on the county-level premium and the producer's historical farm-level yield records using an exponential "shrinkage" crop insurance premium estimator which compresses the premium estimates implied by the individual farm data towards the county mean (Milliman and Robertson, Inc., 2000).

Recent research shows that RMA's premium estimates are subject to substantial errors relative to the "true" (i.e., actuarially correct) premiums. This high degree of inaccuracy in the RMA estimation of crop insurance premiums could, by itself, account for most of the substantial subsidies that are being needed to keep the program solvent (Ramirez and Carpio, 2012). In other words, in contrast to what has been suggested in past literature and public debate, the high

program costs might not be due to poor program management or political influence to benefit particular constituencies (i.e., deliberate subsidies to some crops and regions) (e.g., Harwood et al., 1999). Ramirez and Carpio's (2012) results also suggest that under the current rate-setting protocols, producer error in estimating what their actuarially fair premium (AFP) could have as much of a negative impact on program performance (i.e., the need for high external subsidies) as insurer error, and that random uncertainty in the producers' premium estimates on top of the insurer's error can exacerbate the need for subsidies.

This study focuses on exploring the impact of inaccuracies in premium estimation by both the insurer (RMA) and the producer on the distribution of the premiums paid and thus the subsidies received by the participating farmers. Specifically, using an exponential "shrinkage" estimator akin to the RMA's, given a particular intended subsidy level (e.g., 50%), we estimate the probabilities that a producer would end up paying various percentages of his/her true AFP and thus receiving different effective subsidy levels. We also explore the implications of the RMA exponential "shrinkage" crop insurance premium estimator on the relative economic welfare of participating producers. The results presented in this paper show a wide spread in the effective subsidy levels. More importantly, the study results show that the RMA "shrinkage" estimator has the unintended negative consequence of disproportionally subsidizing the producers who are less effective in managing risk, i.e. those whose farms exhibit more yield variability receive much more generous subsidies that the producers with lower levels of yield variability.

Data

Farm-level yield data from prototypical Midwestern corn producing counties is repeatedly simulated (NR=1000 runs per scenario, SS=10 and 20 yield observations per farm) under the

assumption of normal and non-normal (left-skewed) yield distributions. Each county is assumed to be comprised of NF farms (NF = 50 and 200) whose yields exhibit low (CC=0.25) and moderate (CC=0.50) levels of linear correlation with each other. The true means and standard deviations of the farm-level yield distributions are drawn to randomly range from 150 to 170 and 30 to 40 bushels per acre (wide range scenario) and 155 to 165 and 32.5 to 37.5 bushels per acre (narrow range scenario) according to a simple uniform (i.e., equal probability) distribution.

In the case of the non-normal scenario, the true underlying skewness and kurtosis measures of the distributions are assumed to randomly range from 0 to -3.25 and 0 to 23.5, respectively, also according to a uniform distribution. As described in the following section, the distribution (Ramirez, Misra and Field, 2003) is utilized to simulate non-normal yields with those characteristics. The analyses are conducted under two sample size (SS) scenarios of 10 and 20 observations per farm. Thus, for any particular scenario, each run consists of SS yield simulations from NF different farms.

These yield simulation scenarios are designed to resemble the characteristics of corn production in the Midwestern US. For example, when yields are assumed to be normally distributed, at the highest mean of 170 bushels per acre and lowest standard deviation of 30 bushels per acre the probability of observing a yield value under 120 bushels per acre or over 220 bushels per acre is only 10% (5% under and 5% over). This would have to be a superior farmer with limited downside and substantial upside yield potential. At the lowest mean of 150 bushels per acre and highest standard deviation of 40 bushels per acre, the 5% probability bounds are 85 and 215 bushels per acre. This could be a farmer with sizable downside but also high upside yield potential.

Alternatively, when yields are assumed to follow a substantially left skewed S_U distribution, at the highest mean of 170 bushels per acre and lowest standard deviation of 30 bushels per acre and skewness and kurtosis values of -3.25 and 23.5, the 5% probability boundaries are 115 and 195 bushels per acre (Figure 1). These expand to 95 and 205 bushels per acre at the highest mean and standard deviation of 170 and 40 bushels per acre (Figure 2). In other words, the upside yield potential from the mean of 170 bushels per acre is less than half as much as the downside potential. It is believed that these left-skewed distributions are more consistent with the likely behavior of farm-level corn yields in the Midwestern US.

Yield Simulation

Correlated normal and non-normal yield series are required for the purposes of this study. To this effect, a (1xNF) vector of standard normal draws ($\mathbf{V_t}$) is first correlated by multiplying it times the Cholesky decomposition of the desired (NFxNF) cross-farm correlation matrix (Ramirez, 1997). To simulate normal yields, the resulting (1xNF) vector ($\mathbf{VC_t}$) is element-by-element multiplied times the desired (1xNF) standard deviation vector ($\boldsymbol{\sigma}$) and the result is added to the chosen (1xNF) mean vector ($\boldsymbol{\mu}$). The process is repeated until the specified sample size (SS) is achieved. As previously discussed, the elements of $\boldsymbol{\mu}$ and $\boldsymbol{\sigma}$ are drawn to randomly range from 150 to 170 and 30 to 40 bushels per acre (wide range scenario) and 155 to 165 and 32.5 to 37.5 bushels per acre (narrow range scenario) according to a simple uniform distribution.

In light of its documented flexibility to generate a wide range of mean-variance-skewness-kurtosis combinations, the expanded form of the S_U family of parametric distributions (Ramirez, Misra and Field, 2003) is adopted for simulating non-normal yields. Simulation from this distribution is conducted as follows:

$$(1) \qquad \mathbf{Y_t} = \boldsymbol{\mu} + [\{\boldsymbol{\sigma}^2/G(\theta,\delta)\}^{1/2}.*\{\sinh(\theta(\mathbf{VC_t}+\delta)-F(\theta,\delta)\}]/\theta,$$

$F(\Theta,\delta) = E[\sinh(\theta(\mathbf{VC_t}+\delta)] = \exp(\theta^2/2)\sinh(\theta\delta)$, and

$G(\Theta,\delta) = \{\exp(\theta^2)-1\}\{\exp(\theta^2)\cosh(-2\theta\delta)+1\}/2\theta^2$,

where $\mathbf{Y_t}$ is a (1xNF) vector of correlated non-normal crop yields; $\boldsymbol{\mu}$ is the (1xNF) mean vector; $\boldsymbol{\sigma}$ is the (1xNF) standard deviation vector; $-\infty<\theta<\infty$ and $-\infty<\delta<\infty$ are other (scalar) distributional parameters exclusively controlling skewness and kurtosis; sinh, cosh, and exp denote the hyperbolic sine and cosine and the exponential function; $\mathbf{VC_t}$ is a (1xNF) vector of correlated standard normal draws; and (.*) denotes an element-by-element vector multiplication. According to Ramirez, Misra and Field (2003), the (1xNF) vector of simulated yields exhibits the following characteristics:

(2) $E[\mathbf{Y_t}] = \boldsymbol{\mu}$, $Var[\mathbf{Y_t}] = \boldsymbol{\sigma^2}$, $Skew[\mathbf{Y_t}] = S(\theta,\delta)$, $Kurt[\mathbf{Y_t}] = K(\theta,\delta)$,

where $S(\theta,\delta)$ and $K(\theta,\delta)$ involve lengthy combinations of exponential and hyperbolic sine and cosine functions. Note that the former imply that $E[\mathbf{Y_t}] = \boldsymbol{\mu}$, regardless of the values of $\boldsymbol{\sigma^2}$, θ, and δ, and that the variance of $\mathbf{Y_t}$ is solely determined by $\boldsymbol{\sigma^2}$. The skewness and kurtosis of the $\mathbf{Y_t}$ distribution are exclusively determined by the parameters θ and δ. If $\theta\neq0$ and δ approaches zero, the $\mathbf{Y_t}$ distribution becomes symmetric, but it remains kurtotic. Higher absolute values of θ cause increased kurtosis. If $\theta\neq0$ and $\delta>0$, $\mathbf{Y_t}$ has a kurtotic and right-skewed distribution, while $\delta<0$ results in a kurtotic and left skewed distribution. Higher absolute values of δ produce increased skewness. Because of these characteristics, this expanded form of the S_U family of parametric distributions is capable of generating a wide range of mean-variance-skewness-kurtosis combinations (see Ramirez, McDonald and Carpio 2010, Figure 1). More importantly, for the purposes of this study, these make it possible to independently pre-specify the desired mean, standard deviation, skewness, and kurtosis values for the simulated yield distributions.

Actuarially Fair Premiums

The actuarially fair premiums (AFP) corresponding to each of the yield distributions in the analyses for the Actual Production History (APH) insurance program under a price guarantee (p_g) of $5 per bushel and 60, 65, 70, 75, and 80% coverage levels (CL) are computed using standard methods. Specifically, the formula for computing the AFP is (Ramirez and Carpio, 2012):

(3) $$AFP = \int_0^{\alpha\mu} p_g(\alpha\mu - y)f(y)dy,$$

where $f(y)$ the is the probability density function of yields (y), α is the coverage ratio (i.e., α=CL/100), μ is the true mean of y, and p_g is the guaranteed price.

For the case of normally distributed yields, the integral in equation (3) exhibits the following closed form solution:

(4) $AFP = p_g P(\alpha\mu - \mu) + Z\sigma$, where:

$P = Z(0.4361836T-0.1201676T^2+0.937298T^3)$;

$D = (\mu-\alpha\mu)/\sigma$;

$Z = (2\pi)^{-1/2}\exp(-0.5D^2)$; and

$T = (1+0.33267D)^{-1}$.

Since there is no closed-form solution for that integral when the yield distribution $f(y)$ is not normal (i.e., S_U), the AFP is numerically computed as follows:

(5) $$AFP = \frac{1}{T}\sum_{t=1}^{T} I\{Y_t < \alpha\mu\}p_g(\alpha\mu - Y_t),$$

where I{.} is an indicator function that takes a value of one if true and zero otherwise, the Y_t values are simulated from an S_U distribution with the desired mean, standard deviation, skewness and kurtosis characteristics, T=1,000,000, and p_g, α, and μ are as previously defined.

Select statistics about the actuarially fair premiums corresponding to the different yield simulation scenarios outlined in the previous section, and various coverage levels, are presented in Table 1. For scenarios (i.e., counties) with normal yields and a wider range of true means and standard deviations (150 to 170 and 30 to 40 bushels per acre), at the 65% coverage level, the AFPs range from $1.45 to $8.72 and average $4.56 per acre. Additionally, the average frequency of claims is 18.9 years, with a range of 10.7 to 39.3 years. That is, the most risky of the 200 farmers in this particular simulation batch would, on average, have one claim about every 11 years or so, while the least risky will only have a claim about every 40 years, on average. In contrast, at the 85% coverage level, the AFPs range from $16.97 to $35.63 and average $26.55 per acre, and the frequency of claims ranges from 3.5 to 5 and averages just about 4 years.

In the left-skewed yield scenarios, the average AFPs seem more consistent with what is observed in reality. At 65% coverage, they range from $1.85 to $15.48 and average $8.60 per acre, while at 85% coverage they range from $18.62 to $37.97 and average $28.86 per acre. When a narrowed dispersion of true means (155 to 165 bushels per acre) and standard deviations (32.5 to 37.5 bushels per acre) is assumed, as expected, the average premiums and claim frequencies remain about the same while their ranges are somewhat tighter. Nevertheless, the wide range of AFPs observed in these scenarios, particularly at the lower (65% to 75%) coverage levels, offers an insight to a potential pitfall of the RMA's "shrinkage" estimator.

As it will be demonstrated in the following sections, the RMA estimator yields farm-level premium estimates that are substantially "shrank" towards the county average. Thus, if no subsidies were provided, those producers whose AFPs are close to the lower or upper bounds of the county range would inevitably end up paying quite a bit more or less that what they should.

The RMA "Shrinkage" Estimator

As previously suggested, the RMA "shrinkage" estimator is based on historical losses, costs, and yield information from all farms in a particular county. In order to be able to make the desired comparisons between the RMA-type premium estimates and their corresponding actuarially fair premiums, estimates are repeatedly computed on the basis of simulated normal and non-normal yield samples following the experimental design described in the data section. The RMA-type ratemaking procedure for each farm *i* involves: 1) estimation of farm-level indemnities and liabilities; 2) estimation of county-level rates using farm-level indemnities and liabilities; and 3) estimation of farm-level premiums using county rates (CPR) and farm- and county-level yields.

Estimation of farm-level indemnities and liabilities

Farm-level indemnities paid to a farm with an $\alpha x 100\%$ coverage level of the APH yield is given by:

$$(6) \qquad \mathrm{FLI_{it}} = \mathrm{p_g Y_{it}^*}, \text{ where } \mathrm{Y_{it}^*} = \begin{cases} \alpha \mathrm{APH_{it}} - \mathrm{Y_{it}} & \text{if } \mathrm{Y_{it}} < \alpha \mathrm{APH_{it}} \\ 0 & \text{otherwise} \end{cases},$$

where $\mathrm{FLI_{it}}$ is the indemnity paid to farm *i* in year *t*, $\mathrm{Y_{it}}$ is the observed yield for farm *i* in year *t*, and $\mathrm{APH_{it}}$ is the RMA's approved actual production history yield for farm *i* in year *t*. Farm-level liabilities for the same farm *i* in year t ($\mathrm{FLL_{it}}$) are given by:

$$(7) \qquad \mathrm{FLL_{it}} = \alpha \mathrm{p_g APH_{it}}.$$

Our procedure to calculate $\mathrm{APH_{it}}$ follows the method used by the RMA. At the beginning of the historical period, when a farmer enters the program, the RMA assigns a transitional yield (t-yield) based on the county average. That is, the RMA APH yields are not entirely based on the observed farm-level yields during the first four years of "history." For our analysis, $\mathrm{APH_{it}}$ yields were simulated as follows: $\mathrm{APH_{i1}}$ for all *i*'s was the average yield of a different batch of yield simulations, which is meant to simulate the county average during previous years (t-yield).

APH_{i2} was the first simulated yield value plus three times the t-yield, divided by four. APH_{i3} and APH_{i4} are analogously calculated. Thereafter, APH_{ij} (j=5,…,n) is computed using the average of all available simulated farm-level yield values only.

Estimation of county-level rates

For any year t, the simulated indemnity, liability, and CPR for the NF group of farms are (Milliman and Robertson, Inc., 2000):

(8) $$\text{Indemnity}_t = \sum_{i=1}^{NF} FLI_{it},$$

(9) $$\text{Liability}_t = \sum_{i=1}^{NF} FLL_{it},$$

(10) $$CPR_t = \frac{\text{Indemnity}_t}{\text{Liability}_t}.$$

The simulated *CPR* using *SS* observations (i.e., years) in the sample is:

(11) $$CPR = \frac{1}{SS}\sum_{t=1}^{SS} CPR_t.$$

Estimation of farm-level premiums using county rates and farm- and county-level yields

The main equation underlying the RMA ratemaking procedure is (Milliman and Robertson, Inc., 2000):

(12) $$GLP_i = \alpha\, p_g APH_{iSS} CPR\left(\frac{APH_{iss}}{Yavc}\right)^{Exp},$$

where GLP_i is farm's *i* county-based premium rate, *Exp* (the *Exponential*) is an exponent which value is usually less than -1, and APH_{iSS} and Yavc are the APH yield for farm *i* and county average yield, respectively (Milliman and Robertson, Inc., 2000). Both APH_{iSS} and Yavc are calculated using the entire sample of simulated yields (SS). Although this is a simplified version of the equation used by the RMA, it includes all the elements that are central for our analysis.[1] The logic underlying equation (12) is that the individual farm-level premiums can be established

[1] The RMA procedure includes a myriad of other elements such as caps on premiums levels, adjusting losses and exposures to a common coverage level, and excess loss adjustments (Milliman and Robertson, Inc., 2000).

using the county rate (CPR) as the baseline. The *Exponential* is used so that farmers with yields that are above the area's average pay lower premiums and vice versa (Knight, 2000).[2]

The *Exponential* needed for the calculation of the GLPs was estimated by minimizing the mean root squared proportional errors of the predicted GLPs relative to their corresponding AFPs (i.e., by minimizing $\frac{1}{NF}\sum_{i=1}^{NF}\sqrt{\left[\frac{GLP_i-AFP_i}{AFP_i}\right]^2}$).[3]

It is important to note that the actual method used by the RMA to calculate the *Exponential* is not publicly available. The only RMA document where exponentials are estimated is in Knight's (2000) examination of yield span adjustments, in which an equation similar to (12) is estimated through a two-step Heckman procedure. Coble et al. (2009) suggest the use of non-linear least squares to estimate the *Exponential*. In both cases, the dependent variable in the model is the average indemnity paid to farmers during the 1 to SS period ($\overline{FLI}_{i1-SS}$) which is a nonparametric estimate of the true AFP, and therefore, subject to substantial sampling error (Ramirez, Carpio, and Rejesus, 2011). Since in our case, we know the true AFPs for each farm i, we used these information instead of the estimated AFPs.

Characteristics of the RMA Premium Estimates

The procedure discussed in the above section is used to estimate the set of NF farm-level premium estimates corresponding to each of the previously discussed scenarios (i.e., counties). Summary statistics about these premium estimates for the scenarios where NF=200 and CC=0.50 and a sample size (SS) of 20 yield observations per farm are also presented in Table 1 (statistics

[2] According to Milliman and Robertson, Inc. (2000; p.33), the RMA developed the formula based on research which demonstrated that "on average, the probability of a loss is greater for producers with a yield lower than the average for an area and vice versa."

[3] Similar results were obtained when the *Exponential* was found by minimizing the mean proportional errors ($\frac{1}{NF}\sum_{i=1}^{NF}\left[\frac{GLP_i-AFP_i}{AFP_i}\right]$) or the mean absolute proportional errors($\frac{1}{NF}\sum_{i=1}^{NF}\left|\left[\frac{GLP_i-AFP_i}{AFP_i}\right]\right|$).

for the same scenarios at NF=50, CC=0.25, and SS=10 observations per farm are available from the authors upon request). First note that the premium estimates are biased in the aggregate (i.e., at the county level) and, due to the "shrinkage" nature of the RMA's estimator, are tightly clustered around their average. Their bias can be as high as -12% but, under the normal and the left-skewed yield distributions, it steadily declines with higher coverage levels.

In addition, these statistics provide further insight to the problem faced by the RMA. In the more realistic case of the left-skewed yields and the wider range of true means and standard deviations, for example, the premium estimates at the 65% coverage level only span from $7.23 to $8.10 per acre while the AFPs range from $1.85 to $15.48, and the correlation between the estimated and the true premiums is only 0.21. Clearly, if no subsidies were provided, a substantial number of producers would be paying much more while many others would be charged much less than what is actuarially fair.

The situation improves somewhat when a narrower range of true means and standard deviations is assumed, mainly due to the fact that the AFPs are not as dispersed. Further improvement is observed under higher coverage levels. At 85% coverage, for example, the premium estimates span from $24.44 to $26.35 while the AFPs range from $21.08 to $33.53, although the correlation between the estimated and the true premiums is minimal. Thus, in this scenario, few producers would end up paying significantly less although many still might be charged quite a bit more than what is actuarially fair.

Distribution of Crop Insurance Subsidies

Basic Scenarios

In this section, the set of NF farm-level premium estimates corresponding to each of the scenarios (i.e., counties) will be used to explore the potential impact of RMA premium

estimation inaccuracy on the distribution of crop insurance subsidies across participating producers. The insurer (i.e,. RMA) and producer premium estimates are denoted by IPE and PPE, respectively, and in some scenarios it is assumed that producers are willing to pay a risk-protection premium (RPP) in excess of their PPE. Further, a government subsidy rate (GSR) to the insurer premium estimate (IPE) is assumed in order to replicate what is done in practice. A farmer's decision rule for participating in the program, thus, is given by:

(13) $\text{PPE}+\text{RPP} \geq (1-\text{GSR})\text{IPE}$,

i.e., that his/her own premium estimate plus any risk protection premium he/she is willing to pay is greater than the subsidized insurer's quote. Initially, it is assumed that the producer knows his/her AFP with certainty (i.e., PPE=AFP), but scenarios with various levels of producer uncertainty are explored and discussed later in this section.

Each of the NF farms (i) in a particular scenario is thus characterized by a set of two premium estimates, one by the producer (PPE_i) and one by the insurer (IPE_i), and a corresponding actuarially fair premium (AFP_i). The question of what is the distribution of the premiums paid by the participating producers relative to the AFP (i.e., what they should theoretically be paying) can then be answered by comparing the IPE_i of the participating farmers (i.e., what they ended up paying) with their AFP_i over a large number of repeated samples.

For this purpose, NR=1000 samples of NF farms each are repeatedly drawn for each scenario. The first step is to compute the expected producer participation rate (PPR), which is a function of PPE_i and IPE_i as well as the RPP and GSR. Specifically, letting $I\{.\}$ denote an indicator function that equals 1 if $\{.\}$ is true and 0 otherwise, the PPR for each sample r is:

(14) $$\text{PPR}_r = 100\,\frac{1}{\text{NF}}\sum_{i=1}^{NF} I\{\text{PPE}_i + \text{RPP} \geq (1-\text{GSR})\text{IPE}_i\}.$$

The average of equation (14) across the NR samples (PPR) is utilized to determine the GSR that is required to achieve a target level of participation. Specifically, the average of equation (14) is evaluated at GSRs ranging from zero to one and the value (GSR_{PPR}) that yields the desired expected producer participation rate (PPR=90% and 98%) is selected.

The next step is to calculate insurer premium estimates and actuarially fair premiums considering the farmer participation decision for all NF farms in the NR=1000 samples:

(15) $IPE_{ip} = IPE_i \, x \, I\{PPE_i+RPP \geq (1-GSR_{PPR})IPE_i\}$,

$AFP_{ip} = AFP_i \, x \, I\{PPE_i+RPP \geq (1-GSR_{PPR})IPE_i\}$,

where the subindex *p* is used to indicate that the premiums are conditional on participation in the program. An important side note to equation (15), is that if both PPE_i and IPE_i are subject to error and/or RPP>0, $(1-GSR_{PPR})IPE_{ip}$ could be less, equal, or more than AFP_{ip}. However, if only IPE_i is subject to error (i.e., $PPE_i = AFP_i$) and RPP=0, then $(1-GSR_{PPR})IPE_{ip} \leq AFP_{ip}$ (i.e., the producer would never pay more than the AFP). The next set of logical comparisons is conducted based on IPE_{ip} and AFP_{ip}:

(16) $I_{i,1.2-j} = I\{(1-GSR_{PPR})IPE_{ip} > (1.20-j)AFP_{ip}\}$ for j=0, 0.05, 0.10,…,1.00,

where the index 1.20-j indicates the proportion of premium being considered. For example, if $I_{i,1.2}=1$, this indicates that farmer i paid more than 100(1.20) percent of their AFP. The average across the NR=1000 samples of $100x\sum_{i=1}^{NF} I_{i,1.2-j}/NF$ (j=0, 0.05, 0.10,…,1.00) computes the expected percentage of farmers that ended up paying more than 100(1.20-j) percent of their AFP. Also note that the average value across the NR=1000 samples of:

(17) $PFG_{PPRr}=1-\sum_{i=1}^{NF}(1-GSR_{PPR})IPE_{ip} / \sum_{i=1}^{NF} AFP_{ip}$

calculates the expected proportion of the total indemnities to be paid out that would not be covered by the premiums collected from the producers (PFG_{PPR}), and thus will need to be funded by the government (PFG).

The statistics resulting from this process, assuming a 65% coverage level and a 90% target producer participation rate, are presented in Table 2a. The first scenario (SN1a) assumes normally distributed yields, no producer premium estimation error (i.e., $PPE_i=AFP_i$), no risk protection premium (RPP=0), NF=50 farms per county, SS=10 historical yield observations per farm, the wider range (Range=W) of true means and standard deviations, and a correlation coefficient of CC=0.25 across the NF=50 yield distributions. In this scenario, it is determined from the average of equation (14) across the NR samples (PPR) that a 49% government subsidy rate (GSR=0.49) is required to achieve the target of approximately 90% producer participation rate (PPR=0.901). Also using the average of equation (17) across the NR samples (PFG_{PPR}), it is determined that PFG=0.575, which means that in the long-run 57.5% of the indemnities would have to be funded by the government. In fact, given the high GSR, none of the participating producers end up paying more than what is actuarially fair for them. However, as detailed in Table 2a, while over 15% pay 75% or more of their AFP, in excess of 15% pay 25% or less than what they theoretically should. In other words, 15% of them receive less than a 25% premium subsidy while another 15% have over 75% of their AFP subsidized. Clearly, under this first scenario, the premium subsidies are very unequally distributed across the participating farmers.

Relative to SN1a, the second normal scenario in Table 2a (SN2a) raises the cross-farm correlation (CC) from 0.25 to 0.50. This higher correlation reduces the amount of independent yield information available for the RMA to estimate the premiums. Because of the less accurate premium estimates, a higher GSR (58%) is required to achieve 90% participation and the PFG

increases substantially as well. Given the larger subsidy level, a full 30% of the participating producers now pay just 20% or less of their corresponding AFP, while nearly 15% pay 70% or more of what they theoretically should. So it appears that a stronger correlation exacerbates the inequity in the distribution of the premium subsidies across participating producers.

Increasing the number of farms (NF) from 50 to 200 (SN3a) only affects the accuracy with which the county-level statistics (equations 8 to 11) required for premium estimation can be computed, and the results suggest that the improvement is only marginal (i.e., a slightly lower GSR and PFG and minimal shrinkage on the spread of the distribution of the subsidies). Doubling the sample size (SS) from 10 to 20 yield observations per farm (SN4a), however, noticeably increases the accuracy of the farm-level premium estimates, lowers the required GSR and PFG, and compresses the distribution of the crop insurance subsidies. Narrowing the dispersion (i.e., Range=N) in the true means (155 to 165 bushels per acre) and standard deviations (32.5 to 37.5 bushels per acre) of the NF farms in the county (SN5a) has a similarly benign effect. The main reason for this improvement is that the AFPs are now more tightly clustered around their mean and, since the RMA estimator substantially shrinks the estimates towards the county average, this reduces premium estimation error. In other words, the RMA estimator works best when the farm yield distributions are fairly homogeneous.

The most optimistic scenario while still assuming no premium estimation error by the producers and a zero risk protection premium is SN6a, where NF=200, SS=20, CC=0.25, and there is a very low level of true mean and standard deviation dispersion within the county (Range=N). Even in this overly optimistic scenario, approximately 15% of the farmers pay 85% or more of their AFP while another 15% pay 45% or less than what they should, i.e., at least 15% of them receive less than a 15% subsidy while another 15% have over 55% of their AFP

subsidized. Table 2b contains the statistics for the same scenario but an increased 98% target producer participation rate. As expected, the required GSRs and PFGs are substantially higher, and farmers pay lower percentages of their AFPs across the board. However, the relative dispersion of the premium subsidies remains about the same. In the most optimistic scenario (SN6b), for example, about 15% of the producers receive less than a 30% subsidy while another 15% have over 65% of their AFP subsidized.

Tables 3a and 3b and Tables 4a and 4b contain analogous information for the case of the 75% and 85% coverage levels, respectively. As the coverage level increases the premium estimates become relatively more accurate and, thus, there is a steady decline in the required GSRs and PFGs as well as some reduction in the relative level of dispersion of the premium subsidies. At the highest (85%) coverage level, 98% PPR, and the most optimistic scenario (SN6b in Table 4b), about 15% of the producers receive less than a 15% subsidy while another 15% have over 40% of their AFP subsidized. The GRP and PFG for this scenario (23% and 28.4%), however, are only about half of what is observed in practice, so this might not be a realistic case. In addition, the 3.8 to 4.4 year frequency of loss associated with such a high coverage level (Table 1) seems a bit excessive for a federally subsidized crop insurance product.

Analogous information for the scenarios that assume left-skewed yield distributions is presented in Tables 5a, 5b, 6a, 6b, 7a, and 7b. Everything else held constant, left-skewness decreases the accuracy of premium estimation, particularly at the lower coverage levels, which results in somewhat higher GSRs and PFGs across the board. As a consequence, farmers generally receive higher levels of subsidies. The relative dispersion of the premium subsidies seems to widen as well. At the 65% coverage level, 98% PPR and the most optimistic scenario (NF=200, SS=20, CC=0.25, and Range=N), for example, under normally distributed yields

(SN6b in Table 2b), 15% of the farmers pay 85% or more of their AFP and another 15% pay 45% or less, while under left-skewed yields (SS6b in Table 5b) over 15% pay 75% or more and about 15% pay 30% or less. The difference between the normal and the left-skewed results is less noticeable at the 85% coverage level: under normally distributed yields (SN6b in Table 4), 15% of the farmers pay 85% or more of their AFP and another 15% pay 60% or less, while under left-skewed yields (SS6b in Table 7b) over 10% pay 85% or more and about 12% pay 55% or less. However, both the normal and the left-skewed scenarios exhibit GSR and PFG levels that are much lower than what is observed in practice and are thus deemed unrealistic.

In fact, it can be argued that because of the assumption that the producer knows the AFP with certainty and is not willing to pay a risk protection premium (RPP), none of the previously discussed scenarios are truly realistic. More sophisticated scenarios have to be developed in order to investigate these factors.

More Sophisticated Scenarios

The difficulty with developing these scenarios is that, unlike in the case of the insurer, no one knows how the producers develop an estimate or perception of the maximum crop insurance premium that they are willing to pay. Thus, the only alternative is to devise a process to simulate their premium estimates that makes economic and logical sense and produces results (i.e., GSR and PFG values) that are consistent with what is observed in practice.

Specifically one would assume that since, as the RMA, the farmer weighs his/her recent yield history when deciding how much he/she is willing to pay and would perhaps give some credence to the quote provided by the insurer, there should be some level of correlation between the producer and the RMA premium estimates (PPE_i and IPE_i). One would also assume that the farmer's estimate is at least as accurate and correlated with the AFP as the RMA's. Finally, while

it is reasonable to assume that the producers are willing to pay some risk protection premium for crop insurance, it is also possible that they tend to underestimate their AFP (i.e., believe that they should pay less than what is actuarially called for). If this is the case, their estimate would exhibit a downward bias that might offset any RPP they are willing to pay.

Therefore, in these scenarios, the producer premium estimates are constructed as simple linear functions of the true premium (AFP_i) and the RMA estimate (IPE_i), calibrated so as to exhibit no bias and the desired risk protection premium, level of accuracy, and correlation with AFP_i and IPE_i. Specifically:

(18) $PPE_i = \{1+RPP\}\{AFP_i + CF*(IPE_i-EB_i)\}$,

where EB_i is the expected bias in IPE_i and CF is the calibration factor. EB_i is computed endogenously as the average bias exhibited by the insurer premium estimates for producer i across the NR=1000 runs and its presence ensures that PPE_i is an unbiased estimate for AFP_i. Note that if CF=0 and RPP=0, $PPE_i = AFP_i$ as assumed in the previously discussed scenarios.

SN7a in Table 2a is the same as SN6a in regard to NF, SS, CC, and Range (i.e., the factors driving the characteristics of IPE_i) but while RPP is still zero, CF is set to 0.75. This yields a PPE_i that is unbiased with no RPP, has a percentage root mean square error (around AFP_i) of PRMSE= 27.4% (versus 44.9% for IPE_i), and exhibits a linear correlation of 0.253 with IPE_i. The effect of introducing an error with such characteristics on PPE_i is a marked reduction on the GSR and PFG required for 90% producer participation. Unfortunately, this producer error in premium estimation also broadens the distribution of the premiums they pay by a substantial margin to where many (19%) now pay more than their corresponding AFP while a full 18% pay less than 40% of it. Interestingly, increasing producer error to the same level as the insurer's (PRMSE of about 46%) by setting CF to 1.25 reverses some of the reductions in the GSR and

PFG (SN8a), suggesting that the effect of such error on these two program performance measures is not linear. The degree of dispersion of the subsidies received by participating producers, though, remains about the same. Scenarios SN9a and SN10a are the same as SN7a and SN8a, except that they introduce a 15% risk protection premium (i.e., RPP=0.15). As expected, having a positive RPP substantially reduces the GSR and PFG, but it actually widens the subsidies' dispersion.

As previously noted, the GSR, PFG, and subsidy dispersion markedly decrease with increased coverage levels. However, even at CL=85% and PPR=98%, for all four CF-RPP combinations (SN7b, SN8b, SN9b, and SN10b in Table 4b), the range of the subsidies received by the participating producers remains quite high. At low producer error (CF=0.75, PRMSE= 27.4%) and a RPP of 15%, for example, 14% receive more than a 30% subsidy while 13.7% pay 20% or more of their AFP. The low GSR and PFG (0% and 6%, respectively) associated with this scenario, however, are not consistent with reality. Out of these four, the scenario with the highest GSR and PFG (20% and 25%) is SN8b (CF=1.25/PRMSE=46%, RPP=0). In this case, 8.4% receive more than a 50% subsidy while 10.8% actually end up paying more than their AFP.

Analogous information for these four more sophisticated scenarios (SN8-SN10) assuming left-skewed yield distributions is also presented in Tables 5a, 5b, 6a, 6b, 7a, and 7b. As in the simpler scenarios (SN1-SB7), everything else held constant, left-skewness decreases the accuracy of premium estimation, particularly at the lower coverage levels, which results in somewhat higher GSRs and PFGs across the board. As a consequence, farmers generally receive higher levels of subsidy. The relative dispersion of the premium subsidies seems to widen as well, i.e., yield left-skewness raises the inequity in the distribution of those subsidies across the participating producers. It can thus be argued that this is an unavoidable disadvantage of crop

insurance. While, through substantial external subsidies, it is possible to avoid a situation where too many farmers end up paying more than the AFP, it appears that the distribution of those subsidies across participating farmers will always be highly and randomly uneven. Just by chance, some producers will receive a large share of the subsidy while others get very little or possibly even none at all.

A final important issue that can be analyzed using the data underlying the previously discussed scenarios is whether there is any correlation between the level of risk associated with a particular operation and the percentage subsidy it receives. The relationship between these two variables under one of the more realistic scenarios is plotted in Figure 3. Note that all high-risk operations (with AFPs between $15 and $18 per acre) receive percentage subsidies of ranging from 58% to 65%, which means that these producers end up paying premiums of $6 to $7 per acre. In contrast, low-risk operations (with AFPs between $6 and $7 per acre) receive little or no subsidy and thus end up paying nearly the same premiums as the high-risk operations.

In hindsight, this is an obvious result of the "shrinkage" nature of the RMA method to estimate the farm-level premiums. In this particular case, for example, the AFPs range from $5.5 to $18.5 per acre while the RMA premium estimates range from $10 to $12 per acre. Because of this reason, it is evident that APH crop insurance channels the vast majority of the government subsidies to high-risk producers who are not as adept in managing their yield risks, and there is no reason to expect differently in the case of revenue (CRC) insurance.

Concluding Remarks

The first contribution of this study is to ascertain some key characteristics of the RMA's crop insurance premium estimates. Specifically, under fairly realistic conditions, it is concluded that the estimates are biased both at the individual (farm) and aggregate (county) level. It is also

demonstrated that the farm-level premium estimates are tightly "shrank" towards the county average. Thus, unless the actuarially fair premiums (AFP) are highly homogeneous within the county, if no subsidies are provided those producers whose AFPs are close to the lower or upper bounds of the county range would inevitably end up paying quite a bit more or less than what they actually should.

The main contribution, however, is to explore the potential impact of RMA premium estimation inaccuracy on the distribution of crop insurance subsidies across the producers participating in the program. Through the analyses, it is determined that a variety of factors can negatively impact (i.e., broaden the range) of that distribution, namely a wider mean and variance dispersion across farms, a higher cross-yield correlation, a smaller sample size or number of farms in the county, a lower coverage level, producer uncertainty about his/her AFP, and yield left-skewness.

Under all realistic scenarios comprising feasible combinations of those factors, the distribution of the subsidies is found to exhibit a relatively high level of dispersion to where it seems likely that some farmers will receive little or no subsidies while others have more than 50% of their actuarially fair premium subsidized. In addition, the analyses suggest that APH crop insurance channels the vast majority of the government subsidies to high-risk producers who are not as adept in managing their yield risks, and there is no reason to expect differently in the case of revenue (CRC) insurance. These findings raise the question of whether crop insurance is a sensible, efficient, and equitable mechanism to dispense agricultural subsidies.

Finally, it is hoped that the analytical framework developed in this study can be used by policy makers and the RMA to better understand how the previously discussed factors affect the various aspects of program performance (i.e., the percentage premium subsidy required to

achieve a certain producer participation rate at a given coverage level, the percentage of future indemnities that will then have to be paid by the government, and the relative distribution of the government subsidies across participating producers), and use that information to improve the actuarial and equity/welfare characteristics of the crop insurance program.

References

Barnett, B.J. 2000. "The US Federal Crop Insurance Program." *Canadian Journal of Agricultural Economics* 48,4(2000): 539-551.

Coble, K.H., T.O. Knight, B.K. Goodwin, M.F. Miller, and R.M. Rejesus. *A Comprehensive Review of the RMA APH and COMBO Rating Methodology: Draft Final Report* (2009). Actuarial Publication submitted to the RMA and posted in the RMA website at: http://www.rma.usda.gov/pubs/2009/comprehensivereview.pdf

Harwood, J., R. Heifner, K. Coble, J. Perry, and A. Somwaru. 1999. "Managing Risk in Farming: Concepts, Research, and Analysis." Agr. Econ. Rep. No. 774, USDA/Economic Research Service, Washington, DC.

Knight, T.O. 2000. "Examination of Appropriate Yield Span Adjustments by Crop and Region." Report prepared for the Economic Research Service, USDA, Washington, DC.

Milliman and Robertson, Inc. 2000. "Actuarial Documentation of Multiple Peril Crop Insurance Ratemaking Procedures." Consulting report prepared for the Risk Management Agency, USDA. Kansas City, MO: USDA-Risk Management Agency.

Ramírez, O.A. Estimation and use of a multivariate parametric model for simulating heteroscedastic, correlated, non-normal random variables: The case of corn-belt corn, soybeans and wheat yields. *American Journal of Agricultural Economics* 79(February 1997): 191-205.

Ramirez, O.A. and C.A. Carpio. "Premium estimation inaccuracy and the performance of the US crop insurance program" *Agricultural Finance Review* 72,1(May 2012):117-133.

Ramirez, O.A., C.E. Carpio, and R.M. Rejesus. "Can Crop Insurance Premiums be Reliably Estimated?" *Agricultural and Resource Economics Review* 40,1(2011): 81-94.

Ramirez, O.A., T.U. McDonald and C.A. Carpio. "A flexible parametric family for the modeling and simulation of yield distributions." *Journal of Agricultural and Applied Economics* 42, 2(May 2010):1-17.

Ramirez, O.A., S.K. Misra, and J.E. Field. Crop yield distributions revisited. *American Journal of Agricultural Economics* 85,1(February 2003):108-120.

USDA, Risk Management Agency, Federal Crop Insurance Corporation. Summary of Business Report for 2011 thru 2014, April 2014. Available at: http://www3.rma.usda.gov/apps/sob/current_week/sobrpt2011-2014.pdf

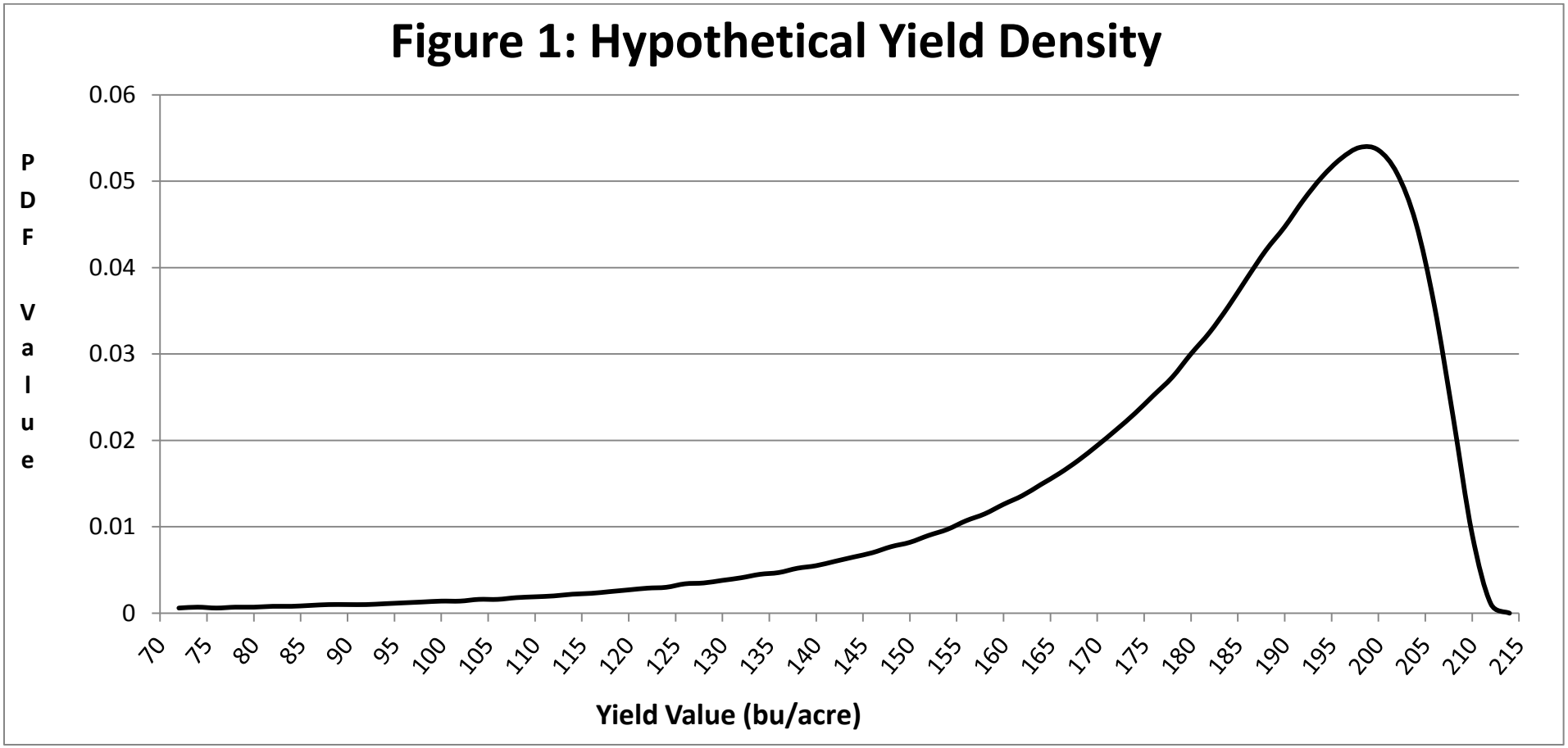
Figure 1: Hypothetical Yield Density
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80
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95
100
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115
120
125
130
135
140
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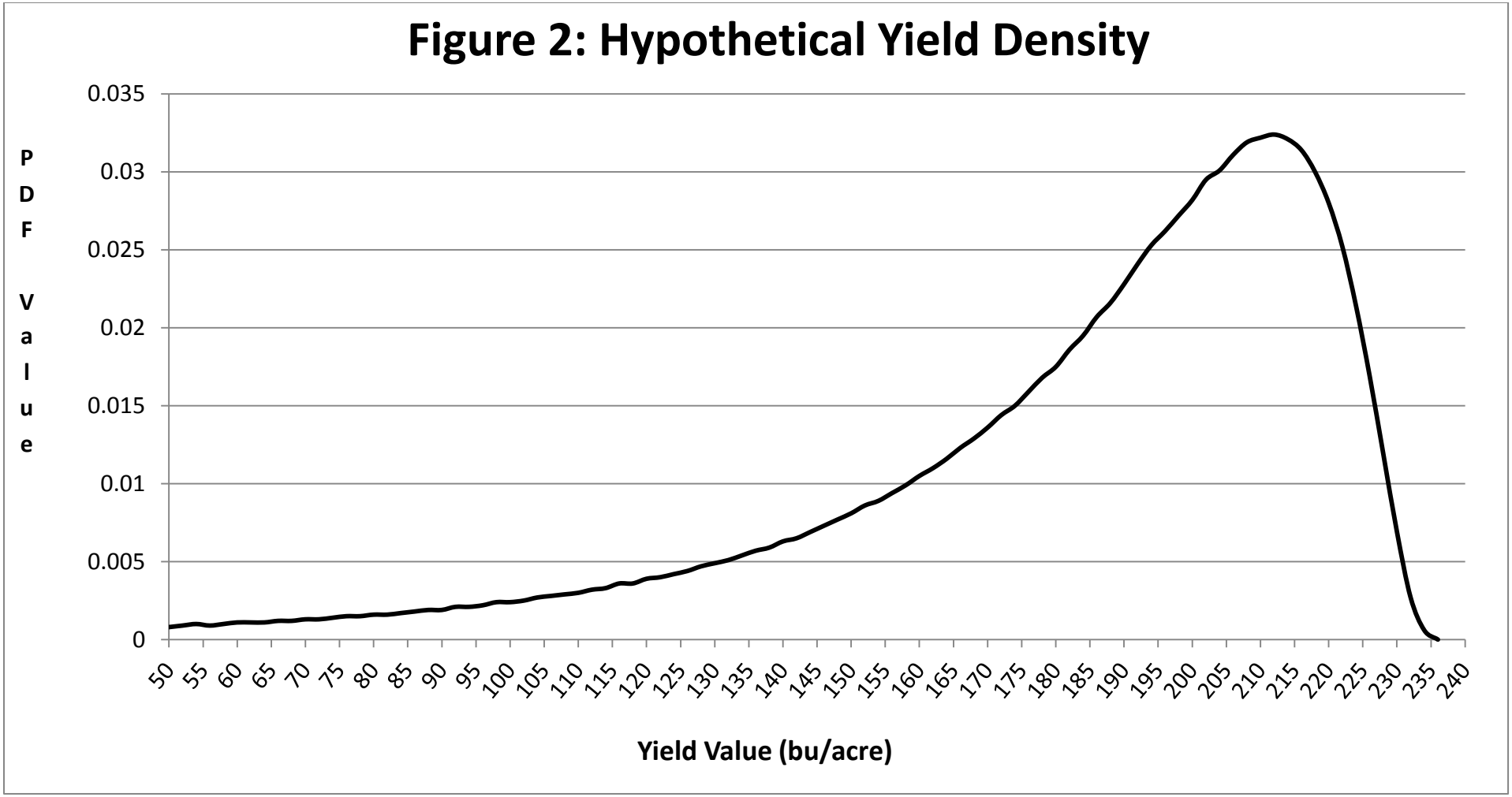
215
Yield Value (bu/acre)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Yield Value (bu/acre)

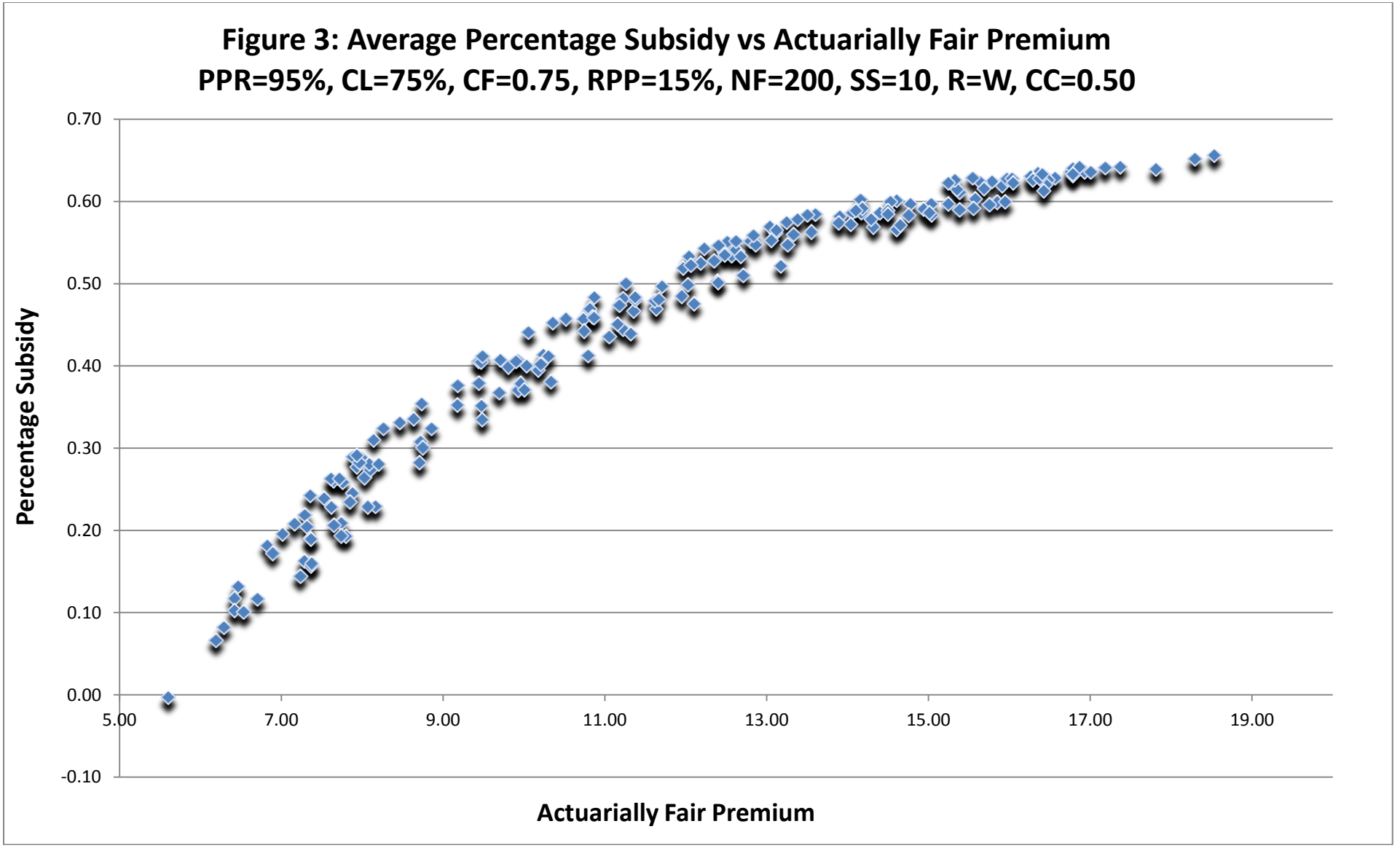
Figure 3: Average Percentage Subsidy vs Actuarially Fair Premium
PPR=95%, CL=75%, CF=0.75, RPP=15%, NF=200, SS=10, R=W, CC=0.50
Percentage Subsidy
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
5.00
7.00
9.00
11.00
13.00
15.00
17.00
19.00
Actuarially Fair Premium

Table 1: Select Premium and Coverage Statistics for the Main Scenarios in the Analysis

Normal		**CL**	**%NZ**	**AFPMIN**	**AFPAVE**	**AFPMAX**	**ESTPMIN**	**ESTPAVE**	**ESTPMAX**	**%BIAS**	**CORREL**	**FREMAX**	**FREAVE**	**FREMIN**
#farms	**200**	65.0%	1.000	1.454	4.560	8.720	3.789	4.195	4.727	-0.080	0.412	39.308	18.901	10.709
mean	**150/170**	70.0%	1.000	2.940	7.445	12.884	6.343	6.903	7.639	-0.073	0.382	21.212	11.963	7.753
sig	**30/40**	75.0%	1.000	5.594	11.756	18.548	10.249	10.997	11.986	-0.065	0.348	12.235	7.965	5.780
skew	**0**	80.0%	1.000	10.028	17.959	26.025	16.012	16.958	18.214	-0.056	0.311	7.550	5.558	4.440
kurt	**0**	85.0%	1.000	16.967	26.547	35.630	24.204	25.303	26.777	-0.047	0.264	4.969	4.055	3.499
Left-Skewed		**CL**	**%NZ**	**AFPMIN**	**AFPAVE**	**AFPMAX**	**ESTPMIN**	**ESTPAVE**	**ESTPMAX**	**%BIAS**	**CORREL**	**FREMAX**	**FREAVE**	**FREMIN**
#farms	**200**	65.0%	1.000	1.851	8.599	15.481	7.234	7.584	8.095	-0.118	0.211	33.193	16.158	10.501
mean	**150/170**	70.0%	1.000	3.568	11.661	19.214	9.958	10.423	11.108	-0.106	0.166	18.671	11.639	7.760
sig	**30/40**	75.0%	1.000	6.522	15.817	23.843	13.737	14.355	15.267	-0.092	0.142	12.204	8.534	5.791
skew	**0/-3.25**	80.0%	1.000	11.309	21.413	30.133	18.898	19.755	20.988	-0.077	0.125	9.251	6.354	4.443
kurt	**0/23.5**	85.0%	1.000	18.615	28.860	37.972	25.981	27.073	28.637	-0.062	0.114	6.955	4.800	3.507
Rigth-Skewed		**CL**	**%NZ**	**AFPMIN**	**AFPAVE**	**AFPMAX**	**ESTPMIN**	**ESTPAVE**	**ESTPMAX**	**%BIAS**	**CORREL**	**FREMAX**	**FREAVE**	**FREMIN**
#farms	**200**	65.0%	0.810	0.000	1.896	8.640	--	--	--		--	Never	86.383	10.756
mean	**150/170**	70.0%	0.865	0.000	3.433	12.785	--	--	--		--	Never	38.367	7.773
sig	**30/40**	75.0%	0.955	0.000	6.153	18.442	--	--	--		--	Never	21.329	5.780
skew	**0/3.25**	80.0%	1.000	0.079	11.007	25.917	10.212	11.367	12.757	0.033	0.472	90.050	8.644	4.439
kurt	**0/23.5**	82.5%	1.000	0.697	14.516	30.433	13.081	14.908	17.060	0.027	0.407	19.630	5.435	3.769
		85.0%	1.000	2.520	18.945	35.520	17.591	19.132	20.865	0.010	0.396	7.915	4.156	3.213
		87.5%	1.000	6.201	24.383	41.212	22.995	24.334	25.864	-0.002	0.378	4.477	3.392	2.784
		90.0%	1.000	11.997	30.878	47.544	29.251	30.567	32.092	-0.010	0.339	3.481	2.870	2.364

Table 1 (continued): Select Premium and Coverage Statistics for the Main Scenarios in the Analysis

Normal		**CL**	**%NZ**	**AFPMIN**	**AFPAVE**	**AFPMAX**	**ESTPMIN**	**ESTPAVE**	**ESTPMAX**	**%BIAS**	**CORREL**	**FREMAX**	**FREAVE**	**FREMIN**
#farms	**200**	65.0%	1.000	2.532	4.052	5.889	3.330	3.532	3.768	-0.128	0.282	25.906	18.799	14.003
mean	**155/165**	70.0%	1.000	4.625	6.792	9.276	5.724	6.036	6.402	-0.111	0.261	15.397	11.999	9.577
sig	**32.5/37.5**	75.0%	1.000	8.053	10.952	14.142	9.461	9.923	10.466	-0.094	0.236	9.644	8.018	6.762
skew	**0**	80.0%	1.000	13.362	17.008	20.883	15.047	15.677	16.438	-0.078	0.204	6.399	5.600	4.973
kurt	**0**	85.0%	1.000	21.141	25.464	29.911	23.037	23.836	24.812	-0.064	0.164	4.464	4.081	3.773
Left-Skewed		**CL**	**%NZ**	**AFPMIN**	**AFPAVE**	**AFPMAX**	**ESTPMIN**	**ESTPAVE**	**ESTPMAX**	**%BIAS**	**CORREL**	**FREMAX**	**FREAVE**	**FREMIN**
#farms	**200**	65.0%	1.000	2.520	7.498	13.572	6.328	6.513	6.729	-0.131	0.201	26.100	16.640	12.324
mean	**155/165**	70.0%	1.000	4.607	10.409	16.869	8.886	9.146	9.466	-0.121	0.091	15.445	11.840	9.353
sig	**32.5/37.5**	75.0%	1.000	8.013	14.444	20.984	12.477	12.877	13.366	-0.108	0.032	11.171	8.588	6.852
skew	**0/-3.25**	80.0%	1.000	13.299	19.970	26.139	17.503	18.097	18.863	-0.094	0.009	8.632	6.338	5.108
kurt	**0/23.5**	85.0%	1.000	21.075	27.422	33.526	24.436	25.285	26.345	-0.078	0.018	6.597	4.755	3.854
Rigth-Skewed		**CL**	**%NZ**	**AFPMIN**	**AFPAVE**	**AFPMAX**	**ESTPMIN**	**ESTPAVE**	**ESTPMAX**	**%BIAS**	**CORREL**	**FREMAX**	**FREAVE**	**FREMIN**
#farms	**200**	65.0%	0.83	0.000	2.074	6.018	--	--	--		--	Never	72.491	15.160
mean	**155/165**	70.0%	0.92	0.000	3.686	9.113	--	--	--		--	Never	57.156	10.128
sig	**32.5/37.5**	75.0%	0.98	0.000	6.465	13.583	--	--	--		--	Never	23.251	6.968
skew	**0/3.25**	80.0%	1.00	0.177	11.218	20.163	10.578	11.244	11.865	0.002	0.519	50.269	7.506	4.934
kurt	**0/23.5**	82.5%	1.00	1.089	14.671	24.383	13.817	14.700	15.426	0.002	0.488	13.262	5.318	4.234
		85.0%	1.00	3.474	19.013	29.253	18.351	18.965	19.465	-0.002	0.609	6.230	4.185	3.527
		87.5%	1.00	7.743	24.329	34.824	23.701	24.184	24.584	-0.006	0.670	4.105	3.449	2.932
		90.0%	1.00	13.986	30.674	41.144	30.016	30.415	30.766	-0.008	0.621	3.414	2.928	2.456

Notes: CL=Coverage Level; %NZ=Percentage of the 200 AFPs that are not zero; AFPMIN=Lowest of the 200 AFPs; AFPAVE=Average of the 200 AFPs; AFPMAX=Maximum of the 200 AFPs; FREMAX=Maximum Frequency of Payment (out of the 200); FREAVE=Average Frequency of Payment (out of the 200); FREMIN=Minimum Frequency of Payment (out of the 200)

TABLE 2: PSR, PPR, PPG and Percentiles of the Distribution of the RMA Premium Estimates under Normal Yields

Table 2a: 65% Coverage 90% PPR

CL=65%	SN1a	SN2a	SN3a	SN4a	SN5a	SN6a	SN7a LPE/NRPP	SN8a HPE/NRPP	SN9a LPE/RPP	SN10a HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.490	0.580	0.560	0.500	0.470	0.250	0.150	0.300	0.030	0.190
PPR	0.901	0.904	0.904	0.900	0.904	0.903	0.901	0.899	0.908	0.900
PPG	0.575	0.663	0.648	0.601	0.593	0.375	0.303	0.402	0.196	0.314
0.20	0.900	0.700	0.747	0.852	0.751	0.996	0.974	0.938	0.981	0.961
0.25	0.832	0.621	0.652	0.770	0.679	0.989	0.949	0.894	0.961	0.928
0.30	0.757	0.547	0.566	0.686	0.609	0.976	0.917	0.837	0.936	0.890
0.35	0.676	0.479	0.490	0.607	0.538	0.953	0.875	0.766	0.908	0.843
0.40	0.596	0.419	0.422	0.532	0.470	0.915	0.821	0.690	0.872	0.781
0.45	0.520	0.351	0.357	0.459	0.407	0.855	0.760	0.616	0.828	0.714
0.50	0.448	0.300	0.302	0.388	0.351	0.772	0.692	0.546	0.778	0.646
0.55	0.366	0.257	0.256	0.317	0.290	0.678	0.623	0.482	0.723	0.583
0.60	0.305	0.216	0.214	0.264	0.249	0.580	0.554	0.425	0.664	0.523
0.65	0.247	0.181	0.177	0.219	0.214	0.482	0.490	0.374	0.605	0.467
0.70	0.198	0.148	0.144	0.178	0.181	0.389	0.430	0.327	0.548	0.417
0.75	0.155	0.118	0.114	0.140	0.151	0.302	0.377	0.284	0.493	0.370
0.80	0.116	0.089	0.088	0.105	0.121	0.222	0.329	0.247	0.444	0.329
0.85	0.082	0.063	0.064	0.076	0.093	0.154	0.287	0.214	0.397	0.291
0.90	0.051	0.040	0.043	0.049	0.062	0.095	0.250	0.185	0.355	0.257
0.95	0.024	0.020	0.022	0.024	0.033	0.044	0.218	0.160	0.316	0.226
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.189	0.138	0.280	0.199
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.165	0.119	0.249	0.174
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.143	0.102	0.220	0.151
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.124	0.087	0.194	0.131
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.107	0.074	0.171	0.114
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.093	0.063	0.150	0.099
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.081	0.054	0.132	0.086

Notes: LPE=Low Producer Error ep2=tp1+(0.75*(ep1-eb1)); HPE=High Producer Error ep2=tp1+(1.25*(ep1-eb1)); NRPP=No Risk Protection Premium; RPP=15% Risk Protection Premium.

Table 2b: 65% Coverage 98% PPR

							SN7b	SN8b	SN9b	SN10b
CL=65%	SN1b	SN2b	SN3b	SN4b	SN5b	SN6b	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.660	0.770	0.760	0.690	0.680	0.420	0.230	0.790	0.110	0.730
PPR	0.980	0.981	0.980	0.980	0.981	0.980	0.982	0.980	0.979	0.980
PPG	0.697	0.793	0.787	0.733	0.722	0.500	0.346	0.819	0.239	0.769
0.20	0.759	0.468	0.476	0.651	0.588	0.989	0.965	0.362	0.975	0.543
0.25	0.644	0.359	0.365	0.535	0.473	0.968	0.934	0.225	0.951	0.377
0.30	0.536	0.283	0.284	0.430	0.377	0.927	0.894	0.138	0.923	0.258
0.35	0.426	0.224	0.223	0.328	0.287	0.852	0.840	0.082	0.888	0.174
0.40	0.341	0.179	0.175	0.261	0.230	0.742	0.776	0.049	0.844	0.114
0.45	0.270	0.140	0.138	0.208	0.184	0.619	0.704	0.029	0.792	0.075
0.50	0.213	0.112	0.110	0.163	0.147	0.498	0.631	0.017	0.734	0.050
0.55	0.166	0.090	0.088	0.129	0.118	0.388	0.559	0.010	0.673	0.033
0.60	0.128	0.071	0.070	0.101	0.096	0.288	0.492	0.006	0.611	0.022
0.65	0.096	0.056	0.056	0.077	0.077	0.211	0.430	0.004	0.551	0.014
0.70	0.071	0.043	0.043	0.058	0.060	0.151	0.376	0.002	0.494	0.009
0.75	0.051	0.032	0.032	0.043	0.047	0.105	0.328	0.002	0.442	0.006
0.80	0.036	0.024	0.024	0.031	0.036	0.070	0.285	0.001	0.395	0.004
0.85	0.023	0.016	0.016	0.020	0.027	0.045	0.248	0.001	0.352	0.003
0.90	0.014	0.010	0.010	0.012	0.017	0.025	0.216	0.000	0.312	0.002
0.95	0.006	0.004	0.005	0.005	0.008	0.011	0.188	0.000	0.278	0.001
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.164	0.000	0.246	0.001
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.143	0.000	0.218	0.001
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.000	0.192	0.000
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.109	0.000	0.171	0.000
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.096	0.000	0.150	0.000
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.084	0.000	0.133	0.000
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.073	0.000	0.117	0.000

Table 3a: 75% Coverage 90% PPR

							SN7a	SN8a	SN9a	SN10a
CL=75%	SN1a	SN2a	SN3a	SN4a	SN5a	SN6a	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.370	0.460	0.440	0.3800	0.370	0.180	0.100	0.160	0.000	0.030
PPR	0.904	0.902	0.900	0.9010	0.900	0.903	0.904	0.899	0.949	0.899
PPG	0.443	0.529	0.520	0.4670	0.469	0.280	0.220	0.254	0.114	0.144
0.20	0.987	0.894	0.928	0.9770	0.913	1.000	0.998	0.997	0.999	0.999
0.25	0.969	0.836	0.878	0.9480	0.866	0.999	0.993	0.988	0.997	0.995
0.30	0.935	0.766	0.802	0.8990	0.812	0.998	0.985	0.974	0.991	0.988
0.35	0.883	0.692	0.718	0.8300	0.755	0.994	0.973	0.955	0.981	0.977
0.40	0.816	0.618	0.634	0.7550	0.693	0.985	0.955	0.924	0.968	0.962
0.45	0.739	0.545	0.553	0.6730	0.623	0.969	0.926	0.872	0.951	0.937
0.50	0.655	0.474	0.478	0.5930	0.548	0.941	0.881	0.804	0.925	0.897
0.55	0.570	0.392	0.406	0.5130	0.472	0.889	0.821	0.729	0.889	0.845
0.60	0.484	0.331	0.335	0.4350	0.401	0.806	0.749	0.655	0.841	0.783
0.65	0.382	0.277	0.276	0.3410	0.324	0.699	0.670	0.582	0.783	0.716
0.70	0.306	0.228	0.223	0.2730	0.271	0.582	0.589	0.513	0.719	0.650
0.75	0.236	0.183	0.176	0.2140	0.221	0.463	0.509	0.449	0.650	0.586
0.80	0.176	0.140	0.134	0.1610	0.178	0.347	0.434	0.389	0.581	0.524
0.85	0.121	0.100	0.096	0.1140	0.137	0.234	0.366	0.333	0.514	0.464
0.90	0.074	0.064	0.062	0.0720	0.095	0.142	0.304	0.281	0.451	0.406
0.95	0.033	0.032	0.031	0.0320	0.052	0.066	0.251	0.235	0.391	0.353
1.00	0.000	0.000	0.000	0.0000	0.000	0.000	0.205	0.196	0.337	0.305
1.05	0.000	0.000	0.000	0.0000	0.000	0.000	0.166	0.163	0.287	0.262
1.10	0.000	0.000	0.000	0.0000	0.000	0.000	0.132	0.133	0.242	0.223
1.15	0.000	0.000	0.000	0.0000	0.000	0.000	0.105	0.109	0.202	0.188
1.20	0.000	0.000	0.000	0.0000	0.000	0.000	0.082	0.088	0.166	0.157
1.25	0.000	0.000	0.000	0.0000	0.000	0.000	0.064	0.070	0.136	0.130
1.30	0.000	0.000	0.000	0.0000	0.000	0.000	0.048	0.056	0.111	0.107

Table 3b: 75% Coverage 98% PPR

							SN7b	SN8b	SN9b	SN10b
CL=75%	SN1b	SN2b	SN3b	SN4b	SN5b	SN6b	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.520	0.640	0.630	0.550	0.550	0.320	0.160	0.370	0.030	0.260
PPR	0.982	0.981	0.980	0.981	0.981	0.982	0.982	0.980	0.979	0.980
PPG	0.557	0.665	0.661	0.594	0.591	0.390	0.256	0.434	0.133	0.339
0.20	0.963	0.768	0.803	0.926	0.855	1.000	0.997	0.987	0.999	0.995
0.25	0.908	0.656	0.676	0.838	0.775	0.998	0.991	0.967	0.996	0.985
0.30	0.826	0.548	0.554	0.735	0.686	0.992	0.980	0.934	0.989	0.969
0.35	0.726	0.446	0.447	0.625	0.585	0.979	0.965	0.872	0.978	0.941
0.40	0.620	0.346	0.348	0.520	0.477	0.953	0.940	0.787	0.964	0.892
0.45	0.516	0.277	0.274	0.410	0.375	0.898	0.899	0.687	0.944	0.825
0.50	0.400	0.218	0.214	0.316	0.292	0.801	0.841	0.582	0.915	0.742
0.55	0.312	0.171	0.166	0.246	0.228	0.671	0.769	0.485	0.874	0.652
0.60	0.240	0.132	0.128	0.190	0.177	0.532	0.688	0.396	0.820	0.564
0.65	0.179	0.102	0.098	0.144	0.137	0.399	0.604	0.319	0.758	0.478
0.70	0.130	0.077	0.075	0.105	0.107	0.278	0.523	0.251	0.691	0.398
0.75	0.092	0.056	0.055	0.076	0.081	0.186	0.446	0.197	0.621	0.326
0.80	0.063	0.040	0.039	0.053	0.060	0.119	0.378	0.153	0.551	0.266
0.85	0.040	0.026	0.026	0.035	0.042	0.072	0.317	0.117	0.485	0.213
0.90	0.023	0.016	0.016	0.020	0.027	0.039	0.263	0.088	0.424	0.169
0.95	0.010	0.007	0.007	0.008	0.013	0.015	0.217	0.065	0.366	0.132
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.178	0.048	0.314	0.103
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.145	0.035	0.267	0.079
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.117	0.025	0.225	0.061
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.094	0.018	0.187	0.046
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.075	0.013	0.155	0.035
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.059	0.009	0.127	0.026
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.006	0.104	0.020

Table 4a: 85% Coverage 90% PPR

							SN7a	SN8a	SN9a	SN10a
CL=85%	SN1a	SN2a	SN3a	SN4a	SN5a	SN6a	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.260	0.350	0.330	0.280	0.280	0.130	0.060	0.090	0.000	0.000
PPR	0.901	0.905	0.902	0.905	0.903	0.902	0.891	0.896	0.995	0.944
PPG	0.317	0.401	0.395	0.346	0.361	0.205	0.147	0.161	0.067	0.078
0.20	1.000	0.983	0.982	0.999	0.968	0.997	1.000	1.000	1.000	1.000
0.25	0.998	0.963	0.970	0.995	0.954	0.997	1.000	1.000	1.000	1.000
0.30	0.994	0.937	0.950	0.987	0.932	0.997	0.999	0.999	1.000	1.000
0.35	0.987	0.899	0.922	0.972	0.902	0.997	0.998	0.998	0.999	0.999
0.40	0.971	0.844	0.874	0.945	0.866	0.996	0.996	0.994	0.998	0.998
0.45	0.938	0.772	0.799	0.894	0.818	0.994	0.990	0.984	0.996	0.995
0.50	0.883	0.695	0.714	0.823	0.761	0.988	0.979	0.960	0.989	0.988
0.55	0.812	0.611	0.624	0.741	0.692	0.975	0.958	0.918	0.975	0.971
0.60	0.724	0.527	0.533	0.648	0.610	0.950	0.920	0.863	0.949	0.937
0.65	0.623	0.433	0.443	0.552	0.516	0.901	0.863	0.791	0.911	0.887
0.70	0.518	0.347	0.352	0.450	0.425	0.810	0.787	0.711	0.860	0.827
0.75	0.390	0.278	0.274	0.336	0.328	0.679	0.695	0.628	0.792	0.759
0.80	0.289	0.214	0.207	0.249	0.258	0.529	0.594	0.541	0.712	0.682
0.85	0.202	0.153	0.147	0.173	0.193	0.372	0.490	0.458	0.624	0.602
0.90	0.124	0.100	0.094	0.107	0.134	0.221	0.391	0.377	0.532	0.517
0.95	0.056	0.048	0.046	0.048	0.071	0.100	0.300	0.301	0.444	0.434
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.223	0.235	0.363	0.355
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.163	0.181	0.291	0.283
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.116	0.136	0.231	0.222
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.079	0.100	0.180	0.171
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.053	0.072	0.137	0.129
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.051	0.103	0.095
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.035	0.075	0.069

Table 4b: 85% Coverage 98% PPR

							SN7b	SN8b	SN9b	SN10b
CL=85%	SN1b	SN2b	SN3b	SN4b	SN5b	SN6b	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.380	0.500	0.490	0.410	0.420	0.230	0.110	0.200	0.000	0.070
PPR	0.980	0.982	0.980	0.980	0.982	0.981	0.981	0.980	0.995	0.979
PPG	0.412	0.522	0.519	0.449	0.456	0.284	0.179	0.256	0.067	0.139
0.20	0.998	0.960	0.973	0.996	0.977	1.000	1.000	1.000	1.000	1.000
0.25	0.994	0.920	0.943	0.986	0.948	1.000	1.000	1.000	1.000	1.000
0.30	0.985	0.858	0.889	0.965	0.909	1.000	0.999	0.998	1.000	0.999
0.35	0.962	0.766	0.790	0.920	0.856	0.999	0.997	0.995	0.999	0.999
0.40	0.910	0.663	0.675	0.841	0.787	0.997	0.993	0.985	0.998	0.997
0.45	0.833	0.554	0.557	0.743	0.701	0.989	0.985	0.960	0.996	0.992
0.50	0.732	0.437	0.442	0.631	0.594	0.972	0.969	0.916	0.989	0.979
0.55	0.617	0.338	0.337	0.516	0.478	0.936	0.937	0.852	0.975	0.949
0.60	0.500	0.261	0.256	0.385	0.358	0.859	0.884	0.770	0.949	0.903
0.65	0.367	0.198	0.191	0.289	0.273	0.726	0.810	0.675	0.911	0.842
0.70	0.271	0.146	0.140	0.212	0.201	0.563	0.719	0.569	0.860	0.770
0.75	0.191	0.103	0.099	0.149	0.144	0.397	0.617	0.464	0.792	0.685
0.80	0.126	0.071	0.067	0.101	0.100	0.248	0.513	0.366	0.712	0.592
0.85	0.077	0.044	0.043	0.063	0.067	0.144	0.417	0.279	0.624	0.497
0.90	0.042	0.025	0.025	0.037	0.040	0.073	0.328	0.208	0.532	0.406
0.95	0.017	0.011	0.011	0.015	0.018	0.028	0.252	0.152	0.444	0.323
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.190	0.108	0.363	0.251
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.140	0.075	0.291	0.191
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.050	0.231	0.142
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.069	0.033	0.180	0.104
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.047	0.021	0.137	0.074
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.013	0.103	0.051
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.007	0.075	0.035

Table 5a: 65% Coverage 90% PPR

							SN7a	SN8a	SN9a	SN10a
CL=65%	SS1a	SS2a	SS3a	SS4a	SS5a	SS6a	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.600	0.630	0.570	0.600	0.540	0.430	0.400	0.590	0.310	0.530
PPR	0.903	0.899	0.903	0.898	0.899	0.897	0.900	0.899	0.902	0.900
PPG	0.674	0.708	0.663	0.677	0.644	0.534	0.502	0.640	0.414	0.590
0.20	0.804	0.645	0.726	0.762	0.722	0.986	0.899	0.750	0.931	0.808
0.25	0.696	0.560	0.627	0.658	0.642	0.944	0.823	0.645	0.879	0.710
0.30	0.591	0.485	0.539	0.566	0.567	0.865	0.739	0.549	0.815	0.618
0.35	0.497	0.419	0.462	0.484	0.501	0.766	0.659	0.463	0.745	0.536
0.40	0.408	0.345	0.397	0.405	0.437	0.666	0.584	0.389	0.675	0.460
0.45	0.329	0.295	0.336	0.333	0.380	0.570	0.513	0.326	0.609	0.396
0.50	0.273	0.249	0.287	0.279	0.316	0.482	0.449	0.277	0.547	0.338
0.55	0.225	0.208	0.243	0.231	0.270	0.404	0.390	0.236	0.489	0.291
0.60	0.184	0.175	0.204	0.190	0.229	0.328	0.338	0.201	0.435	0.251
0.65	0.150	0.144	0.169	0.155	0.193	0.266	0.292	0.172	0.387	0.218
0.70	0.120	0.116	0.137	0.124	0.160	0.212	0.254	0.147	0.340	0.190
0.75	0.094	0.093	0.108	0.096	0.129	0.164	0.222	0.125	0.302	0.165
0.80	0.068	0.070	0.083	0.072	0.099	0.123	0.195	0.106	0.267	0.144
0.85	0.048	0.049	0.059	0.051	0.072	0.086	0.171	0.091	0.237	0.126
0.90	0.029	0.031	0.037	0.033	0.046	0.054	0.150	0.078	0.211	0.110
0.95	0.013	0.015	0.018	0.015	0.023	0.025	0.133	0.067	0.189	0.096
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.117	0.057	0.169	0.084
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.103	0.049	0.152	0.073
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.091	0.042	0.136	0.064
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.081	0.036	0.122	0.056
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.071	0.030	0.110	0.048
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.063	0.026	0.099	0.042
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.023	0.090	0.037

Notes: LPE=Low Producer Error ep2=tp1+(0.75*(ep1-eb1)); HPE=High Producer Error ep2=tp1+(1.25*(ep1-eb1)); NRPP=No Risk Protection Premium; RPP=15% Risk Protection Premium.

Table 5b: 65% Coverage 98% PPR

							SN7b	SN8b	SN9b	SN10b
CL=65%	SS1b	SS2b	SS3b	SS4b	SS5b	SS6b	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.760	0.810	0.770	0.780	0.740	0.600	0.660	0.990	0.600	0.990
PPR	0.981	0.979	0.979	0.980	0.979	0.979	0.980	0.961	0.980	0.963
PPG	0.789	0.834	0.804	0.807	0.776	0.654	0.706	0.991	0.647	0.991
0.20	0.547	0.376	0.440	0.485	0.503	0.893	0.684	0.000	0.773	0.000
0.25	0.411	0.294	0.338	0.365	0.400	0.761	0.564	0.000	0.663	0.000
0.30	0.322	0.231	0.264	0.285	0.309	0.630	0.457	0.000	0.563	0.000
0.35	0.254	0.183	0.207	0.225	0.248	0.515	0.364	0.000	0.473	0.000
0.40	0.204	0.146	0.162	0.178	0.199	0.414	0.293	0.000	0.394	0.000
0.45	0.164	0.117	0.127	0.140	0.160	0.329	0.236	0.000	0.326	0.000
0.50	0.129	0.093	0.101	0.112	0.127	0.260	0.191	0.000	0.271	0.000
0.55	0.102	0.075	0.079	0.087	0.102	0.203	0.156	0.000	0.227	0.000
0.60	0.081	0.059	0.062	0.069	0.080	0.157	0.126	0.000	0.191	0.000
0.65	0.063	0.046	0.048	0.055	0.063	0.118	0.103	0.000	0.161	0.000
0.70	0.048	0.036	0.036	0.043	0.049	0.087	0.084	0.000	0.135	0.000
0.75	0.036	0.028	0.027	0.032	0.038	0.063	0.069	0.000	0.114	0.000
0.80	0.025	0.020	0.020	0.023	0.027	0.044	0.056	0.000	0.096	0.000
0.85	0.017	0.013	0.013	0.016	0.019	0.028	0.045	0.000	0.081	0.000
0.90	0.010	0.008	0.008	0.009	0.011	0.016	0.037	0.000	0.068	0.000
0.95	0.004	0.004	0.004	0.005	0.005	0.007	0.030	0.000	0.058	0.000
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.049	0.000
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000	0.041	0.000
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.000	0.035	0.000
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.029	0.000
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.025	0.000
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.021	0.000
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.018	0.000

Table 6a: 75% Coverage 90% PPR

							SN7a	SN8a	SN9a	SN10a
CL=75%	SS1a	SS2a	SS3a	SS4a	SS5a	SS6a	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.410	0.490	0.450	0.430	0.420	0.250	0.210	0.270	0.090	0.160
PPR	0.900	0.900	0.901	0.899	0.902	0.897	0.902	0.903	0.901	0.903
PPG	0.494	0.570	0.539	0.515	0.519	0.354	0.322	0.343	0.210	0.247
0.20	0.977	0.858	0.897	0.954	0.873	1.000	0.993	0.981	0.996	0.992
0.25	0.945	0.778	0.838	0.905	0.817	0.999	0.976	0.956	0.986	0.977
0.30	0.890	0.696	0.757	0.835	0.758	0.995	0.949	0.922	0.967	0.953
0.35	0.816	0.618	0.670	0.754	0.690	0.986	0.912	0.879	0.943	0.923
0.40	0.731	0.543	0.584	0.671	0.618	0.963	0.864	0.822	0.914	0.886
0.45	0.641	0.474	0.504	0.585	0.544	0.913	0.803	0.753	0.878	0.838
0.50	0.551	0.410	0.432	0.504	0.473	0.836	0.733	0.680	0.832	0.779
0.55	0.466	0.336	0.366	0.429	0.406	0.739	0.660	0.604	0.777	0.714
0.60	0.367	0.283	0.307	0.344	0.332	0.632	0.585	0.529	0.717	0.646
0.65	0.295	0.235	0.257	0.280	0.278	0.524	0.511	0.459	0.651	0.577
0.70	0.233	0.192	0.211	0.224	0.227	0.417	0.440	0.396	0.585	0.511
0.75	0.179	0.154	0.171	0.174	0.185	0.317	0.375	0.338	0.521	0.449
0.80	0.132	0.120	0.133	0.129	0.147	0.230	0.313	0.290	0.459	0.395
0.85	0.092	0.087	0.097	0.089	0.111	0.157	0.262	0.248	0.401	0.343
0.90	0.056	0.057	0.065	0.055	0.076	0.096	0.218	0.212	0.347	0.300
0.95	0.027	0.028	0.033	0.025	0.042	0.044	0.180	0.181	0.295	0.262
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.149	0.154	0.253	0.228
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.121	0.131	0.215	0.198
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.098	0.110	0.182	0.173
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.079	0.093	0.154	0.149
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.063	0.078	0.129	0.129
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.065	0.108	0.110
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.054	0.090	0.095

Table 6b: 75% Coverage 98% PPR

							SN7b	SN8b	SN9b	SN10b
CL=75%	SS1b	SS2b	SS3b	SS4b	SS5b	SS6b	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.580	0.680	0.650	0.610	0.610	0.410	0.300	0.580	0.200	0.540
PPR	0.980	0.981	0.981	0.979	0.979	0.979	0.979	0.978	0.981	0.980
PPG	0.621	0.711	0.688	0.650	0.650	0.475	0.380	0.615	0.282	0.580
0.20	0.913	0.666	0.734	0.847	0.775	0.999	0.986	0.894	0.992	0.923
0.25	0.815	0.548	0.599	0.730	0.674	0.993	0.962	0.799	0.975	0.849
0.30	0.698	0.443	0.477	0.609	0.563	0.974	0.926	0.679	0.950	0.744
0.35	0.577	0.342	0.377	0.498	0.458	0.920	0.876	0.552	0.919	0.626
0.40	0.470	0.272	0.296	0.387	0.354	0.822	0.811	0.432	0.880	0.509
0.45	0.357	0.216	0.233	0.305	0.279	0.700	0.736	0.327	0.829	0.404
0.50	0.279	0.171	0.183	0.238	0.220	0.570	0.656	0.246	0.766	0.310
0.55	0.216	0.135	0.142	0.185	0.174	0.446	0.576	0.183	0.698	0.238
0.60	0.166	0.105	0.110	0.141	0.137	0.333	0.497	0.137	0.628	0.181
0.65	0.125	0.082	0.084	0.107	0.108	0.244	0.424	0.101	0.557	0.138
0.70	0.093	0.062	0.063	0.081	0.081	0.175	0.356	0.074	0.490	0.103
0.75	0.067	0.045	0.046	0.058	0.061	0.121	0.296	0.054	0.427	0.077
0.80	0.046	0.032	0.033	0.041	0.046	0.080	0.246	0.039	0.368	0.058
0.85	0.030	0.021	0.022	0.027	0.032	0.050	0.205	0.029	0.314	0.043
0.90	0.017	0.012	0.013	0.016	0.020	0.028	0.169	0.021	0.268	0.032
0.95	0.007	0.005	0.006	0.007	0.010	0.012	0.140	0.015	0.228	0.024
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.115	0.011	0.194	0.018
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.094	0.008	0.164	0.013
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.006	0.138	0.010
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.062	0.004	0.117	0.007
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.003	0.098	0.005
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.002	0.083	0.004
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.001	0.070	0.003

Table 7a: 85% Coverage 90% PPR

							SN7a	SN8a	SN9a	SN10a
CL=85%	SS1a	SS2a	SS3a	SS4a	SS5a	SS6a	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.270	0.360	0.350	0.290	0.310	0.140	0.080	0.100	0.000	0.000
PPR	0.901	0.899	0.902	0.901	0.899	0.899	0.904	0.900	0.972	0.929
PPG	0.337	0.424	0.426	0.360	0.406	0.221	0.168	0.159	0.079	0.066
0.20	0.998	0.972	0.968	0.996	0.951	0.998	1.000	1.000	1.000	1.000
0.25	0.995	0.943	0.943	0.988	0.926	0.998	1.000	0.999	1.000	1.000
0.30	0.988	0.905	0.911	0.973	0.891	0.998	0.998	0.994	0.998	0.998
0.35	0.975	0.854	0.869	0.952	0.850	0.998	0.992	0.986	0.994	0.994
0.40	0.952	0.788	0.811	0.919	0.804	0.996	0.982	0.971	0.985	0.986
0.45	0.909	0.712	0.729	0.863	0.752	0.993	0.964	0.951	0.972	0.973
0.50	0.845	0.633	0.637	0.788	0.692	0.984	0.938	0.924	0.953	0.956
0.55	0.762	0.552	0.548	0.701	0.613	0.967	0.903	0.888	0.929	0.933
0.60	0.670	0.474	0.461	0.610	0.524	0.932	0.857	0.841	0.900	0.902
0.65	0.571	0.384	0.379	0.515	0.432	0.864	0.799	0.781	0.865	0.865
0.70	0.467	0.320	0.308	0.422	0.337	0.754	0.726	0.708	0.820	0.818
0.75	0.351	0.258	0.247	0.318	0.269	0.617	0.640	0.624	0.763	0.758
0.80	0.262	0.202	0.191	0.238	0.211	0.471	0.547	0.538	0.691	0.684
0.85	0.182	0.151	0.140	0.171	0.161	0.331	0.456	0.455	0.610	0.603
0.90	0.113	0.105	0.095	0.107	0.112	0.201	0.371	0.376	0.526	0.521
0.95	0.053	0.053	0.050	0.051	0.060	0.095	0.291	0.308	0.445	0.443
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.224	0.250	0.367	0.371
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.168	0.201	0.299	0.308
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.122	0.158	0.239	0.256
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.086	0.122	0.188	0.209
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.061	0.094	0.145	0.169
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.072	0.109	0.135
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.055	0.081	0.107

Table 7b: 85% Coverage 98% PPR

							SN7b	SN8b	SN9b	SN10b
CL=85%	SS1b	SS2b	SS3b	SS4b	SS5b	SS6b	LPE/NRPP	HPE/NRPP	LPE/RPP	HPE/RPP
NF	50	50	200	50	50	200	200	200	200	200
SS	10	10	10	20	10	20	20	20	20	20
Range	W	W	W	W	N	N	N	N	N	N
CC	0.25	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25
PSR	0.410	0.530	0.520	0.440	0.480	0.260	0.140	0.260	0.010	0.140
PPR	0.980	0.981	0.981	0.981	0.980	0.981	0.982	0.981	0.981	0.980
PPG	0.448	0.560	0.554	0.480	0.518	0.317	0.210	0.303	0.086	0.193
0.20	0.995	0.928	0.940	0.987	0.944	1.000	1.000	0.999	1.000	1.000
0.25	0.986	0.865	0.889	0.967	0.894	1.000	0.999	0.995	1.000	0.999
0.30	0.968	0.777	0.811	0.934	0.834	1.000	0.996	0.984	0.998	0.994
0.35	0.926	0.672	0.693	0.871	0.764	0.998	0.988	0.965	0.994	0.986
0.40	0.853	0.562	0.572	0.777	0.673	0.993	0.973	0.936	0.984	0.970
0.45	0.751	0.457	0.456	0.665	0.557	0.980	0.950	0.897	0.970	0.949
0.50	0.636	0.351	0.351	0.550	0.437	0.951	0.916	0.844	0.951	0.918
0.55	0.516	0.273	0.273	0.435	0.323	0.884	0.872	0.772	0.927	0.880
0.60	0.385	0.210	0.209	0.321	0.245	0.763	0.814	0.682	0.896	0.829
0.65	0.288	0.162	0.158	0.239	0.185	0.606	0.743	0.578	0.860	0.763
0.70	0.210	0.121	0.118	0.175	0.135	0.444	0.655	0.474	0.812	0.677
0.75	0.146	0.088	0.087	0.123	0.098	0.297	0.562	0.373	0.753	0.583
0.80	0.096	0.061	0.061	0.082	0.069	0.187	0.470	0.289	0.678	0.487
0.85	0.060	0.040	0.040	0.051	0.047	0.108	0.383	0.219	0.596	0.400
0.90	0.031	0.024	0.023	0.030	0.029	0.056	0.301	0.163	0.512	0.318
0.95	0.013	0.011	0.010	0.013	0.015	0.022	0.233	0.119	0.432	0.252
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.176	0.086	0.354	0.199
1.05	0.000	0.000	0.000	0.000	0.000	0.000	0.129	0.063	0.289	0.154
1.10	0.000	0.000	0.000	0.000	0.000	0.000	0.093	0.045	0.231	0.118
1.15	0.000	0.000	0.000	0.000	0.000	0.000	0.066	0.032	0.182	0.089
1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.023	0.140	0.067
1.25	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.016	0.105	0.049
1.30	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.011	0.078	0.036