Evaluating a Proposed Modification to
Federal Crop Insurance

By

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Abstract:

A proposed modification to the Federal Crop Insurance Program would allow crop

producers to simultaneously purchase both a farm-level crop insurance policy and a

supplemental county-level crop insurance policy. This study evaluates this proposal for

representative cotton farms in Georgia. The goal is to test whether the additional risk

protection provided by the supplemental policy is considered to be worth the additional

cost.

Key words: certainty equivalent, combined insurance product, group risk plan, multiple
peril crop insurance

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Evaluating a Proposed Modification to Federal Crop Insurance

The U.S. federal crop insurance program offers federally subsidized and reinsured yield and revenue insurance policies to crop producers. These policies protect crop producers against yield losses caused by natural perils such as drought, excess moisture, wind damage, disease, and insect infestation. The revenue insurance products also provide some protection against revenue shortfalls caused by low prices. The program, which is implemented through the Risk Management Agency (RMA) of the U.S. Department of Agriculture, has expanded greatly in recent years. This has occurred largely due to new insurance products being offered, insurance products being offered for new crops and regions, and increased premium subsidies.

The traditional federal crop insurance product is Multiple Peril Crop Insurance (MPCI), also known as Actual Production History (APH) insurance. This product provides protection against farm-level yield losses caused by a variety of natural perils. In the early 1990s, the federal crop insurance program began offering a county-level yield insurance product known as the Group Risk Plan (GRP) for selected crops and regions. This product pays indemnities based not on farm-level yield shortfalls but rather based on shortfalls in the county-level yield. Various farm-level revenue insurance products (e.g., Crop Revenue Coverage and Revenue Assurance) were added in the mid-1990s and in the late 1990s a county-level revenue insurance product known as Group Risk Income Protection (GRIP) was made available for selected crops and regions.[1] In 2006, approximately 75% of program liability was for farm-level yield and revenue insurance

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[1] The terms "farm-level" and "county-level" are used here to distinguish these two classes of insurance products. However, under certain conditions, farmers can purchase MPCI and some of the farm-level revenue insurance products at a sub-farm level. That is, different parts of the farm can be insured as separate insurance units.

policies. Approximately 14% of program liability was for county-level yield and revenue insurance policies with the remaining 11% of liability being for a variety of insurance products targeted primarily to producers of specialty crops.

While the farm-level insurance products protect against farm-level yield losses, they are subject to problems such as adverse selection and moral hazard (Knight and Coble, 1997). The county-level products are much less subject to adverse selection and moral hazard problems but policyholders are exposed to basis risk. In this context, basis risk refers to the fact that a farm may experience a yield loss but not receive an indemnity from a GRP or GRIP policy because there was no county-level yield shortfall. Conversely, it is also possible that a farm may not experience a yield loss but still receive a GRP or GRIP indemnity because of a shortfall in the county-level yield.

Currently, for a given crop produced in a given county, crop insurance purchasers must choose only one federal crop insurance product. That is to say, that an insurance purchaser must choose either a yield or a revenue insurance product and must choose to insure at either the farm-level or the county-level. In the 109th Congress, Representative Randy Neugebauer (TX) introduced legislation (H.R.721) that would authorize the RMA to offer GRP coverage as a supplement to an underlying farm-level insurance policy (MPCI or one of the revenue insurance products). This study evaluates the implications of this proposal for representative cotton farms in Georgia. The goal is to test whether the additional risk protection provided by the supplemental GRP policy is considered to be worth the additional cost. Specifically, we compare outcomes assuming that the representative farms purchase MPCI (at various coverage levels), GRP, or the proposed combined insurance product.

Crop Insurance Products

MPCI insurance is based on the farm's actual production history (APH) yield. In its most basic form, the APH yield is a 10-year rolling average for the insured unit. APH yields can be initiated with as few as four years of yield records and then build to ten years. MPCI indemnities per acre are calculated as

(1) $\widetilde{n}_{MPCI} = \max(0, \overline{y}_i - \widetilde{y}_i) \times price\ election$

where $\widetilde{n}_{MPCI}$ is the indemnity per acre, $\overline{y}_i$ is a trigger yield equal to the product of the APH yield and the selected coverage level, and $\widetilde{y}_i$ is the stochastic realized farm-level yield. For MPCI, the available coverage levels are from 50% to 85% in 5% increments. The maximum price election is established by the RMA. Policyholders can select a price election anywhere between 60% and 100% of the maximum. For cotton in Georgia, the maximum price election for 2006 was $0.53.

For GRP the indemnity is calculated as

(2) $\widetilde{n}_{GRP} = \max\left(0, \dfrac{\overline{y}_c - \widetilde{y}_c}{\overline{y}_c}\right) \times protection\ per\ acre$

where $\widetilde{n}_{GRP}$ is the GRP indemnity, $\overline{y}_c$ is a trigger yield equal to the product of the expected county yield and the selected coverage level, and $\widetilde{y}_c$ is the stochastic realized county yield. For GRP, the available coverage levels are from 70% to 90% in 5% increments. Protection per acre is calculated as

(3) $protection\ per\ acre = expected\ county\ yield \times price\ election \times scale$

where $90\% \leq scale \leq 150\%$. The GRP indemnity function has a "disappearing deductible" which means that, in an extreme case, if the realized county yield is zero the

effective coverage is 100%. Procedures for establishing the expected county yield are described in Skees, Black and Barnett (1997).

For the proposed combined insurance product the indemnity per acre would be calculated as

$$(4) \qquad \tilde{n}_{combined} = \tilde{n}_{MPCI} + \left(\left(1 - coverage_{MPCI} \right) \times \tilde{n}_{GRP(\max)} \right)$$

where $\tilde{n}_{combined}$ is the indemnity per acre on the combined product, $\tilde{n}_{MPCI}$ is as defined in (1), $coverage_{MPCI}$ is the coverage level selected for the MPCI portion of the policy, and $\tilde{n}_{GRP(\max)}$ is equal to the GRP indemnity equation in (2) with protection per acre set at the maximum level (i.e., scale = 150%).

Previous Studies

We are aware of only one other study that has examined the impacts of the combined insurance product proposed in H.R. 721. Knight (2006) evaluated the proposed combined insurance product for six representative farms: one cotton farm in Texas, one cotton farm in Mississippi, one corn farm in Ohio, one corn farm in Kansas, and two wheat farms in Kansas. For each farm, three levels of MPCI yield protection were considered (50%, 65%, and 75%) in combination with 90% GRP coverage. The findings indicated that the combined coverage offered under H.R. 721 would provide additional revenue risk protection for all of the farms. The combined insurance product provided the greatest benefit (relative to an MPCI policy alone) in counties where yield risk for the insured crop was relatively high. In counties with relatively low yield risk, the combined insurance product generated only modest additional benefits relative to an MPCI policy alone. The added benefits of the combined insurance product declined for higher MPCI

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coverage levels. This study extends Knight's analysis to consider the implications of the proposed combined insurance product for representative cotton farms in Georgia.

Data

Two types of yield data are used in the analysis. The first is farm-level yield data collected from the USDA's Risk Management Agency (RMA). These data are APH yield histories from Georgia farmers who purchased farm-level cotton insurance (MPCI or revenue insurance) in 2001. Thus, the data are for 1991 to 2000. Farms with actual yield data for at least the last 6 consecutive years were included in the study.[2]

Historical county-level yield data were obtained from the National Agricultural Statistics Service (NASS). These data are available for cotton production in Georgia from 1971 to 2005. Due to a positive time trend, the data were detrended using simple linear regression

(5) $\quad CY_t = \beta_0 + \beta_1 t + \varepsilon_i$

where CY_t is the county yield in year t. Detrended county yields were generated by:

(6) $\quad CY_t^{det} = \dfrac{CY_t}{CY_t^{pred}} CY_{2005}^{pred}$

where CY_t^{det} is the detrended county yield, CY_t^{pred} is the predicted county yield in year t, and CY_{2005}^{pred} is the predicted county yield for year 2005.

For the s years when both farm-level and county-level yield data are available ($6 \leq s \leq 10$), the ratio of the farm yield to the county yield is calculated as:

(7) $\quad \varepsilon_{is} = \dfrac{y_{is}}{CY_s}$

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[2] Only actual verified yield data are included in the analysis (e.g., T-yields, etc. have been excluded). The actual yield data have been aggregated to the whole-farm or "enterprise unit" level.

where y_{is} is yield for farm i in year s and ε_{is} is the ratio of the yield on farm i to the county yield in year s.

Following Miller, Barnett, and Coble (2003), pseudo farm yields are calculated by combining the detrended county yield data with the estimates of ε_{is} for the farms in the county. Assuming all the values of ε_{is} are equally likely to happen in any given year, a vector of pseudo farm yields for each county is calculated as the direct product of each ε_{is} and each value of CY_t^{det}

$$(8) \qquad y_m^{pseudo} = \varepsilon_{is} \times CY_t^{det}$$

where $m = 1, ..., M$. Since farms with at least 6 consecutive years of yield data are used in this study and there are 35 years of county yield data, the minimum number of pseudo farm yield observations for each representative farm is $M = 35 \times 6 \times N$ and the maximum is $M = 35 \times 10 \times N$, where N is the number of farms in the county for which farm-level data are available.[3]

Yield Distributions

County and representative farm yield distributions can be estimated either by assuming a parametric distributional family, such as the normal, gamma, or beta or by applying nonparametric methods such as kernel smoothing. For this study, the county and representative farm yield distributions were estimated using kernel smoothing. For representative farms, the kernel density of a given point, y, is defined as

$$(9) \qquad \hat{f}(y) = n^{-1} \sum_{i=1}^{n} K_h(y - y_m^{pseudo})$$

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[3] This procedure can generate a small number of unreasonably high pseudo farm yields. For this analysis pseudo farm yields were censored at 2,000 pounds per acre.

where h is the bandwidth or smoothing parameter, $K_h(u) = \frac{1}{h}K\left(\frac{u}{h}\right)$ and K is the kernel

density function (Ker and Coble, 2003). Similar procedures were used to estimate the

kernel density of the county yield distributions.

Revenue Calculation

Per acre market revenue is calculated as the product of the realized farm-level

yield and the loan rate of $0.53 per pound of cotton. Since the insurance products being

analyzed protect only against yield shortfalls (rather than revenue shortfalls), price is

treated as a constant rather than as a stochastic variable.

For MPCI, GRP, and the proposed combined insurance product, the per acre

premium cost was calculated using RMA FCI-35 premium rate tables available on the

RMA website. MPCI premium rates are conditioned on the APH yield which, for this

study, was set equal to the mean yield for each representative farm. The relevant

premium subsidies were applied to each product to generate subsidized premium costs.

For each of the insurance products, per acre revenue net of insurance purchasing

is calculated as

(10) $\qquad R_k^{net} = R^{market} + \tilde{n}_k - \pi_k$

where k is an insurance purchasing choice equal to either no insurance, MPCI, GRP, or

the proposed combined insurance product, R^{market} is market revenue without an insurance

contract, $\tilde{n}_k$ is the insurance indemnity as calculated in equations (1), (2), or (4), and π_k

is the premium. For MPCI, coverage levels of 55%, 75% and 85% were considered. The

price election was set at the maximum value of $0.53 per pound. For GRP, the coverage

level was set at 90%. Two scale levels were considered, 100% and 150%. For the

combined insurance product the GRP coverage level was set equal to 90%. Note that if k is no insurance, $R_k^{net} = R^{market}$.

Decision Criterion

The various insurance contracts are compared based on certainty equivalent revenues (CER) from the constant relative risk aversion utility function

(11) $$U_k = \frac{R_k^{net\,1-\gamma}}{1-\gamma} \quad \text{when } \gamma \neq 1, \text{ and}$$

$$U_k = \log(R_k^{net}) \quad \text{when } \gamma = 1$$

where R_k^{net} is from (10) and γ is the measure of relative risk aversion. For this analysis, γ was set equal to 2. The certainly equivalent of (11) is

(12a) $\quad CE_k = U^{-1}\left(EU_k\left(R_k^{net}\right)\right)$

or for each of the insurance choices

(12b) $\quad CE_{No\,Insurance} = U^{-1}(\int U(R^{market})f(y^{pseudo})dy^{pseudo})$

(12c) $\quad CE_{MPCI} = U^{-1}(\int U(R_{MPCI}^{net})f(y^{pseudo})dy^{pseudo})$

(12d) $\quad CE_{GRP} = U^{-1}(\int U(R_{GRP}^{net})f(y_c)dy_c)$

(12e) $\quad CE_{Combined} = U^{-1}\begin{pmatrix} \int U(R^{market})f(y^{pseudo})dy^{pseudo} + \\ \int U(\tilde{n}_{MPCI})f(y^{pseudo})dy^{pseudo} - \pi_{MPCI} + \\ \int U((1-\text{cov}erage_{MPCI})\times\tilde{n}_{GRP(\max)})f(y_c)dy_c - \pi_{GRP(\max)} \end{pmatrix}$

Numerical methods were used to integrate under the kernel density functions.

Results

Table 1 shows certainty equivalent revenues (CERs) under various scenarios. The insurance choices shown are MPCI (*coverage* level at 55%, 75% and 85%), the proposed

combined insurance (*coverage* level for MPCI portion at 55%, 75% and 85%) and GRP (*coverage* level at 90% with *scale* at 150% or 100%).

For each representative farm, the CERs for any of the insurance choices are higher than the CER without purchasing insurance. This is not surprising since the premiums on the insurance products are subsidized. GRP with scale at 150% is preferred to GRP with scale at 100% for each representative farm. However, MPCI at any coverage level is preferred to either of the GRP choices.

For any given MPCI coverage level, the combined insurance policy is preferred to the MPCI policy alone for most of the representative farms. The exceptions are the Brooks and Dooly County representative farms. Consistent with Knight's (2006) findings, the lower the MPCI coverage, the larger the difference between the CERs for the combined insurance policy and those for the MPCI policy alone. When the underlying MPCI policy is at 85% coverage, the supplemental GRP policy generates only small increases in CERs. When the underlying MPCI policy is at 55% coverage, the supplemental GRP policy generates larger increases in CERs. The intuition behind this finding is that, the lower the MPCI coverage (higher the MPCI deductible), the greater the benefit of having a supplemental GRP policy that provides additional protection against yield losses.

Conclusion

This study compared MPCI, GRP, and a proposed insurance product that combines a supplemental GRP policy with an underlying MPCI policy. The comparison was conducted for representative cotton farms in 10 Georgia counties. The purpose of the analysis was to test whether the supplemental GRP policy contained in the combined

insurance product is worth the additional cost, relative to just a stand alone MPCI policy.

The results indicate that for a given MPCI coverage level the combined insurance product

generates higher certainty equivalent revenues than an MPCI policy for eight of the 10

representative farms. Also, the difference between the combined product certainty

equivalent revenues and the MPCI certainty equivalent revenues is larger for lower levels

of MPCI coverage.

Table 1: Representative Farm Certainty Equivalent Revenues

County where Representative Farm in Located	No Insurance	MPCI 55% Coverage	MPCI 75% Coverage	MPCI 85% Coverage	Combined Policy with 55% MPCI Coverage and 90% GRP Coverage	Combined Policy with 75% MPCI Coverage and 90% GRP Coverage	Combined Policy with 85% MPCI Coverage and 90% GRP Coverage	GRP with 90% Coverage and 150% Scale	GRP with 90% Coverage and 100% Scale
Colquitt	386.95	418.17	439.81	459.39	421.50	441.66	460.50	394.36	391.89
Irwin	313.57	359.96	383.42	402.79	370.98	389.55	406.46	338.06	329.90
Mitchell	259.01	438.90	467.92	491.30	446.11	471.92	493.70	275.01	269.67
Wilcox	256.78	325.07	348.18	369.07	335.14	353.78	372.43	279.18	271.71
Worth	331.83	405.19	428.06	452.59	411.34	431.48	454.64	345.51	340.95
Early	325.71	438.84	464.92	488.71	456.06	474.49	494.45	363.97	351.22
Turner	252.58	297.19	318.45	337.17	305.41	323.01	339.90	270.83	264.75
Crisp	191.36	282.81	306.41	325.19	286.97	308.72	326.58	200.59	197.51
Dooly	168.32	266.82	294.35	312.67	259.73	290.41	310.30	184.08	174.47
Brooks	289.71	343.94	358.91	378.72	336.70	354.89	376.30	305.81	300.44

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