Journal of Agricultural and Applied Economics, 32,1(April 2000):123–132

Revenue Insurance for Georgia and South Carolina Peaches

Stephen E. Miller, Kandice H. Kahl, and P. James Rathwell

ABSTRACT

We estimate actuarially fair premium rates for yield and revenue insurance for Georgia and South Carolina peaches. The premium rates for both products decrease at a decreasing rate as the mean farm-level yield increases. In general, the premium rate for revenue insurance exceeds the premium rate for yield insurance for a given coverage level and expected yield. Although the revenue and yield insurance rates differ in a statistical sense, they do not appear to differ in an economic sense except at high coverage levels for growers with very high yields.

Key Words: *crop insurance, peaches, revenue insurance, yield insurance.*

The Federal Crop Insurance Reform Act of 1994 directed the Federal Crop Insurance Corporation (FCIC) to develop a pilot crop insurance program that would provide farmers with coverage against reduced gross income as a result of reduced yield and/or price. Several revenue insurance products have since been made available for the major agronomic crops: Crop Revenue Coverage (CRC) is available for corn, cotton, grain sorghum, rice, soybeans, and wheat in the major producing states; Income Protection (IP) is available for barley, corn, cotton, grain sorghum, soybeans, and wheat in selected states; Revenue Assurance (RA) is available for corn and soybeans in North Central states and for wheat in North Dakota; and Group Risk Income Protection (GRIP) is available for corn and soybeans in Illinois, Indiana, and Iowa. Revenue insurance is available now for only two horticultural crops in limited geographic areas: avocados in Ventura County, California, and pecans in selected counties in Georgia, New Mexico, and Texas. The acreage and value of individual horticultural crops are small relative to the acreage and value of the individual major agronomic crops, so the extent of the potential market has favored the initial development of revenue products for agronomic crops. Whether revenue insurance is feasible for horticultural crops in addition to avocados and pecans is an open question.

In response to complaints of Georgia (GA) and South Carolina (SC) growers about the current peach yield insurance product, the FCIC commissioned a study to evaluate the feasibility of peach revenue insurance in those states. The purpose of this research is to provide that evaluation. Specifically, we provide a comparison of estimated actuarially fair premium rates for yield and revenue insurance products for GA and SC peaches. In subse-

The authors are professors in the Department of Agricultural and Applied Economics, Clemson University.

This research was funded by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under Agreement No. 97-COOP-2-4545. The views expressed here are those of the authors and do not necessarily represent those of the U.S. Department of Agriculture. The authors would like to thank two anonymous reviewers for their helpful comments.

quent sections of the paper we discuss our procedures for estimating premium rates for the yield and revenue insurance products, present our results, and offer our conclusions.

Procedures for Estimating Premium Rates

The current crop insurance product for peaches is an individual yield guarantee. Under an individual yield guarantee, the grower receives an indemnity whenever his or her actual yield falls below the yield guarantee. The grower selects the yield guarantee by selecting a particular percentage of the expected yield.[1] Thus, the yield guarantee is the expected yield (pounds/acre) multiplied by the selected coverage level.[2] The grower can select from coverage levels between 50 and 75 percent in five-percent increments. Under revenue insurance, the grower would receive an indemnity whenever the actual revenue at harvest (i.e., the actual yield times the market price at harvest) is less than the revenue guarantee, calculated as the grower's expected yield times the price election specified in the crop insurance contract times the selected coverage level.

In the way of notation, $y_{k,i}$ represents the ith yield (pounds/acre) for farm k, and p_i is the ith market price ($/pound). The mean yield for farm k is

$$(1) \quad \bar{y}_k = E(y_{k,i}), \quad \text{and}$$

the mean market price is

$$(2) \quad \bar{p} = E(p_i).$$

We consider each coverage level from 50 to 75 percent that is offered in the current peach crop insurance program, and use c_j to denote the jth coverage level (which is a percentage) written in decimal form. The yield guarantee with a jth coverage level for farm k is

$$(3) \quad Y_{j,k} = c_j\bar{y}_k.$$

For example, the yield guarantee for 50-percent coverage is $Y_{50,k} = 0.5\bar{y}_k$.

For yield insurance, the yield loss (i.e., $\max[Y_{j,k} - y_{k,i}, 0]$) is valued at the crop insurance price election, P. The ith loss for farm k with a jth coverage level is

$$(4) \quad L^Y_{j,k,i} = \max[P(Y_{j,k} - y_{k,i}), 0] = P\max[Y_{j,k} - y_{k,i}, 0],$$

with mean

$$(5) \quad \bar{L}^Y_{j,k} = E(L^Y_{j,k,i}).$$

For revenue insurance, the ith loss for farm k with a jth coverage level is

$$(6) \quad L^I_{j,k,i} = \max[PY_{j,k} - p_iy_{k,i}, 0],$$

with mean

$$(7) \quad \bar{L}^I_{j,k} = E(L^I_{j,k,i}).$$

A loss under yield insurance requires that $y_{k,i} < Y_{j,k}$, while a loss under revenue insurance can be triggered by a low yield and/or a low market price.

The actuarially fair premium is the expected loss, $\bar{L}^Y_{j,k}$ for yield insurance and $\bar{L}^I_{j,k}$ for revenue insurance. The pure premium rate is calculated as the ratio of the actuarially fair premium to the maximum loss. For both products considered here, the maximum loss occurs when the farm has a zero yield and equals $PY_{j,k}$. The pure premium rates for farm k with a jth coverage level are

$$(8) \quad R^Y_{j,k} = \frac{\bar{L}^Y_{j,k}}{PY_{j,k}}, \quad \text{and}$$

$$(9) \quad R^I_{j,k} = \frac{\bar{L}^I_{j,k}}{PY_{j,k}}$$

[1] The FCIC measures the expected yield by the grower's approved production history, or APH. The APH for peaches is calculated using the grower's actual yields for a minimum of the four and a maximum of the five preceding years. The FCIC assigns proxy yields when actual yields are available for less than four years.

[2] The FCIC formerly measured peach yields per acre in 48-pound bushels, but now measures the yields in 50-pound bushels. We use pounds rather than bushels to avoid confusion over the changing bushel definition.

for yield insurance and revenue insurance, respectively.[3]

Since equations (8) and (9) have the same denominator, the relative magnitudes of the premium rates of the alternative products can be evaluated by comparing the numerators (i.e., equations (5) and (7)). For a given mean yield and coverage level, the relationship between premium rates for yield insurance and revenue insurance is an empirical question. If $y_{k,t} \geq Y_{j,k}$, $L^{Y}_{j,k,t} = 0$ and $L^{I}_{j,k,t} \geq 0$. If $y_{k,t} < Y_{j,k}$, $L^{Y}_{j,k,i} > 0$ and $L^{I}_{j,k,i} \geq 0$. If $y_{k,t} \geq Y_{j,k}$, $L^{I}_{j,k,t}$ is more likely to be positive when $\text{cov}(p, y_k) < 0$ than when $\text{cov}(p, y_k) = 0$. However, when $y_{k,i} < Y_{j,k}$, $L^{I}_{j,k,t}$ is more likely to equal zero when $\text{cov}(p, y_k) < 0$ than when $\text{cov}(p, y_k) = 0$. Thus, information that $\text{cov}(p, y_k) < 0$ is not sufficient to determine the relative sizes of $\bar{L}^{Y}_{j,k}$ and $\bar{L}^{I}_{j,k}$.

Farm-level peach yield data are required to evaluate equations (1)–(9). These data are available for GA and SC farms participating in the FCIC program, but only from 1986 onward (FCIC, various years). We limit our analysis to farms with four or more years of actual yields through 1997. For GA, 60 such farms are located in three regions, including eight farms in the North region, 24 farms in the Central region, and 28 farms in the South region. For SC, the data are available for 149 farms in ten counties, including 94 farms in the Upper State region, 51 farms in the Ridge region, and four farms in the Coastal Plains region. The average sample sizes are 5.8 years for GA farms and 6.4 years for SC farms.

It is not practical to estimate parametric yield and revenue distributions for the individual farms with such small sample sizes. We could estimate "empirical premium rates" for the individual farms as in Skees and Reed, but Goodwin and Ker (1998a) argue that large sample sizes are required to obtain accurate empirical premium rates unless smoothing methods are used to estimate a continuous distribution from the discontinuous empirical distribution. Our approach is to simulate smooth farm yield and revenue distributions by augmenting the limited farm data with yield data over aggregated areas that are available for longer periods. Yield data are available by state for both GA and SC, by region for GA, and by county for SC.

We use the following yield and price models:

(10) $$S_t = \alpha_0 + \alpha_1 T_t + \mu_t,$$

(11) $$p_t = \exp(\delta_0 + \delta_1 S_t + w_t).$$

(12) $$C_{m,t} = S_t + \beta_m + \nu_{m,t}, \quad \text{and}$$

(13) $$y_{k,t} = C_{m,t} + \phi_k + e_{k,t},$$

where S_t is the state-level yield (pounds/acre) in year t; T_t is a time-trend variable; p_t is the constant 1996-dollar state-level price ($/pound) in year t; $C_{m,t}$ is the yield (pounds/acre) for county (region) m in year t; $y_{k,t}$ is the yield (pounds/acre) for farm k in county (region) m in year t; μ_t, w_t, $\nu_{m,t}$, and $e_{k,t}$ are disturbance terms; and α_0, α_1, δ_0, δ_1, β_m, and ϕ_k are parameters to be estimated.

State-level peach yield data for GA and SC are available for 1919 onward from the National Agricultural Statistics Service (and its predecessor agencies). We estimate equation (10) for each state using data from 1955–1998 (n = 44) since there appears to have been a structural change in the yield series for both GA and SC about 1955. There is no evidence of trend (at conventional significance levels) in yields for either state, so we set $\alpha_1 = 0$ for both GA and SC.[4]

Annual peach production is determined by bearing acreage and yield per acre. Because peach trees are perennials, the year-to-year percentage changes in peach bearing acreage are small relative to the year-to-year percentage changes in peach yields. Also, peaches for the fresh market are not storable across crop-years. Therefore, we treat peach supply as fixed within a given year, so that shifts in supply (due to variations in yield primarily) trace out the inverse demand function given by

[3] The actual premium rate differs from the pure premium rate for various reasons (e.g., to include reserves for catastrophic events).

[4] Details of the statistical results for the yield and price models are available from the authors upon request.

equation (11). We estimate equation (11) for each state with data for 1956–1998 (n = 43) as reported by the National Agricultural Statistics Service.[5] Although tests for functional form (Maddala, pp. 220–23) are inconclusive, the exponential functional form is used here because it gives the highest squared correlation between the actual and predicted prices for both GA and SC.[6]

The point estimates and 95-percent confidence limits for the price flexibilities at the mean and maximum sample values of state-level yields are:

		Price Flexibility		
State	S_t (Pounds/ Acre)	Lower Limit	Point Estimate	Upper Limit
GA	6,087 (mean)	−0.72	−0.49	−0.25
	11,236 (max)	−1.32	−0.90	−0.47
SC	8,256 (mean)	−0.67	−0.44	−0.20
	12,761 (max)	−1.04	−0.68	−0.32

The reciprocal of the absolute value of the price flexibility is the lower limit of the absolute value of the price elasticity (Houck). Although the lower limits of the 95-percent confidence intervals for the GA and SC price flexibilities are greater than one in absolute value at the maximum observed yields, our point estimates of the direct price flexibilities at those yields are less than one in absolute value, indicating that demand is elastic over the observed range of yields. Thus, state-level peach revenues vary directly with yield so that revenues increase (decrease) as yield increases (decreases) over the range of observed state yields. These results may be surprising, as SC and GA typically rank second and third, respectively, after California in peach production.[7] However, our results are consistent with the estimated peach price flexibilities for California from three studies summarized by Nuckton (p. 68). Each study found that California peach prices were inflexible with respect to California peach production.

Yield data for three GA regions (North, Central, and South) are available from the Georgia Agricultural Statistics Service for 1988–1997 (n = 10), and for the ten SC counties from the South Carolina Agricultural Statistics Service for 1955 and selected years from 1958–1997 ($38 \le n \le 41$).[8] Our estimate of β_m from equation (12) is the mean difference between $C_{m,t}$ and S_t.

Substituting from equations (10) and (12) and recalling that $\alpha_1 = 0$ here, equation (13) can be rewritten as

$$(14)\quad y_{k,t} = \alpha_0 + \beta_m + \phi_k + \mu_t + \nu_{m,t} + e_{k,t}.$$

According to equation (14), farm k's yield in year t is explained by

(a) the parameter α_0, the mean state-level yield;
(b) the county-specific parameter β_m, the mean difference between the yield of county (region) m and the state-level yield;
(c) the farm-specific parameter ϕ_k, the mean difference between the yield of farm k and county (region) m;
(d) the random disturbance term μ_t that affects the yields of all farms in the state in year t (e.g., a state-wide freeze);
(e) the random disturbance term $\nu_{m,t}$ that affects the yields of all farms in county (re-

[5] Only state-wide price data are reported. The price data are not available for 1955, when freezes wiped out the GA and SC peach crops.

[6] The predicted values of p_t are calculated as $\exp(\hat{\delta}_0 + \hat{\delta}_1 S_t + \hat{\sigma}^2/2)$, where the carets denote least squares estimates and σ^2 is the variance of the disturbance terms of the price model. The term $\hat{\sigma}^2/2$ adjusts for the estimated difference between the log of the mean of the p_ts and the mean of the logs of the p_ts (Kmenta, pp. 511–12). The squared correlations between the actual and predicted prices are 0.30 for GA and 0.31 for SC.

[7] From 1955–1998, the states' respective shares of national freestone peach production were 34, 16, and 9 percent for California, SC, and GA, respectively (National Agricultural Statistics Service).

[8] The SC yield for 1955 was zero, so we set SC county yields to zero for that year.

Table 1. Summary Statistics for Premium Rates for Individual Yield Guarantee (R_j^Y) and Revenue Protection (R_j^I) Peach Crop Insurance Products for Alternative Coverage Levels (j) for 60 Georgia (GA) and 149 South Carolina (SC) Farms

		Coverage Level j (Percent)					
State	Item	50	55	60	65	70	75
GA	Mean of R_j^Y	0.252	0.258	0.265	0.272	0.280	0.288
		(0.021)[a]	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
	Mean of R_j^I	0.256	0.264	0.272	0.281	0.291	0.301
		(0.022)	(0.022)	(0.021)	(0.021)	(0.021)	(0.020)
	Mean of $(R_j^I - R_j^Y)$	0.004	0.005	0.007	0.009	0.010	0.013
	Paired t-test	6.439	7.783	9.714	12.323	15.686	19.519
SC	Mean of R_j^Y	0.226	0.234	0.242	0.250	0.259	0.268
		(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
	Mean of R_j^I	0.232	0.241	0.251	0.261	0.271	0.282
		(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
	Mean of $(R_j^I - R_j^Y)$	0.006	0.007	0.009	0.010	0.012	0.014
	Paired t-test	27.647	33.244	39.300	43.857	45.586	45.025

[a] Numbers in parentheses are standard errors.

gion) m in year t (e.g., a county- (region-) wide freeze); and

(f) the random disturbance term $e_{k,t}$ that affects only farm k's yield in year t (e.g., a localized hailstorm or frost).

Our estimate of ϕ_k is the mean difference between $y_{k,t}$ and $C_{m,t}$ ($n \geq 4$).

Adapting procedures from Atwood, Baquet, and Watts; and Prescott and Stengos, we simulate 10,000 yields and prices for each state, 10,000 yields for each county (region) in the state conditional on the simulated state yields, and 10,000 yields for each farm in the county (region) conditional on the simulated county (region) yields. We calculate the simulated farm revenues from the simulated state-level prices and the simulated farm yields. The simulated variables are computed as yield (price) forecasts plus simulated yield (price) forecast errors. The yield (price) forecasts are based on the point estimates of the parameters of equations (10)–(13). The simulated forecast errors are computed from simulated sampling errors in estimation of the parameters of equations (10)–(13) based on the point estimates and bootstrapped estimates of the parameters, and simulated disturbance terms based on the residuals from estimating equations (10)–(13).[9,10]

We use the simulated yields and prices in equations (1)–(9) to calculate premium rates for yield insurance and revenue insurance for each coverage level for each of the 60 GA farms and the 149 SC farms. In computing the premium rates, we set the crop insurance price election, P, equal to $\bar{p}$, the mean of the simulated state-level prices (i.e., $0.34/pound for GA and $0.31/pound for SC).

Results

Table 1 provides summary statistics for the premium rates for the two products. For both

[9] A reviewer stated that our method, based on "bootstrapping pairs," overestimates the variances of the simulated yields and prices and suggested that "bootstrapping residuals" would be appropriate. We would agree if we were confident that our yield and price models are free of specification errors. Efron and Tibshirani point out that "bootstrapping pairs is less sensitive to assumptions than bootstrapping residuals" (p. 113). They indicate that even if the models are correctly specified, bootstrapping pairs is not disastrous because the difference between the two methods decreases as n increases. We prefer to be conservative in this regard and thus allow for the possibility that our models are not correctly specified.

[10] The estimation and simulation procedures were carried out using Stata®.

states, the mean premium rate for revenue insurance is higher than the mean premium rate for yield insurance for each coverage level. The null hypothesis that the mean difference between premium rates for the products is zero is rejected at the one-percent level at each coverage level for both GA and SC.[11] Note that the mean difference in premium rates for the revenue and yield insurance products increases as the coverage level increases for both states. Summary statistics for the ratios of premium rates (not shown) indicate that the rates for the two products also diverge in a relative sense as the coverage level increases for both GA and SC. The mean of the ratio of the revenue insurance premium rate to the yield insurance premium rate is 1.013 with 50-percent coverage and 1.066 with 75-percent coverage for GA, and 1.032 with 50-percent coverage and 1.069 with 75-percent coverage for SC.

Plots of the estimated premium rates for the two products against mean yield show that the premium rates for the two products decrease at a decreasing rate as mean yield increases in both GA and SC. Since the premium rates are bounded by zero and one, we use the logistic functional form (Greene, pp. 227–28) in explaining the premium rates with mean yields for a given coverage level. Based on preliminary analyses, the GA models allow for an intercept shift for Central farms relative to North and South farms and a common mean yield coefficient across the three regions. The SC models allow for intercept and mean yield coefficient shifts for Ridge farms relative to Upper State and Coastal Plain farms. The final regression results for 50-, 65-, and 75-percent coverage levels are shown in Table 2.[12] Over the range of mean yields used in estimation, the fitted premium rates for Central GA are lower than any other region, and the fitted rates for North and South GA are lower than the fitted rates for the Upper State and Coastal Plain of SC. The fitted rates for the SC Ridge are less (greater) than the fitted rates for the other SC regions for yields of about 8,500 pounds per acre and lower (higher).

Table 3 provides a comparison of the fitted premium rates for the two products at 50-, 65-, and 75-percent coverage levels for the GA and the SC regions. As mentioned earlier, the estimated premium rates decrease as the mean yield increases. In Kahl *et al.*, we provide a comparison of our estimated premium rates for yield insurance to the current FCIC yield insurance rates. The current FCIC rates are "flat" in that they do not vary with the grower's yield experience. In general, our fitted yield insurance rates are above (below) current rates for growers with below (above) average yields. Also, our fitted yield insurance rates increase less than current rates as the coverage level increases except at very high farm-level yields. A comparison of the premium rates for the yield and revenue insurance products leads to the following conclusions:

- holding mean yield constant, the fitted revenue insurance rate equals or exceeds the fitted yield insurance rate for all coverage levels in all regions except for coverage levels below 65 percent in Central GA;
- holding mean yield constant, the ratio of revenue insurance to yield insurance rates increases as the coverage level increases except at low yield levels in South GA and Upper State SC;
- holding the coverage level constant, the ratio of revenue insurance to yield insurance rates increases as the mean yield increases; and
- the changes in the ratio of revenue insurance to yield insurance rates as the coverage level increases are smaller at low yield levels than at high yield levels.

In general, the differences in the crop insurance product designs have little effect at low coverage levels and mean yields, but are larger at high coverage levels and mean yields.

As discussed earlier, the ratios of premium rates are equivalent to ratios of pure premiums for the two products since equations (8) and (9) have a common denominator. Offutt and

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[11] The premium rates are not normally distributed since they are bounded by zero and one. Thus, the paired t-test of the equality of means of the premium rates of the two products for a given coverage level is only approximate.

[12] The regression results for the other coverage levels are available from the authors upon request.

Table 2. Regression Results for Logistic Functional Form Models Explaining the Premium Rates for Peach Yield Insurance (R_j^Y) and Peach Revenue Insurance (R_j^I) for Alternative Coverage Levels (j) for 60 Georgia (GA) and 149 South Carolina (SC) Farms[a]

		Dependent Variable = R_j^Y			Dependent Variable = R_j^I		
		Coverage Level j (Percent)			Coverage Level j (Percent)		
State	Statistic	50	65	75	50	65	75
GA	$\hat{a}_0$	0.145	0.155	0.159*[b]	0.175	0.171	0.168*
	$\hat{a}_1$	−1.008***	−0.878***	−0.788***	−1.080***	−0.911***	−0.790***
	$\hat{a}_2 \times 100$	−0.021***	−0.019***	−0.017***	−0.021***	−0.018***	−0.016***
	R^2[c]	0.859	0.857	0.853	0.853	0.848	0.845
	RMSE[d]	0.063	0.063	0.063	0.066	0.065	0.064
SC	$\hat{b}_0$	0.130	0.163*	0.172**	0.148	0.163*	0.163**
	$\hat{b}_1$	−0.524**	−0.531***	−0.525***	−0.537**	−0.538***	−0.521***
	$\hat{b}_2 \times 100$	−0.019***	−0.017***	−0.016***	−0.018***	−0.016***	−0.014***
	$\hat{b}_3 \times 100$	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***
	R^2	0.748	0.739	0.732	0.741	0.728	0.716
	RMSE	0.065	0.064	0.063	0.066	0.065	0.064

[a] The models are:

$$\hat{R}^Y_{j,k} \text{ (or } \hat{R}^I_{j,k}) = \frac{1}{1 + \exp(-(\hat{a}_0 + \hat{a}_1 D_{Central,k} + \hat{a}_2 \bar{y}_k))} \quad \text{and}$$

$$\hat{R}^Y_{j,k} \text{ (or } \hat{R}^I_{j,k}) = \frac{1}{1 + \exp(-(\hat{b}_0 + \hat{b}_1 D_{Ridge,k} + \hat{b}_2 \bar{y}_k + \hat{b}_3 D_{Ridge,k} \times \bar{y}_k)))}$$

for GA and SC, respectively, where: $\hat{R}^Y_{j,k}$ ($\hat{R}^I_{j,k}$) is the fitted premium rate for yield (revenue) insurance for coverage level j for farm k; $\bar{y}_k$ is the mean of the simulated yields (pounds/acre) for farm k; $D_{Central,K}$ equals 1 if farm k is located in Central GA, 0 otherwise; and $D_{Ridge,k}$ equals 1 if farm k is located in the SC Ridge, 0 otherwise.

[b] ***, **, and * denote significance at one, five, and ten percent levels, respectively.

[c] The squared correlation between the actual and predicted values of R_j^Y (or R_j^I).

[d] Root mean square error, computed from the squared differences between the actual and predicted values of R_j^Y (or R_j^I).

Table 3. Fitted Premium Rates for an Individual Yield Guarantee Product ($\hat{R}_j^Y$) and the Ratio of Fitted Premium Rates for Income Protection and Individual Yield Guarantee Products ($\hat{R}_j^I/\hat{R}_j^Y$) for Selected Average Yields ($\bar{y}$) and Coverage Levels (j) for Georgia and South Carolina Peaches[a]

Location	($\bar{y}$)[b]	$\hat{R}^Y_{50}$	$\hat{R}^Y_{65}$	$\hat{R}^Y_{75}$	$\hat{R}^I_{50}/\hat{R}^Y_{50}$	$\hat{R}^I_{65}/\hat{R}^Y_{65}$	$\hat{R}^I_{75}/\hat{R}^Y_{75}$
North GA	2,289	0.417	0.431	0.441	1.019	1.020	1.022
	10,217	0.119	0.146	0.167	1.037	1.096	1.129
Central GA	3,070	0.181	0.214	0.239	0.969	1.007	1.038
	13,735	0.023	0.035	0.047	0.974	1.108	1.202
South GA	1,089	0.479	0.488	0.493	1.017	1.013	1.012
	11,133	0.101	0.125	0.146	1.039	1.106	1.145
Upper State SC	718	0.499	0.510	0.515	1.010	1.003	1.000
	24,515	0.012	0.018	0.025	1.079	1.226	1.322
Ridge SC	4,477	0.278	0.300	0.315	1.018	1.021	1.026
	20,693	0.049	0.071	0.090	1.094	1.164	1.194
Coastal Plain SC	3,354	0.379	0.400	0.413	1.016	1.017	1.018
	7,140	0.232	0.260	0.281	1.027	1.045	1.056

[a] Fitted premium rates for the GA and SC regions are from the logistic equations shown in Table 2.

[b] Average yields (pounds/acre) are the minimum and maximum simulated average farm-level yields used in estimation of the logistic equations.

Lins report estimated premiums for yield and revenue insurance for Illinois corn under the assumption that farm yields follow a beta distribution, prices follow a Weibull distribution, and that yields and prices are independent. Under their assumptions, the ratios of premiums for revenue versus yield insurance are 1.45 for 50-percent coverage, 1.42 for 65-percent coverage, and 1.40 for 75-percent coverage. Goodwin and Ker (1998b) give the farmer-paid premiums for yield, and IP and RA revenue insurance at the 75-percent coverage level for an Iowa corn farm. The rate-making practices for these revenue insurance products allow for dependence between prices and farm yields. The ratios of the revenue to yield insurance premiums are 0.53 for IP insurance and 0.75 for RA insurance. The ratios for GA and SC peaches estimated here are closer to one than those reported for Illinois and Iowa corn. The different results could be caused by differences in the true yield and price distributions for the two commodities in the different regions and/or by differences in the assumptions used in estimating the distributions.

Revenue insurance is available currently for avocados and pecans. From the county actuarial tables (FCIC, 1999), the premium rates for 50-percent coverage for avocados in Ventura County, California range from 0.916 (for growers with the lowest yields) to 0.148 (for growers with the highest yields). For 75-percent coverage, the avocado premium rates range from 0.925 to 0.243. The premium rates for pecans in each of three GA counties range from 0.218 to 0.042 for 50-percent coverage, and from 0.363 to 0.070 for 75-percent coverage. Multiplication of our estimated pure premium rates for peach revenue insurance by a factor of 1.263 to allow for reserve loads (Driscoll) gives adjusted premium rates for peaches that can be compared to the published rates for avocados and pecans. After adjustment, the fitted rates for Central GA peaches range from 0.222 to 0.028 for 50-percent coverage, and from 0.313 to 0.072 for 75-percent coverage, similar to the endpoints of the pecan rate schedules for the corresponding coverage levels. The Upper State of SC has the highest and lowest rates for peaches at each coverage level over the range of mean yields used in estimation of the premium rate models. These rates range from 0.636 to 0.016 for 50-percent coverage and from 0.650 to 0.042 for 75-percent coverage. Overall, the revenue risks for GA and SC peach growers appear to be lower than for California avocado growers.

Although our estimated premium rates for yield and revenue insurance differ in a statistical sense, the differences may not be significant in an economic sense. As discussed above, the demand for peaches appears to be elastic over the range of relevant yields for both GA and SC, so that peach revenues in GA and SC vary directly with state-level yields. Farm-level demands should be more elastic, and so an individual yield guarantee product would be a close substitute for a revenue insurance product. Over the range of mean yields we used in estimation of the premium rate models, the largest percentage difference in pure premiums is at 75-percent coverage of the highest yield in Upper State SC where the ratio of the two premiums is 1.322 (calculated as 0.033/0.025). The difference in premium levels in this situation is $45.60/acre, or 0.60 percent of the mean revenue per acre.[13] The mean yield at which the ratio of the fitted revenue insurance and yield insurance premiums is at a maximum need not coincide with the mean yield at which the difference in the fitted revenue and yield insurance premium levels is at a maximum. For North and South GA, and Coastal Plain and Ridge SC, the maximum difference in revenue and yield insurance premiums occurs at the maximum mean yields used in estimation of the premium rate model parameters. For Central GA, the maximum difference of $30.62/acre occurs when the mean farm-level yield is 13,310 pounds/acre and equals 0.68 percent of mean revenue per acre; and for Upper State SC, the maximum difference of $60.19 occurs when the mean farm-level yield is 16,640 pounds/acre and equals 1.17 percent of mean revenue per acre.

[13] The difference is calculated as $\$0.31/\text{pound} \cdot 0.75 \cdot 24{,}515\ \text{pounds/acre} \cdot [0.033 - 0.025]$.

When the pure premiums for the revenue and yield insurance products are evaluated at county- (region-) average yield levels, the difference between the premiums for 75-percent coverage is less than $50/acre and is less than 10 percent of the yield insurance premium except for Cherokee County in Upper State SC. For a 50-percent coverage level, the difference in the revenue and yield insurance premiums is less than $12/acre and is less than 4.5 percent of the yield insurance premium at county- (region-) average yield levels for all counties (regions).

Conclusions

We use simulated state-level prices and farm-level yields for GA and SC peaches to estimate actuarially fair premium rates for two crop insurance products—an individual yield guarantee product and a revenue insurance product. Comparisons of these rates lead to the following general conclusions:

- the premium rates for both products decrease at a decreasing rate as the mean farm-level yield increases;
- the premium rate for revenue insurance equals or exceeds the premium rate for yield insurance for a given coverage level and average farm yield except for coverage levels below 65 percent in Central GA;
- the premium rate for revenue insurance decreases less than the premium rate for yield insurance as average yield increases, so that revenue insurance becomes more expensive relative to yield insurance as average yield increases; and
- although the revenue and yield insurance premium rates differ in a statistical sense, they do not appear to differ in an economic sense except at high coverage levels for growers with high yields.

Our results show that yield insurance is a close substitute for revenue insurance for most GA and SC peach growers. Based on our contacts with growers, we expect that there would be only a limited demand for revenue insurance. The growers seem more interested in changing the current yield insurance product than in having access to revenue insurance. Whether yield insurance and revenue insurance would be close substitutes for other horticultural crops is a question that merits research.

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