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Federal Crop Insurance Options for Upland Cotton Farmers and Their Revenue Effects

Ashley Hungerford and Erik O'Donoghue





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Abstract

The Agricultural Act of 2014 introduced two new crop insurance programs for upland cotton: the Supplemental Coverage Option (SCO) and the Stacked Income Protection Plan (STAX). SCO and STAX are known as “shallow loss” programs because they typically have lower deductibles and do not compensate for the bigger losses that other Federal crop insurance programs cover. This report examines the structures of SCO and STAX and how these programs interact with Revenue Protection, a preexisting crop insurance policy. It provides estimates of the contribution of SCO and STAX to revenue and downside risk reduction for upland cotton producers in various counties, revealing how risk reduction differs across counties with different inherent revenue risk caused by regional variations in yield. The report describes 2015 enrollment in STAX and SCO and finds that STAX enrollment is tied to the market share of cotton in a given county.

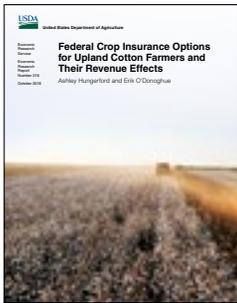
Keywords: Cotton, crop insurance, Stacked Income Protection Plan, Supplemental Coverage, 2014 Farm Act

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Federal Crop Insurance Options for Upland Cotton Farmers and Their Revenue Effects

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What Is the Issue?

The 2014 Farm Act changed the structure of several commodity support programs for agriculture. Before, cotton was a covered commodity and eligible for support payments. Now, if cotton producers want Government-sponsored protection in addition to preexisting Federal crop insurance programs, like Revenue Protection (RP), they must purchase one of the shallow-loss insurance policies, the Supplemental Coverage Option (SCO) or the Stacked Income Protection Plan (STAX). Since these programs were first implemented in 2015, this report explains the mechanics of the two programs and provides estimates of their potential for reducing cotton producers' revenue risk.

What Did the Study Find?

This report analyzes how different realized yields, harvest prices, subsidy levels, and program guarantees affect the outcomes of SCO and STAX under expected yields and projected prices for 2014.

- When STAX indemnity payments are isolated from any other insurance programs, STAX reduces revenue risk by an estimated 2 to 10 percent depending on the area loss trigger (ranging from 75 to 90 percent of the expected revenue for the county) selected by the farmer. SCO cotton indemnity payments, alone, reduce revenue risk by an estimated 7 percent.
- In many cases, STAX has a lower farmer-paid premium than SCO while providing higher indemnity payments. The lower farmer-paid premium for STAX is caused by the higher premium subsidy provided for STAX compared to SCO.

Since upland cotton is grown throughout the southern United States, this report examines how SCO and STAX affect producer revenue across these disparate areas.

- The analysis of three cotton-producing counties (low, medium, and high risk) shows that higher revenue risk (often a function of yield variability) is closely associated with lower revenue. The high-revenue risk county receives lower average net payments from SCO and STAX than the lower risk county. The lower average payment for the high-revenue risk county is caused by the lower expected revenue for the high-revenue risk county, which leads to a lower guarantee and smaller maximum payments compared to the low-revenue risk county.

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- Producers in low-risk counties receive greater risk reduction benefits from STAX and SCO than from Revenue Protection (RP) with (the most commonly chosen) 70 percent coverage level. Producers in high-risk counties receive greater risk reduction benefits from the RP policy, which insures against more significant losses.
- The majority of cotton-producing counties with high revenue risk are located in Texas. These counties in Texas also have the greatest risk reduction when RP (70 percent coverage) is applied in combination with SCO or STAX. The pattern of risk reduction for counties across the United States is similar for SCO and STAX, though the risk reduction afforded by STAX is higher.

Finally, the report examines the 2015 enrollment of STAX and SCO.

- STAX enrollment was approximately 20 percent (12,000 policies) of what RP enrollment was in 2015 (59,000 policies). Of the 8.5 million acres planted to upland cotton, 7 million acres were covered by RP and 2.5 million acres were covered by STAX.
- Only 120 SCO policies were purchased by cotton producers in 2015. The popularity of STAX over SCO is in keeping with simulation results indicating a higher expected payment under STAX.
- As the share of cotton operations among total crop operations in a county increases, so does the proportion of STAX policies to cotton operations. As such, STAX is more intensively used in counties where on-farm income from cotton is relatively higher.

How Was the Study Conducted?

This study contains both (1) simulation exercises examining average payments and risk reduction under STAX and SCO, and (2) regression modeling investigating STAX enrollment in 2015.

For our simulation study, county yield data for all counties that produced upland cotton between 1975 and 2013 are from USDA's National Agricultural Statistics Service. Prices for cotton (1975-2013) are from USDA's Risk Management Agency (RMA). Only counties with continuous cotton production (recorded every year) are included in the analysis, leaving 151 cotton-producing counties, which represent 67 percent of U.S. cotton acres in 2013. County base premium rates for Federal crop insurance policies are also from RMA.

In this analysis, yields at the national, State, and county levels are simulated in order to estimate revenue along with payments from STAX and SCO. Simulation is needed because STAX and SCO are new programs. Relying on the realized revenues from 2015 would not provide robust average estimates for payments. The historical yields and prices collected are used to estimate averages and give likely ranges for variables. Each of 10,000 simulated observations contains a simulated national market price and simulated yields for each county in the data set. The county-level simulated yields are adjusted to reflect the idiosyncratic—i.e., farm-specific—risk of a representative farm of a given county.

With the representative farm yield, county yields, and market price, revenue for the representative farm and county can be calculated. If the revenue is below the guarantee for STAX or SCO, a payment is calculated for the respective program; otherwise, the gross payment is zero. The payments and revenues for each representative farm and county are calculated for each of the 10,000 simulated observations. With simulated revenues and payments, measures of risk reduction can be calculated.

Using the RMA's *Summary of Business* to collect data on STAX policies sold and the 2012 Agricultural Census for data on cotton operations and total crop operations, regression modeling examines the relationship between the market penetration of STAX and the concentration of cotton operations (out of total crop operations) per county. A Tobit model is used to account for the large number of counties where cotton operations are present but no STAX policies were purchased.

Federal Crop Insurance Options for Upland Cotton Farmers and Their Revenue Effects

Introduction

Revenue from cotton production is dependent on many factors, only some of which can be controlled by farm management practices. Price and yield risks that span producers are known as systemic risks (Miranda and Glauber, 1997). Although some Federal programs address (systemic) yield and price risks separately, addressing systemic revenue risk is more effective in stabilizing farm income than addressing price or yield risk individually. Revenue tends to vary more year to year than does yield, especially from 2000 on (figure 1). This may explain why revenue-based programs are more appealing to cotton producers than yield-based insurance programs such as Yield Protection.

Federal programs for cotton have varied over the years. Before the Agricultural Act of 2014—also known as the 2014 Farm Act—cotton was eligible for most Federal farm programs.¹ The 2014 Farm Act eliminated multiple programs, including the Direct and Countercyclical Program, while introducing several new programs, including the Agriculture Risk Coverage (ARC) Program, Price Loss Coverage (PLC) Program, Supplemental Coverage Option (SCO), and Stacked Income Protection Plan (STAX). ARC and PLC are available for covered commodities only, disqualifying cotton under the 2014 Farm Act. STAX and SCO are area-based revenue insurance products open to cotton producers.² Only cotton producers can enroll in STAX, while SCO is open to producers of a large range of field crops as well as select fruits and vegetables. This report focuses on the two new programs for cotton and examines the mechanics of the programs and their revenue impacts.

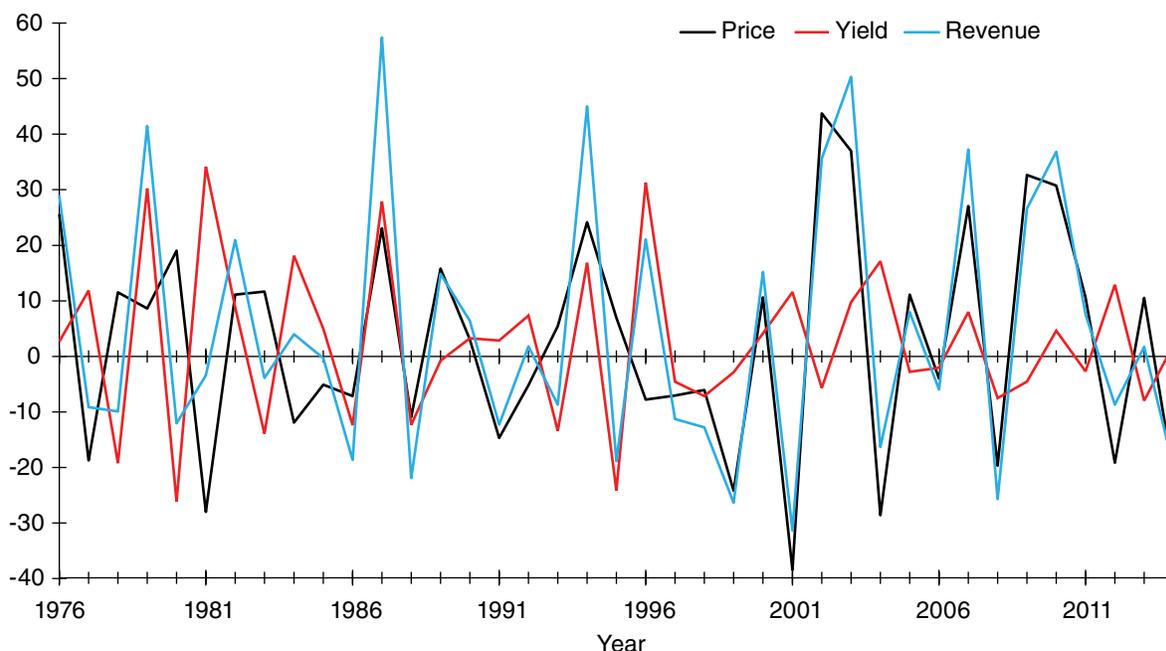
¹A covered commodity is a field crop that is eligible for certain USDA Farm Service Agency programs. Currently, covered commodities include corn, soybeans, wheat, rice, peanuts, grain sorghum, lentils, chickpeas, dry peas, and other oilseeds.

²Area-based insurance products pay indemnities when the average yield or revenue (depending on the product) of an area (e.g., county) falls below a pre-specified level. This is in contrast with individual-level insurance products that pay indemnities when the yield or revenue of an individual farm falls below a pre-specified level.

Figure 1

Year-to-year change in market price, yield, and revenue for U.S. cotton, 1976-2014

Year-to-year change



Source: USDA, Economic Research Service, USDA National Agricultural Statistics Service, Quick Stats (2015).

Crop insurance has grown over the last several years to be the largest Federal program for agriculture, excluding nutritional assistance. The most popular form of crop insurance is Revenue Protection (RP), which accounted for nearly 80 percent of insurance policies for cotton in 2014 (RMA, 2014a). Subject to a deductible, RP guarantees the enrolled producer a percentage of the expected revenue (expected yield³ times the higher of the projected price⁴ or harvest price). Other crop insurance policies offered to cotton and other major field crops include Yield Protection (YP) and Revenue Protection with Harvest Price Exclusion (RPHPE). All three policies can be used in conjunction with SCO or STAX.

RP, YP, and RPHPE policies typically have higher deductibles than SCO and STAX but protect against more severe losses; therefore, these policies are referred to as “deep loss” programs.⁵ The Federal Government subsidizes the premiums for these crop insurance programs.⁶ Higher coverage levels generally are not as heavily subsidized as lower levels of coverage (O’Donoghue, 2014).

³The expected yield is calculated using the producer’s Actual Production History (APH).

⁴For cotton, the projected price is based on the Intercontinental Exchange December futures contract (CTZ).

⁵Other less commonly chosen deep-loss insurance programs include Actual Production History Insurance and Area Risk Protection Insurance (ARPI).

⁶The Federal Government also subsidizes crop insurance companies’ administrative and operating expenses and covers a portion of the underwriting risk.

Program Descriptions

STAX is an area-based revenue insurance policy that a producer can purchase as a stand-alone product or with a companion (“deep loss”) policy. STAX has the same option for harvest price protection as does Revenue Protection. Producers make two selections that determine the STAX coverage range. The first, called the area loss trigger, ranges from 75 to 90 percent in 5-percent intervals and determines the upper bound of coverage. When area revenue falls below this area loss trigger, the producer receives a payment from STAX. The lower bound of coverage is, in part, determined by whether the producer chooses to have a companion policy associated with STAX.⁷

The producer must also select a protection factor (PF), which ranges from 0.80 to 1.20 in increments of 0.01. The PF is multiplied by the coverage selected by the producer to give the maximum dollar amount of coverage provided by the STAX policy (see appendix for the STAX payment equation). The Federal Government subsidizes 80 percent of the premium for STAX (RMA, 2014b).

In contrast to STAX, which can be purchased as a stand-alone policy, **SCO** is an add-on crop insurance policy that must be purchased with one of the following underlying policies: Revenue Protection, Yield Protection, or Revenue Protection with Harvest Price Exclusion (RMA, 2014c). The payment trigger for SCO reflects the trigger of the underlying policy (see box, “STAX and SCO Payment Examples”). For example, SCO indemnity payments are triggered by county *revenue* losses if the underlying policy is Revenue Protection and by county *yield* losses if the underlying policy is Yield Protection. Payments from SCO are triggered when the county revenue or yield, depending on the underlying policy, falls below 86 percent of the expected level. The maximum SCO payment is the difference between 86 percent of the expected level and the coverage of the underlying policy. If, for example, a producer has an RP policy with 70-percent coverage, the producer’s maximum SCO payment is 16 percent (86 percent - 70 percent) of the expected revenue. Although SCO payments are triggered by a drop in *county* yield or revenue, payment amounts are based on the expected yield or revenue of the *individual* producer. Producers pay a premium for SCO, with 65 percent subsidized by the Federal Government (see appendix for the SCO payment equation).

⁷If a companion policy is selected, the producer chooses a lower bound of the coverage range. The lower bound of the coverage range cannot extend below the companion policy’s coverage level or 70 percent, whichever is higher. The STAX coverage range is then the difference between the upper bound (the area loss trigger) and this lower bound. (In this report, we assume the producer always selects the maximum area loss trigger of 90 percent. An area loss trigger of 90 percent means that a producer will receive a payment if the actual county revenue falls below 10 percent of the expected county revenue.) For example, if the producer selects the maximum area loss trigger of 90 percent and does buy a companion policy (or buys a companion policy with a coverage level of 70 percent or lower), the coverage range is then 90 percent minus 70 percent, or 20 percent of the expected area revenue.

STAX and SCO Payment Examples

Example of STAX

Suppose a producer selects STAX with a protection factor of 1.10 and harvest price protection. The area loss trigger for the STAX policy is 90 percent, and the producer has an RP policy with 70 percent coverage. Further, suppose the projected price is \$0.75 per pound and the harvest price is \$0.70 per pound. Since the projected price is greater than the harvest price, by the provisions of RP, the projected price will be used to calculate the expected revenue. With an expected county yield of 1,000 pounds per acre, the expected county revenue equals \$750 per acre. The producer will receive a payment if the actual county revenue is below \$675 per acre, or below 90 percent of the expected \$750 per acre. The producer will receive the maximum payment if area revenue falls below 70 percent of the expected revenue. The maximum gross payment for STAX is the coverage range multiplied by county expected revenue and the protection factor of 1.10, which is $(0.90-0.70) \times \$750 \times 1.10 = \165.00 per acre.

Example of SCO

Suppose the same producer chooses SCO instead of STAX. The producer still chooses to enroll in RP, with 70 percent coverage, along with SCO. The expected county revenue is \$750 per acre based on the projected price of \$0.75 and the expected county yield of 1,000 pounds. Further, suppose the producer's expected yield is 1,060 pounds per acre, meaning the producer's expected revenue is \$795 per acre. SCO will pay out when the county revenue is below \$645 (86 percent of expected revenue calculated with the projected price). The maximum gross payment for SCO is the difference in revenue between the coverage rate for SCO and the coverage rate for the Revenue Protection policy, which is 16 percent (86 percent - 70 percent = 16 percent) of the farmer's expected revenue of \$795 per acre: $0.16 \times \$795 = \127.20 per acre.

The Mechanics of STAX and SCO

SCO and STAX enable producers to minimize downside risk. This section examines how these programs compare, using both simple payment calculations for a set of prices and yields and statistical simulations that account for uncertain prices and yields (see box, "Overview of Data and Analysis Methods"). Throughout, we assume the companion policy for STAX and the underlying policy for SCO is Revenue Protection with 70 percent coverage, the most common insurance policy for upland cotton in 2014 and 2015. Also, the 90-percent area loss trigger applies for STAX, and almost all producers who purchased STAX chose harvest price protection as well. Unless otherwise specified, all STAX analysis is conducted using a 90-percent area loss trigger and harvest price protection (RMA, 2015).

Table 1 provides results for RP with 70 percent coverage and STAX with a protection factor of 1 under varying STAX coverage ranges. The values in table 1 are based on analysis of a representative farm in each cotton producing county across the United States, and are weighted by total planted cotton acres in the county. The simulation results assume the projected price and expected yields for

Table 1

Farm-level expected payments, reduction in gross revenue risk, and choice of area loss triggers for U.S. upland cotton-producing counties^a

Area loss trigger	RP with 70% coverage			STAX payments			Both STAX and RP with 70% coverage		
	—STAX not included—			—RP not included—					
	Payment (\$/acre) ^c	Change in gross rev. risk (\$/acre) ^b	% Change in gross rev. risk ^b	Payment ^c (\$/acre)	Change in gross rev. risk (\$/acre) ^b	% Change in gross rev. risk ^b	Payment ^c (\$/acre)	Change in gross rev. risk (\$/acre) ^b	%Change in gross rev. risk ^b
75%	23.45	-0.12	-19.3	4.28	-0.01	-2.3	27.73	-0.13	-21
80%	23.45	-0.12	-19.3	9.44	-0.03	-4.7	32.88	-0.14	-23
85%	23.45	-0.12	-19.3	15.58	-0.04	-7.2	39.03	-0.15	-25
90%	23.45	-0.12	-19.3	22.78	-0.06	-9.8	46.23	-0.16	-28

Notes: RP = Revenue Protection and STAX = Stacked Income Protection Plan.

^aAnalysis assumes expected cotton price and yields for 2014.

^bThe term “change in gross revenue risk” is the variability of revenue with payments less the variability of revenue without payments, and percent change in gross revenue is the percent change in this variability. Variability is defined as the standard deviation of revenue divided by the mean of revenue, or gross revenue risk.

^cGross payment minus the farmer-paid premium.

Source: USDA, Economic Research Service results based on simulation model.

2014. The table shows net payments (subtracting out the farmer-paid premium) and risk reduction with and without the companion RP policy, as well as the percentage change in gross revenue risk.⁸

The average payment for RP with a 70-percent coverage rate is \$23.45 per acre, with an associated revenue risk reduction of just over 19 percent. Simulated STAX payments (not added to the RP payments, column 2) range from \$4.28 to \$22.78 per acre for the area loss triggers between 75 percent and 90 percent. When STAX indemnity payments are isolated from any other insurance programs, STAX is found to reduce revenue risk by an average of 2 to 10 percent depending on the area loss trigger chosen by the farmer. Combined STAX (20 percent coverage) and RP (70 percent coverage) payments increase maximum risk reduction from 10 percent (STAX only) to almost 28 percent.

While the STAX protection factor will not change the probability of a farmer receiving an indemnity payment, increasing (or decreasing) the protection factor from 1 will increase (or decrease) both payments and the magnitude of the risk reduction. Accordingly, the STAX premium increases as the protection factor is increased.⁹

⁸The gross revenue risk is measured by the coefficient of variation, which equals the standard deviation of the gross revenue divided by the mean of the gross revenue. The change in the gross revenue risk is the coefficient of variation of total gross revenue (gross revenue plus the support payment) less the coefficient of variation for gross revenue without support payments. Because “shallow loss” covers a smaller range of losses than does a “deep-loss” program, the risk reduction estimates for a “shallow-loss” program will consistently be lower than for a “deep-loss” program.

⁹In a statistical context, the actuarially fair insurance premium is equal to the average of the statistical distribution of indemnity payments. Hence, any program change that increases indemnity payments also increases the actuarially fair insurance premium, and consequently, the farmer-paid premium.

Overview of Data and Analysis Methods

In this analysis, yields at the national, State, and county levels are simulated in order to estimate revenue along with payments from STAX and SCO. Simulation is needed because STAX and SCO are new programs. Relying on the realized revenues from 2015 would not provide robust average estimates for payments.

State and county yield data for all States and counties that produced upland cotton between 1975 and 2013 are from USDA's National Agricultural Statistics Service¹ (NASS, 2014). However, only States and counties with continuous (annual) time series of yields could be included in the analysis, leaving 151 cotton-producing counties.² National yields for this time period are collected as well. Prices for cotton (1975 to 2013), along with county base premium rates for Federal policies, are from USDA's RMA (RMA, 2014d).

For the modeling and simulation, we follow the methodology described by Cooper and Delbecq (2014). Each county yield time series is regressed on a time dummy variable in order to detrend yields. The non-parametric univariate distribution for each time series of the detrended county yields is then estimated. The univariate distribution of the deviates of futures prices (or the differences between futures prices at signup time and harvest time) are also estimated. The covariance matrix among the county yields and the deviates of futures prices are calculated and used in the multivariate distribution that connects the univariate distributions from the previous step. The function that connects these univariate distributions together to create the multivariate distribution is called a copula function. Next, 10,000 random draws of yields and prices are made from the copula function. Each random draw is a vector containing a simulated county yield for each county in the crop's dataset and one simulated price deviate for the crop.

From the county base premium rates, we can derive the farm-level variation in yields for each county, following Coble and Dismukes (2008). Using this farm-level variation, the idiosyncratic risk for a representative farm for each county can be deduced. To create a simulated yield for a representative farm, random draws of idiosyncratic variation are added to simulated county yields until the variation equals the RMA county base premium rate. The variation in yields is either systemic or idiosyncratic. The correlated draws from the copula model provide systemic variation, while the variation derived from the county base premium rates provides idiosyncratic variation. All yield draws are truncated at zero to prevent negative yields. Using the simulated prices and yields, we then calculate cotton revenue and its coefficient of variation for the representative farms of each county in the data set.

¹RMA uses RMA Actual Production History to calculate premiums for its programs.

²The counties with sufficient data available for analysis account for approximately 65 percent of total planted upland cotton acres. As such, average payment and risk reduction estimates of all counties in the sample do not necessarily represent the average payment or risk reduction estimates of all cotton-producing counties in the United States. Counties not included in the sample likely have fewer producers and may have higher yield risk. If so, the estimates provided in this report may be more heavily weighted towards counties with lower yield risk.

Isolating Supplemental Coverage Option (SCO) indemnity payments from any deep-loss policies, SCO reduces revenue risk by an estimated 7 percent (table 2). SCO and Revenue Protection (70 percent coverage) together produce total net payments of \$37.21 per acre and afford risk reduction of almost 25 percent, which is comparable (but with lower payments) to the risk reduction under STAX (with an 85-percent area loss trigger) and RP (70 percent coverage).

Table 2

Expected payments and reduction in revenue risk across all cotton-producing counties for SCO¹

Scenario	Expected SCO payment ^c	Reduction in gross revenue risk	
		Change	% change
	(\$/acre)		
SCO without RP payments ²	13.76	-0.04	-7.2
SCO with RP payments	37.21	-0.15	-24.8

Notes: SCO = Supplemental Coverage Option and RP = Revenue Protection.

¹Analysis assumes projected (national) price and expected (county) yields for 2014.

The projected price is \$0.78 per pound.

²The “SCO without RP payments” case is for illustration only. Farmers cannot purchase SCO without an underlying insurance policy such as RP.

^cGross payment from SCO minus the farmer-paid premium.

Source: USDA, Economic Research Service results based on simulation model.

Farmer-paid premiums simulated in table 3 are based on the 2014 projected price of \$0.78 per pound and an expected county revenue¹⁰ of \$498.95 per acre. In this analysis, the area loss trigger is held constant at 90 percent while the coverage level of the companion policy (Revenue Protection) varies from 85 percent down to 70 percent. Hence, the coverage range for STAX (area loss trigger minus companion policy coverage) ranges from 5 percent to 20 percent. Since increasing the coverage range increases the probability of a STAX payment and maximum net payment, higher STAX coverage rates have higher premiums. Although the protection factor does not affect the probability of a payment (the trigger), increasing the protection factor increases the indemnity issued; consequently, a higher protection factor increases the STAX premium.

For these reasons, a STAX policy with 5-percent coverage and a protection factor of 0.8 has the lowest premium of \$0.86 per acre (not shown), while a STAX policy with 20-percent coverage and a protection factor of 1.2 has the highest premium, \$6.84 per acre (table 3). With an underlying RP policy at 70 percent coverage, the premium for SCO would be \$8.94 per acre, which is higher than any coverage level and protection factor combination under STAX.

Figure 2 shows how SCO and STAX net payments (gross payments less the farmer-paid premium) differ over a range of harvested yields under two harvest prices. Based on the projected price determined by RMA, we use two hypothetical harvest-time prices: \$0.55 and \$0.97 per pound.¹¹ In these charts, SCO has an underlying policy of Revenue Protection with 70 percent coverage, and STAX

¹⁰This expected county revenue is a weighted average of all counties in the dataset.

¹¹These hypothetical high and low prices were chosen based on the price distribution suggested by the RMA volatility factor of 0.14 and a projected price of \$0.78 per pound. According to the log-normal price distribution presumed by RMA, the probability of the price at harvest time being at or below \$0.55 per pound is 2.5 percent, as is the probability of the price being at or above \$0.97 per pound.

has 20 percent coverage and protection factors equal to 0.8 and 1.2. For ease of comparison, STAX and SCO payments do not include RP payments.

When the harvest price is below the projected price of \$0.78 per pound, the harvest price is not used in either the SCO or STAX guarantee (figure 2a). The SCO policy does not provide support over as wide a range of yield outcomes as does STAX because SCO payments commence at lower revenue triggers (86 percent of expected county revenue) than STAX (90 percent). However, the maximum gross payments for both STAX and SCO are made when county revenue falls below 70 percent of expected revenue. In both the high and low price scenarios, SCO payments are below both STAX payments (with protection factors of 0.8 and 1.2) due to the lower premium subsidy and payment trigger for SCO. Net payments can be negative for SCO and STAX because the producer-paid premium may be larger than the payment or there may be no payment at all.

Table 3

Payment triggers¹ and farmer-paid STAX premiums for varying coverage levels and protection factors²

Coverage	Protection factor (PF)		
	PF = 0.8	PF = 1	PF = 1.2
	Farmer premium (\$/acre)		
5%	1.44	1.80	2.16
10%	2.66	3.34	4.00
15%	3.70	3.90	5.55
20% ³	4.56	5.70	6.84

Notes: STAX = Stacked Income Protection Plan.

¹Assumes that farmers have chosen harvest price protection for the the STAX guarantee.

Therefore, payments may be triggered at a higher revenue if the harvest price is higher than the projected price.

²Assumes projected price and expected yields for 2014. The projected price is \$0.78 per pound.

³This is also the required premium if the producer has a companion policy with coverage less than 70 percent or no companion policy.

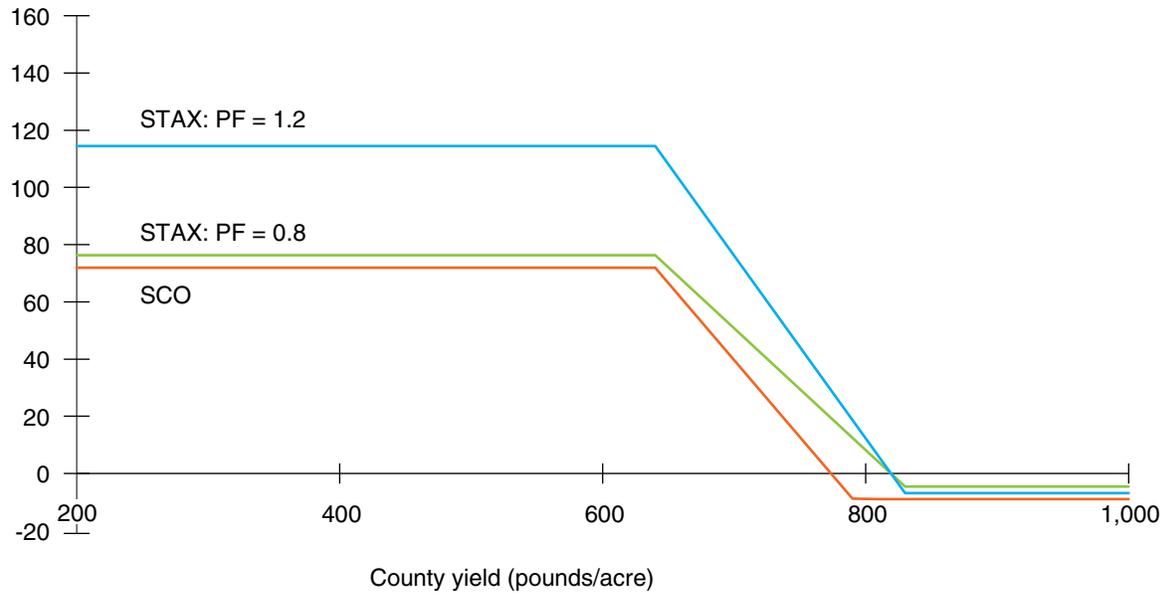
Source: USDA, Economic Research Service results based on simulation model.

Figure 2

Net STAX and SCO net payments over a range of yields under low and high harvest price scenarios: (a) \$0.55 per pound (b) \$0.97 per pound

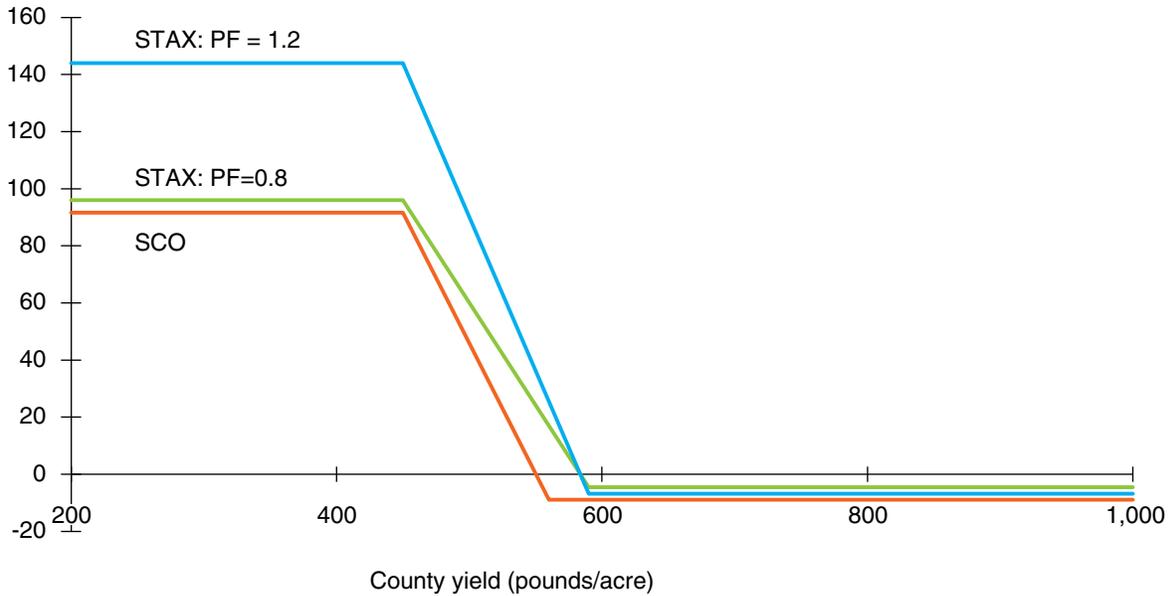
(a) Low harvest price scenario (\$0.55 per pound)

Payment (\$/acre)



(b) High harvest price scenario (\$0.97 per pound)

Payment (\$/acre)



Notes: STAX = Stacked Income Protection Plan; PF = protection factor; SCO = Supplemental Coverage Option; and RP = Revenue Protection.

Source: USDA, Economic Research Service results based on simulation model.

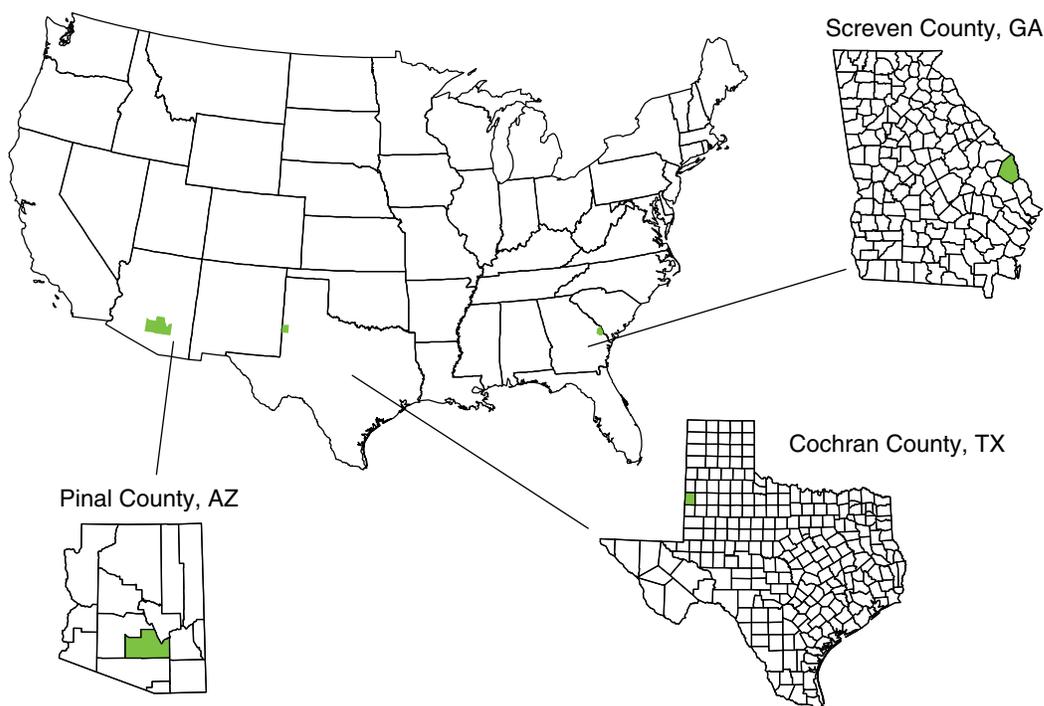
Reduction in Revenue Risk Under STAX and SCO

By identifying the gross revenue risk for representative farms at the county level, this section explores how STAX and SCO reduce downside risk across farms with low, medium, and high revenue risk. While all cotton farms in this analysis face the same national price distribution, farmers differ from one another not only in the mean and variability of yields, but also in the correlation of their yields with national price.¹² Price-yield correlation tends to be low for U.S. cotton producers. Depending on the county, the price-yield correlation ranges from -0.35 to 0.35, with many counties near zero (see Appendix A3). As such, most differences in revenue risk across cotton producers derive from differences in yield risk.

Figure 3 displays three geographically dispersed counties that vary distinctly in their gross revenue risk, with producers in each county representing low (Pinal County, AZ), medium (Screven County, GA), and high (Cochran County, TX) revenue risk. Table 4 shows the expected revenue for three cotton-producing farms in these counties under different projected prices when the producer has enrolled in (1) no crop insurance, (2) RP only, (3) RP and STAX, and (4) RP and SCO. Figure 4 shows the distribution of gross revenues for these counties under several of these scenarios. As before, we assume RP has 70 percent coverage and STAX (with a protection factor of 1) has price protection as well.

Figure 3

Locations of Pinal County, AZ; Screven County, GA; Cochran County, TX



Source: USDA, Economic Research Service.

¹²Assume two farmers have the same yield distribution but different levels of (negative) correlation between yield and national price. If Farmer A's yield distribution has a more negative correlation with national price than Farmer B, Farmer A will have a lower revenue risk. This is because farmer A is more likely to have high yields when prices are low, which offsets the price.

Table 4

Average gross revenue for three farms of different county-level revenue risk, with and without STAX and SCO¹

County	Revenue in \$ per acre (95% confidence interval in parentheses)			
	Revenue only	Revenue + RP	Revenue + RP+ STAX	Revenue + RP+ SCO
Low projected price: \$ 0.56 per pound				
Low risk (Pinal, AZ)	\$844 (231, 1597)	\$873 (575, 1577)	\$906 (566, 1579)	\$890 (565, 1573)
Medium risk (Screven, GA)	\$401 (79, 775)	\$418 (266, 762)	\$444 (299, 756)	\$434 (287, 754)
High risk (Cochran, TX)	\$169 (0, 506)	\$173 (37, 503)	\$176 (36, 504)	\$175 (36, 504)
2014 projected price: \$0.78 per pound				
Low risk (Pinal, AZ)	\$1,175 (322, 2225)	\$1,216 (800, 2197)	\$1,261 (789, 2200)	\$1,240 (787, 2190)
Medium risk (Screven, GA)	\$558 (110, 1078)	\$583 (370, 1062)	\$618 (417, 1054)	\$605 (400, 1050)
High risk (Cochran, TX)	\$235 (110, 1078)	\$242 (51, 701)	\$245 (51, 702)	\$244 (50, 702)
High projected price: \$ 1.00 per pound				
Low risk (Pinal, AZ)	\$1,507 (412, 2853)	\$1,559 (1026, 2817)	\$1,617 (1011, 2820)	\$1,590 (1009, 2808)
Medium risk (Screven, GA)	\$715 (141, 1383)	\$747 (475, 1361)	\$793 (534, 1351)	\$775 (513, 1346)
High risk (Cochran, TX)	\$301 (0, 905)	\$311 (66, 899)	\$314 (65, 900)	\$313 (65, 900)

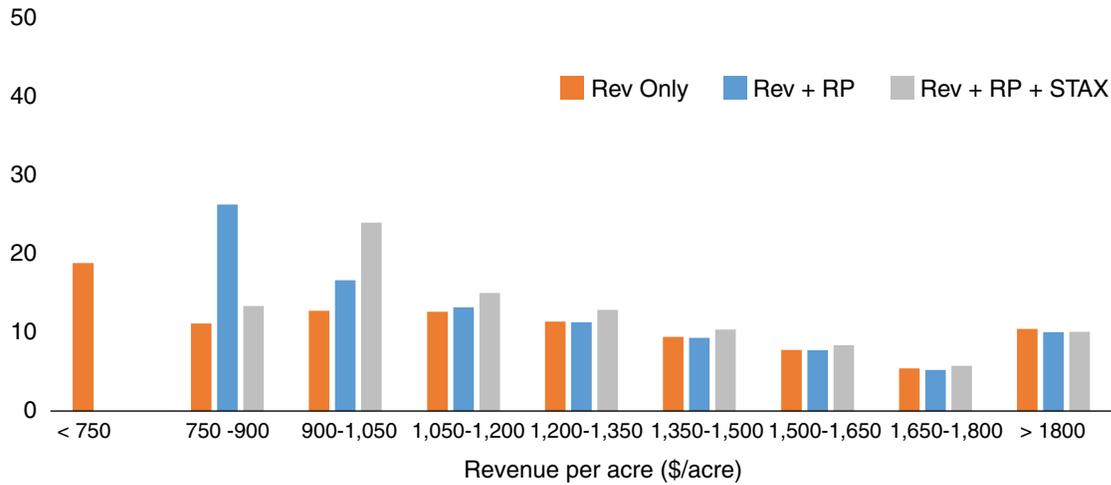
Notes: ¹RP = Revenue Protection; STAX: Stacked Income Protection Plan; and SCO = Supplemental Coverage Option. Source: USDA, Economic Research Service results based on simulation model.

Figure 4

Distribution of gross revenue for a representative farm in three counties of differing revenue risk with and without STAX¹

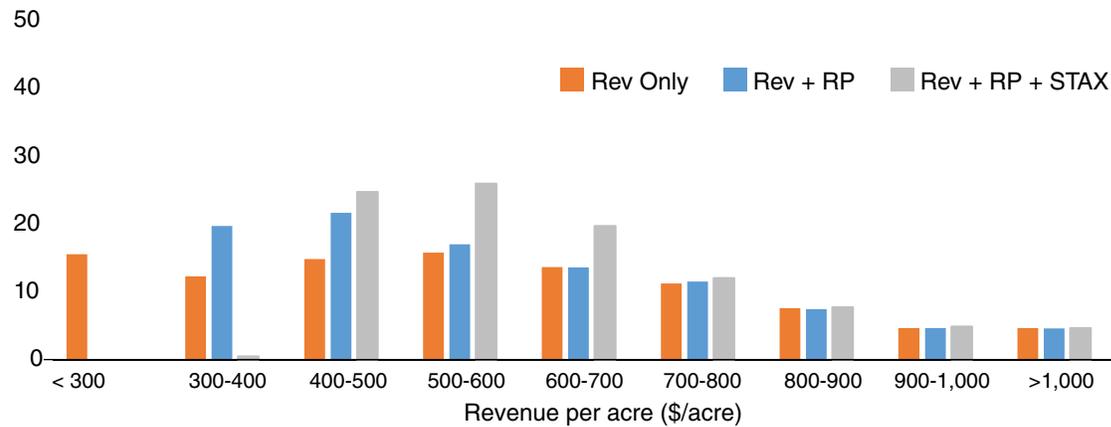
(a) Representative farm of the low-risk Pinal County, Arizona

Probability of revenue (\$/acre)



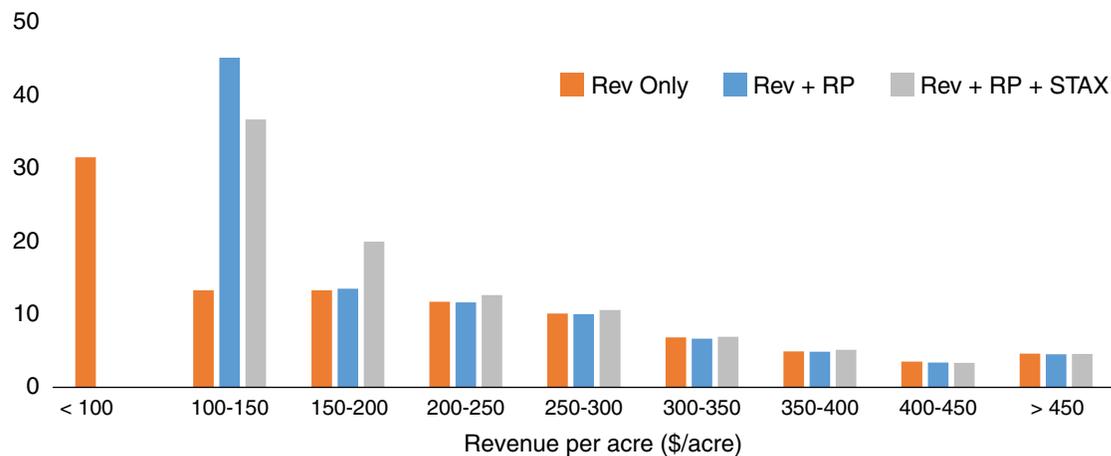
(b) Representative farm of the medium-risk Screven County, GA

Probability of revenue (\$/acre)



(c) Representative farm of the high-risk Cochran County, TX

Probability of revenue (\$/acre)



Notes: ¹STAX = Stacked Income Protection Plan; REV = Revenue; and RP = Revenue Protection.

Source: USDA, Economic Research Service. The results are based off of the simulations for the representative farms of the high-risk county (Cochran County, TX), medium-risk county (Screven County, GA), and the low-risk county (Pinal County, AZ).

Average revenue risk tends to vary across the United States given that cotton yield risk varies by county. Data suggest that farmers in counties with higher revenue risk tend to have producers that generate lower average revenues, and vice versa. Not surprisingly then, the representative farm for low-risk Pinal County has the highest revenue, while the representative farm for high-risk Cochran County has the lowest revenue. The confidence intervals¹³ for revenue are larger for representative farms in the lower risk counties; however, the lower risk counties have higher upper bounds. The representative producer in Cochran County has \$0 per acre as the lower bound of the confidence interval for gross revenue. In other words, producers in Cochran County are more likely to lose their entire crop than producers in Pinal County or Screven County. For Cochran County, the confidence intervals for revenue increase as the projected price increases. This is because a large number¹⁴ of the simulated outcomes result in a yield of 0 pounds per acre for Cochran County, so no matter how high the predicted price for cotton, the lower bound for gross revenue of a representative Cochran County producer will always be zero. As the projected price increases, however, the upper bound of the confidence interval will rise, leading to larger confidence intervals.

Relationship between shallow-loss and deep-loss indemnity payments

The various crop insurance programs affect farmers differently depending on the gross revenue risk associated with the county. Does the amount of risk a producer faces alter his or her valuation of the various crop insurance programs available? How much additional value do shallow-loss programs add to the traditional deep-loss programs, such as RP? In other words, are STAX and SCO of more value (relative to a deep-loss policy like RP) for some producers than others?

To better understand the relationship between shallow-loss programs like SCO and STAX and a deep-loss program such as RP, we create ratios of the total premiums for shallow-loss programs to the total premiums for RP for representative farms in cotton-producing counties.¹⁵ The total premium combines the Government-paid and farmer-paid premiums together and, as such, represents the dollar value of risk covered by the program. If the ratio of total premium for SCO to total premium for RP (denoted as “SCO/RP”) is greater than one, this indicates that more risk is covered by the shallow-loss program relative to the deep-loss program. If SCO/RP is less than one, then more risk is covered by the deep-loss program relative to the shallow-loss program. The same logic applies to the ratio of total premiums for STAX to total premiums for RP (denoted as “STAX/RP”). If more revenue risk is covered by the shallow-loss policy, all else being constant, the producer would be more incentivized to purchase the shallow-loss policy.¹⁶

¹³The 95% confidence interval is calculated by sorting the 10,000 possible revenues for each representative farm from smallest to largest. The 9,500 revenues that fall in the middle of the 10,000 sorted revenues form the 95% confidence interval. The smallest revenue in the 95% confidence interval is called the lower bound, and the largest revenue is the upper bound.

¹⁴Technically, more than 2.5 percent of observations. In a 95% confidence interval, 2.5 percent of observations remain above the upper bound and 2.5 percent remain below the lower bound. If more than 2.5 percent of observations are equal to 0, as is the case here, the lower bound of the confidence interval will remain at 0, no matter the price level realized.

¹⁵The total premiums simulated in this analysis are actuarially fair; no administrative fees are included.

¹⁶This analysis is not an argument for substitutability between shallow-loss and deep-loss policies, but an explanation for why some producers may rely more heavily on shallow loss to reduce revenue risk.

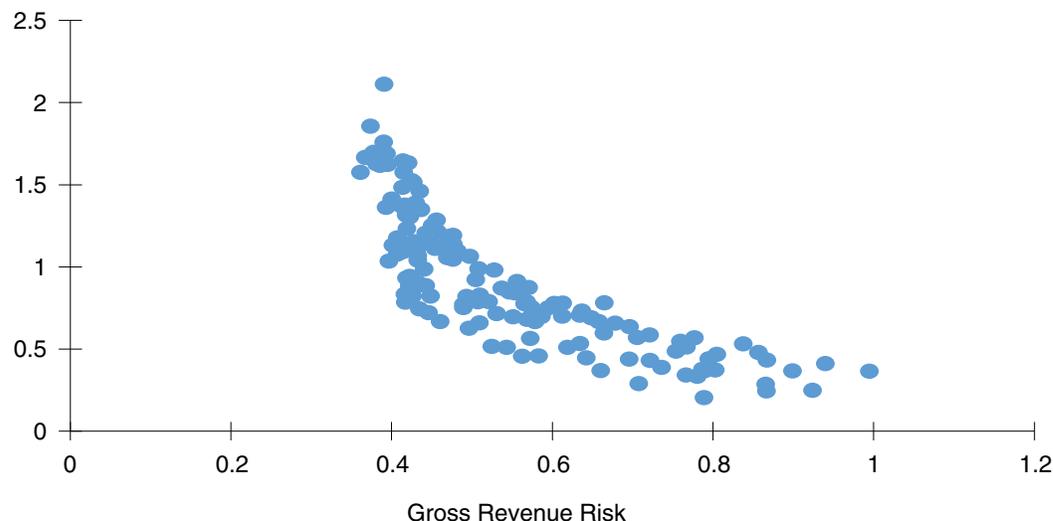
Figure 5a shows the SCO/RP ratios plotted against the gross revenue risk without crop insurance, while figure 5b does the same for STAX/RP. The underlying policy for SCO is RP with 70 percent coverage. The STAX policy has 20 percent coverage and a protection factor of 1. Each observation/ratio represents a cotton-producing farm for each county in the dataset.

Figure 5

Ratio of SCO or STAX premium to RP premium versus the gross revenue risk (for a representative farm in each cotton-growing county)^a

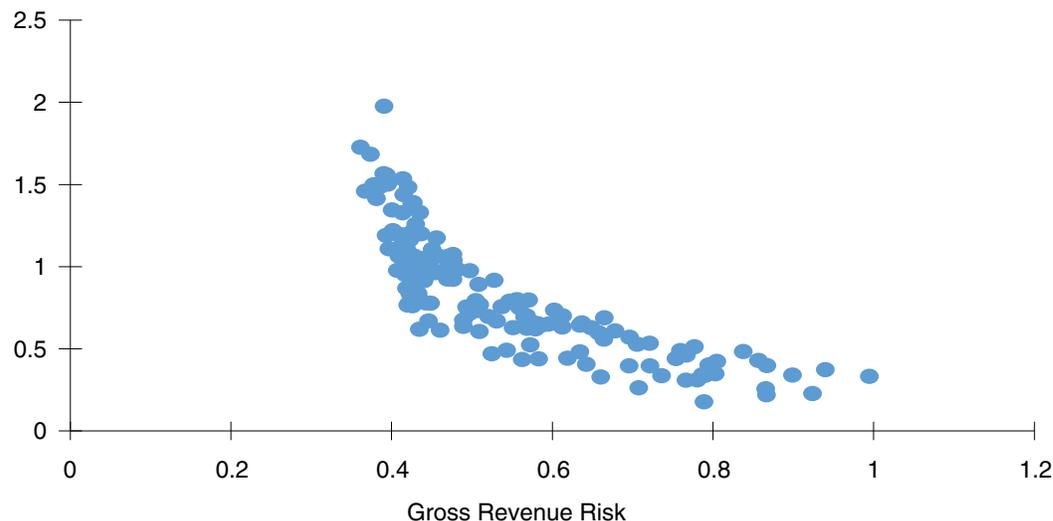
(a) Ratio of Supplemental Coverage Option to Revenue Protection premiums

SCO/RP



(b) Ratio of Stacked Income Protection Plan to Revenue Protection premiums

STAX/RP



Notes: ^aGross revenue risk is defined as the coefficient of variation of gross revenue. The higher the value, the higher the variability of revenue. STAX = Stacked Income Protection Plan; SCO = Supplemental Coverage Option; and RP = Revenue Protection.

Source: USDA, Economic Research Service results based on simulation model.

Both SCO/RP and STAX/RP have inverse relationships with gross revenue risk. Therefore, low-risk producers have more of their risk covered by a shallow-loss program than a deep-loss program. Low-risk producers are less likely to incur large losses. Losses that they do experience are also likely to be smaller in magnitude than those incurred by high-risk producers—exactly the types of losses covered by shallow-loss programs. As the gross revenue risk of producers increases (with yield variability in the county), they face a greater likelihood of suffering a significant loss compared to producers in low-risk areas. As a result, more of their risk will be covered by the deep-loss program relative to the shallow-loss program.

The distribution of SCO/RP and STAX/RP are similar (figures 5a and 5b). However, the ratio of STAX/RP is slightly higher than the ratio of SCO/RP since STAX covers a larger range of revenue than SCO. STAX payments (with 20 percent coverage) are triggered when county revenue is below 90 percent of expected revenue, while SCO payments are triggered when county revenue is below 86 percent of expected revenue.

Impacts of SCO and STAX on farmer revenue risk by region

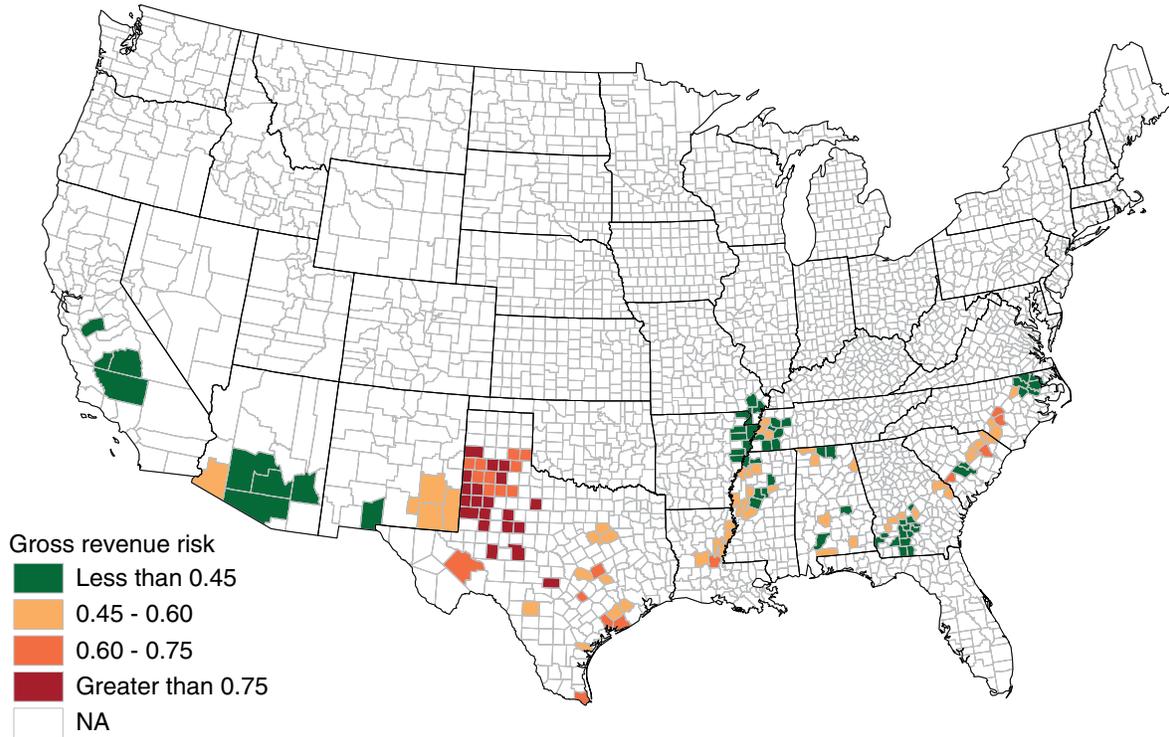
While we have explored how SCO and STAX operate—both in relation to each other and relative to RP—and examined the effects of these programs on producer revenues, we have yet to measure the changes in gross revenue risk for producers across the country. Figure 6 depicts gross revenue risk and expected risk reduction under several insurance programs for cotton-producing farms by county. In figure 6a, green counties are the least risky in terms of having the least variability in cotton revenue without crop insurance, while red counties are the most risky ones. Figures 6b, 6c, and 6d show the change in the gross revenue risk for RP, SCO with RP, and STAX with RP (with respect to the baseline in figure 6a). Gray counties are those in which representative farms undergo the least change in gross revenue risk. Blue counties are those benefiting from the greatest risk reduction. White counties are those that did not grow cotton continuously over 1975-2013.

Several patterns emerge for cotton revenue risk, and its abatement, across the United States. Many of the highest risk representative farms (hereafter, “farms”) are in Texas counties. Cotton farms in counties near the Mississippi River in Louisiana and Mississippi tend to be higher risk than farms farther north in Tennessee, Arkansas, and Missouri. A band of cotton-producing counties from North Carolina to Georgia has a mix of low- and medium-risk farms. Most cotton-producing farms in the Western United States are low risk. The low revenue risk in California, Arizona, and New Mexico may be due to irrigation. Although many acres of cotton in northern Texas are irrigated, the amount of water applied per acre of cotton in the Western United States is over double the amount applied in northern Texas (NASS, 2014). As a result, cotton-producing representative farms in the Western United States can better control yield risk, and hence revenue risk, compared to northern Texas despite comparable aridity.

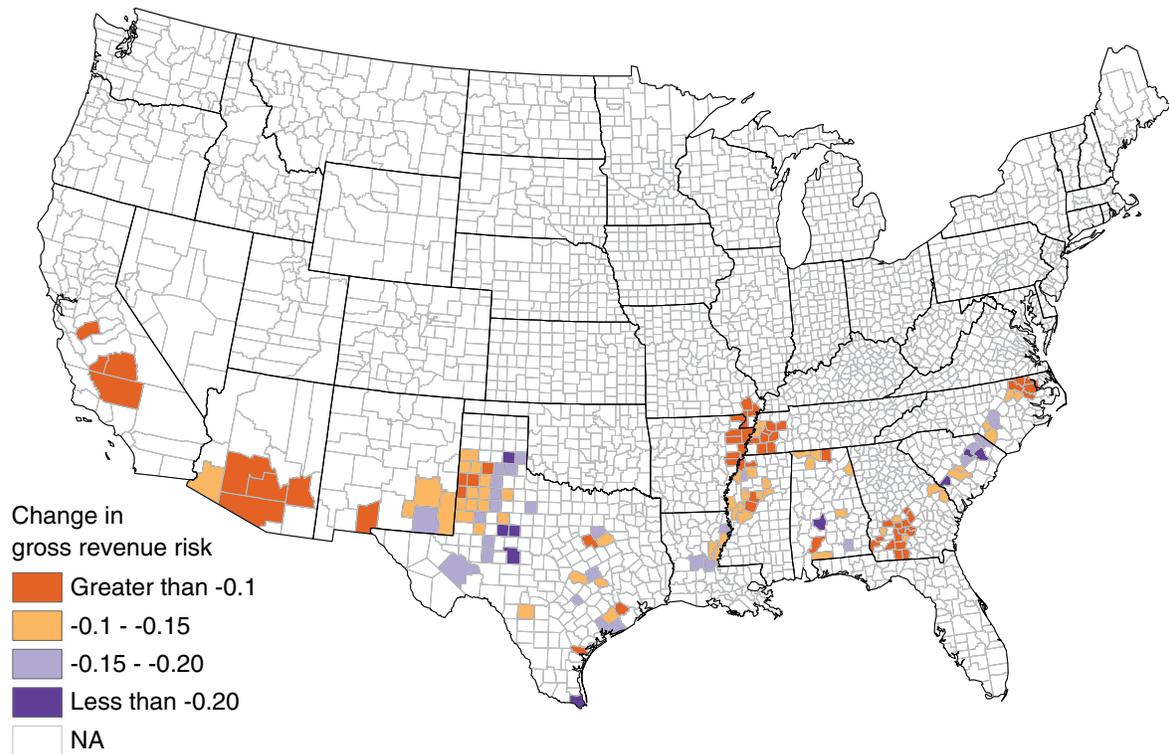
Figure 6

Cotton gross revenue risk and change in revenue risk with SCO, STAX, and RP crop insurance for county-level representative farms^{1,2}

(a) Revenue with no support payments



(b) Revenue + RP

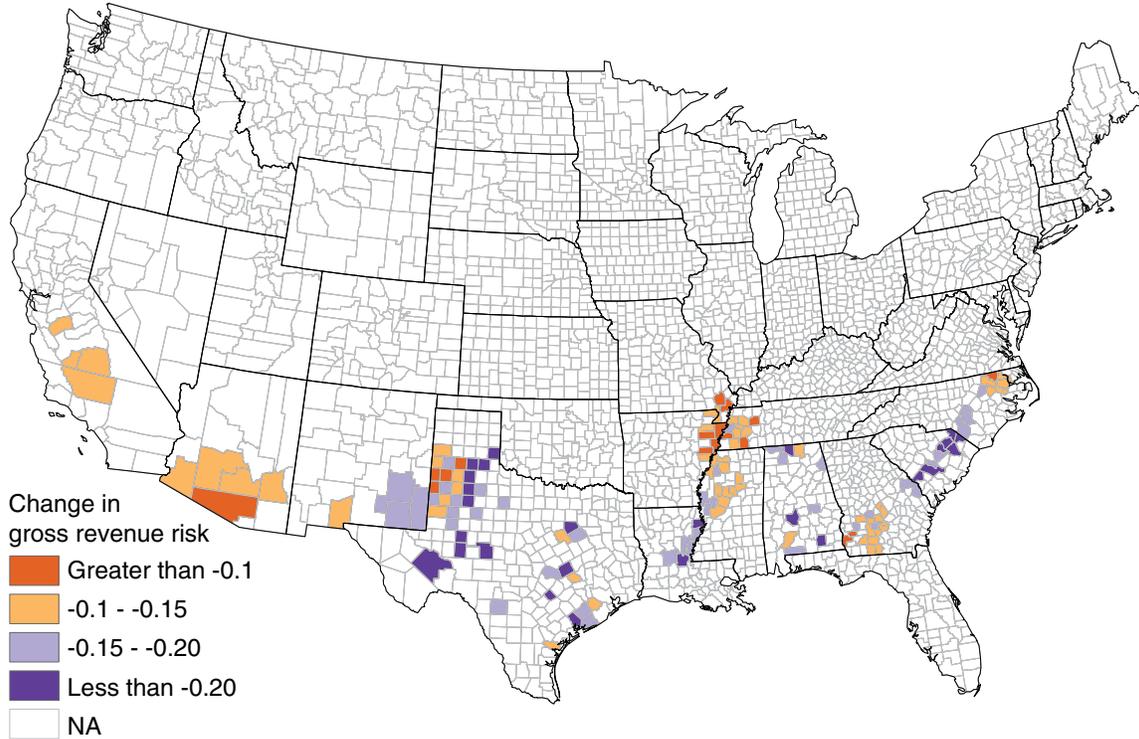


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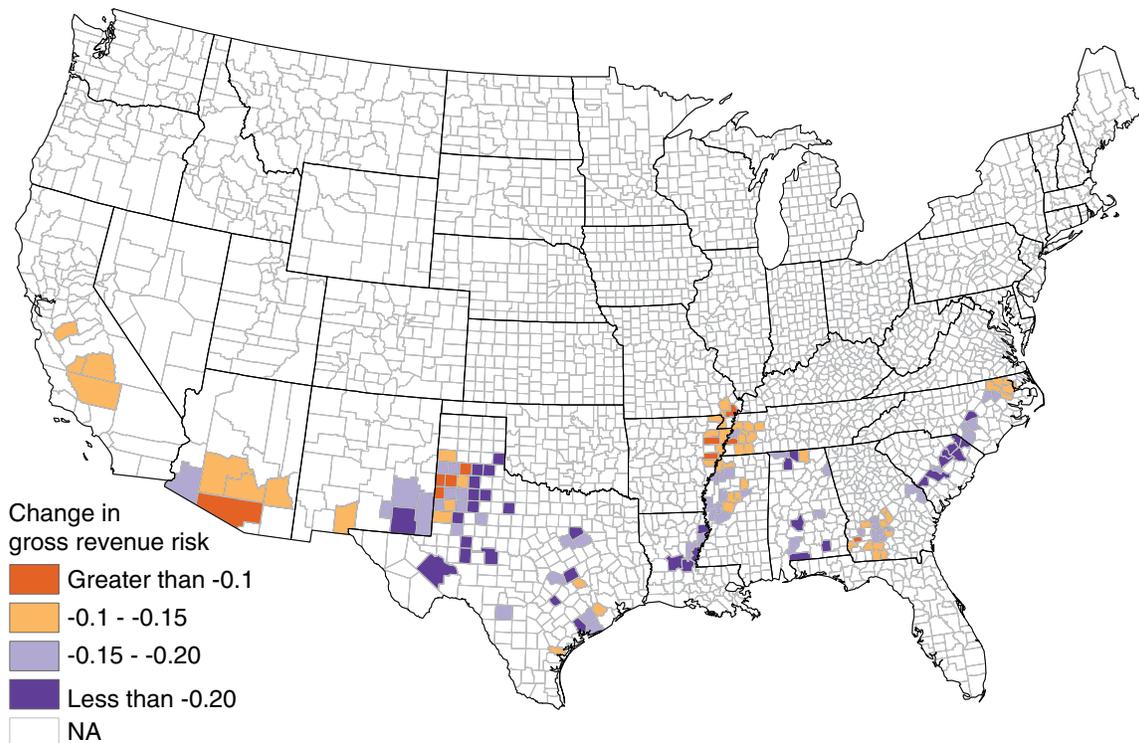
Figure 6

Cotton gross revenue risk and change in revenue risk with SCO, STAX, and RP crop insurance for county-level representative farms^{1,2}—continued

(c) Revenue + RP + SCO



(d) Revenue + RP + STAX



¹Revenue Protection (RP) is assumed to be purchased with 70 percent coverage.

²Change in revenue risk equals (coefficient of variation of gross revenue with crop insurance payments) less (coefficient of variation of gross revenue).

The higher the value, the higher the variability of revenue. NA indicates not applicable due to lack of continuous cotton annual yield data; STAX = Stacked Income Protection Plan; and SCO = Supplemental Coverage Option.

Source: USDA, Economic Research Service results based on simulation model.

While all three risk management strategies lead to similar *patterns* of risk reduction across the United States, the three strategies differ in the *amount* of risk reduced. Some representative farm counties in the western panhandle of Texas fail to have the highest level of risk reduction despite being in the highest gross revenue risk category. Since RP, STAX, and SCO mitigate losses from low revenue, the reduction in downside risk is larger for farms carrying higher revenue risk. As expected, the risk reduction with STAX or SCO used in combination with RP is higher than that afforded by RP alone. The reduction in revenue risk from STAX is slightly higher than from SCO.

Enrollment in Shallow-Loss Programs for Upland Cotton

Despite the evidence of risk reduction achieved by SCO and STAX for cotton producers, program enrollment to date has been modest. While 83,000 deep-loss policies were purchased for cotton in 2015, just 12,000 shallow-loss policies were bought, with the same pattern emerging for the 2016 commodity year. Table 5 demonstrates the disparity between acres covered by the most popular cotton crop insurance, Revenue Protection, and acres covered by STAX. This section examines in which regions producers are enrolling in shallow-loss programs from cotton and whether the concentration of cotton operations affects enrollment.

Table 5

Popularity of crop insurance and STAX for cotton producers in 2015

Total acres planted to cotton (million acres)	8.5
Acres with Revenue Protection (RP) (Share of planted cotton acres)	7 (82%)
Acres with STAX (Share of planted cotton acres)	2.5 (29%)

Notes: STAX = Stacked Income Protection Plan and RP = Revenue Protection.

Source: USDA, Economic Research Service; USDA; National Agricultural Statistics Service, Quick Stats; and USDA, Risk Management Agency, Summary of Business, 2015.

Few producers choose to enroll in STAX only. Those that do are scattered throughout the Southern United States. In most counties where deep-loss policies (e.g., RP) are present, at least one producer enrolled in STAX as well (figure 7a).¹⁷

Many counties where STAX is used actually report very few policies, as in northern Alabama and southern California (figure 7b). Counties producing cotton along the Mississippi River generally have fewer STAX policies than elsewhere. Northern Texas, Southern Alabama, and southern Georgia all have clusters of counties where the number STAX policies is high.

Using the Risk Management Agency's *Summary of Business* to collect data on STAX policies sold and 2012 Agricultural Census data on cotton operations and total crop operations, figure 8 shows the relationship between the market penetration of STAX and the relative concentration of cotton farming (share of cotton operations out of total crop operations per county). Market penetration of STAX is measured by the number of STAX policies sold divided by the number of cotton-producing operations per county. Of the 635 counties with cotton operations recorded by the 2012 Census, 393 (62 percent) had at least 1 STAX policy and 243 counties had none. Not surprisingly, counties with a great concentration of cotton farming have a higher likelihood of enrolling in STAX. The logistic regression (see appendix A2) shows that increasing the concentration of cotton operations in a county by 1 percent increases the odds of at least one producer purchasing STAX by 14 percent.¹⁸

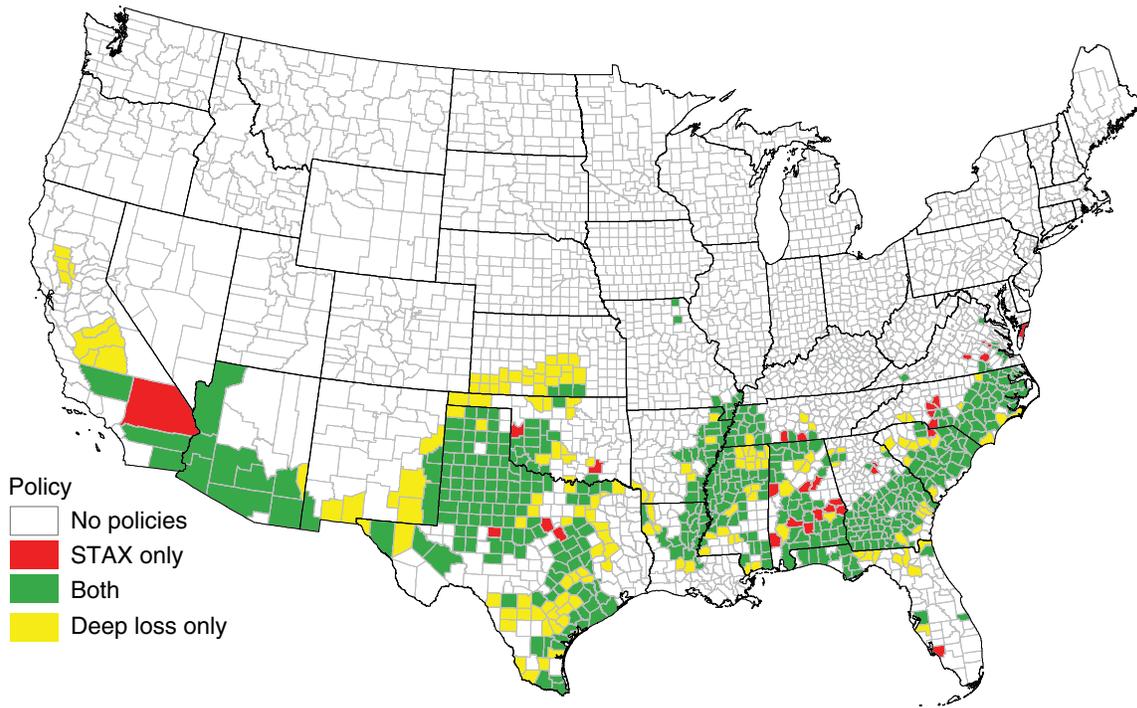
¹⁷The number of counties included in figure 7a is greater than the number of counties included in the simulation analysis. This is because counties included in the 2015 RMA count only had to produce upland cotton in 2015, whereas the simulation analysis required unbroken county-level data series on cotton from 1975-2013. Imposition of this requirement led to analysis reduction in the number of counties included in the analysis.

¹⁸A logistic regression of the presence of STAX in counties regressed on the concentration of cotton operations is provided in the appendix. Logistic regression estimates the odds of an event happening (STAX being present in a county based on an explanatory variable (concentration of cotton operations)).

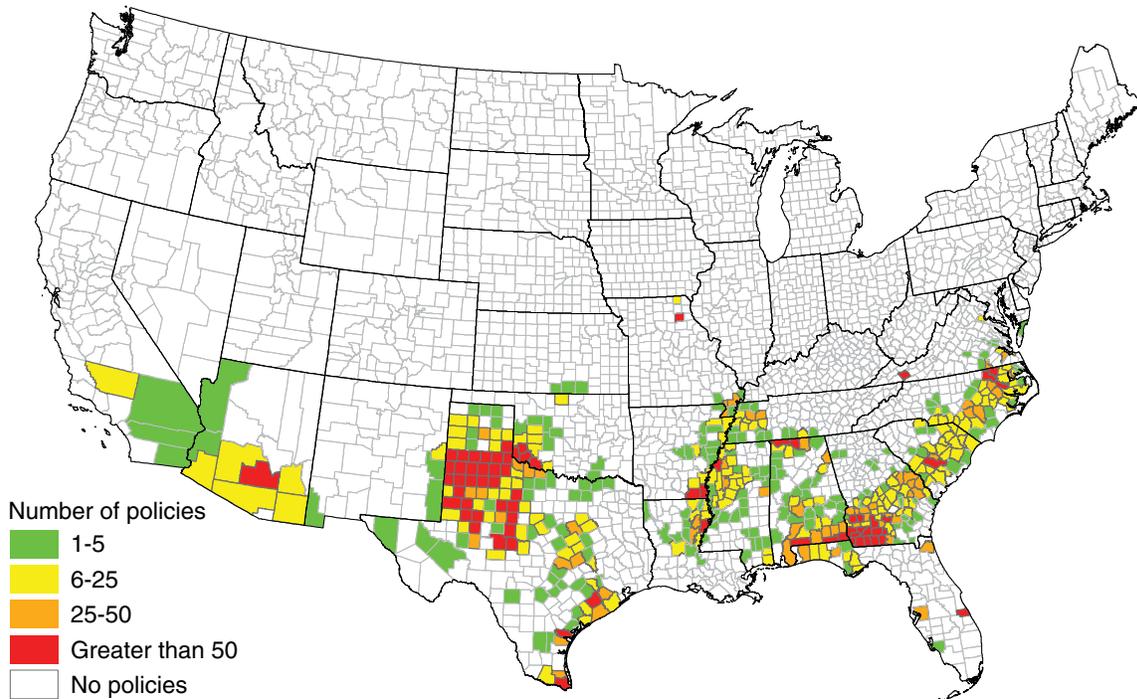
Figure 7

STAX and deep-loss cotton insurance enrollment by county, 2015

(a) County-level presence of various policy combinations



(b) Number of STAX policies sold (by county)



Note: STAX = Stacked Income Protection Plan.

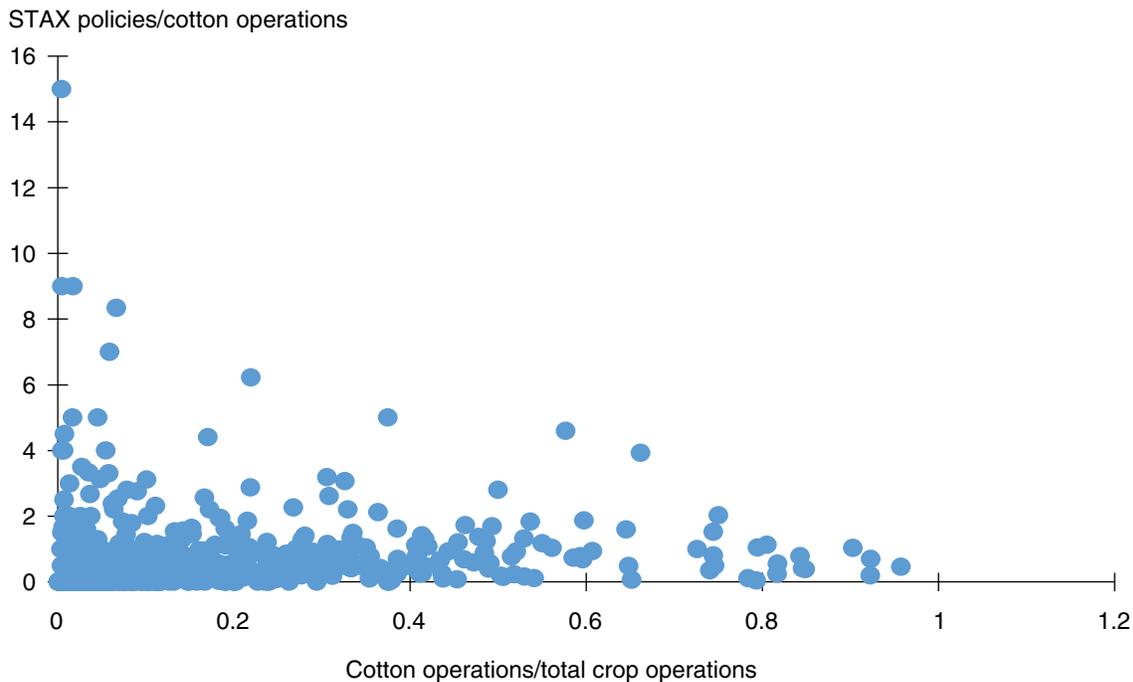
Source: USDA, Economic Research Service. USDA, Risk Management Agency, 2016.

Figure 8 plots the number of cotton operations divided by total crop operations in a county against the number of STAX policies sold divided by the number of cotton operations in a county. For 122 counties, the number of STAX policies exceeds the number of cotton operations. The number of cotton operations may have decreased since the 2012 Census, causing the ratio of STAX policies to cotton operations to be greater than one for these counties. But some operations may have multiple STAX policies if the policies are applied to different cotton fields of the operations. Some 243 counties in our dataset had no producers that purchased STAX. Because of the large number of counties with the value of “zero” for the variable STAX Policies/Cotton Operations, the regression model (see appendix A2) is a Tobit model that properly accounts for the zero values.

The regression model shows a statistically significant relationship between the concentration of cotton operations and the proportion of STAX operations to cotton operations. As the concentration of cotton operations among total crop operations increases, so does the proportion of STAX policies to cotton operations. Therefore, in areas where cotton is a more prevalent crop among producers, STAX policies are more likely to be purchased. For example, suppose County A only has 10 crop operations and 8 operations produce cotton. County B has 100 total crop operations and 30 operations grow cotton. The Tobit regression predicts that County A will have a higher proportion of producers purchasing STAX policies compared to County B.

Figure 8

Cotton operations/total crop operations versus STAX policies/cotton operations per county



Note: STAX = Stacked Income Protection Plan.
Source: USDA, Economic Research Service.

Conclusion

The new upland cotton crop insurance programs in the 2014 Farm Act—the Supplemental Coverage Option (SCO) and the Stacked Income Protection Plan (STAX)—offer strategies for producers to manage systemic risk, or risk correlated across producers. This report examines how the new cotton insurance programs make payouts under various yields and prices and analyzes the risk reduction benefits of these programs under recent prices and yields. Under the assumption that a cotton producer chooses Revenue Protection with 70 percent coverage (the most common policy and coverage rate among cotton producers), STAX with 20 percent coverage and a protection factor of 1.0 provides higher net payments and greater risk reduction than SCO.

In 2015, over 11,900 STAX policies were underwritten for cotton, while only 120 SCO policies were underwritten. The overwhelming popularity of STAX compared to SCO aligns with its superior performance in this report. Still, there are far fewer STAX policies than the 58,000-plus RP policies written for cotton in 2015 (RMA, 2015). Possible explanations for why the enrollment of STAX was particularly low in 2015 include unfamiliarity with the new program and low cotton prices. There is evidence that the concentration of cotton operations—the number of cotton operations divided by total crop operations in a county—is positively related to STAX adoption. It is possible that the relative adoption of SCO and STAX could change as prices, yield expectations, and farmer-perceived revenue volatility change in the coming years.

The cotton base acres held by producers prior to the Agricultural Act of 2014 were converted to generic base acres. Cotton is no longer a covered commodity and is not eligible for payment under the new Agriculture Risk Coverage (ARC) or Price Loss Coverage (PLC) programs. Producers participating in ARC/PLC with generic (former cotton) base acres have the option to grow a covered commodity on those generic acres and are eligible to receive ARC/PLC payments associated with that covered commodity. ARC and PLC are administered by USDA's Farm Service Agency. Whether planting a covered commodity or cotton on generic acres is optimal depends on the relative prices of the commodities, the expectation of ARC or PLC payments (which is not an option if cotton is planted), the relative cost of inputs, and other factors. Future analysis could explore the complexities of planting decisions for generic acres.

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Appendixes

Appendix A1: Formulas for Programs

The equation below provides a formal definition of the net STAX indemnity payment. The indemnity payment, along with revenues and the premium, is shown “per acre” in the equation.

$$\frac{STAX}{acre} = \min \left[\max \left\{ \left(Area\ Loss\ Trigger - \frac{Final\ Area\ Revenue}{Expected\ Area\ Revenue} \right), 0 \right\}, (Area\ Loss\ Trigger - \max(0.7, Cov.level_{CP})) \right] * Protection\ Factor * E[Area\ Revenue] - Premium$$

In the equation, *Area Loss Trigger* is the coverage level of the STAX policy, which ranges from 70 percent to 90 percent. *Cov. level_{CP}* is the coverage rate of the companion policy, and ranges as high as 85 percent in 5-percent increments starting from 50 percent. Thus, (*Area Loss Trigger*— $\max(0.7, Cov.level_{CP})$) in the equation above is always positive, and there is no overlap in the coverage rate between the underlying insurance policy and the STAX policy. *E(Area Revenue)* is the expected (average) revenue for the area. If the STAX policy has harvest price protection, then *E(Area Revenue)* is calculated using the higher of the projected price or harvest price along with the historical yields. Otherwise, the expected revenues are calculated using the projected price and historical yields. *Final Area Revenue* is the revenue calculated at harvest time for the area of interest. *Premium* is the farmer-paid premium. The producer must also select the *Protection Factor*, which ranges from 0.80 to 1.20 and can be changed in increments of 0.01. As depicted by use of the “max” and “min” symbols, the maximum payment for STAX occurs when county revenues fall below either the companion policy coverage level or 70 percent, whichever is higher. The higher the *Cov.level_{CP}* and/or the *Protection Factor*, the higher the *Premium* paid by the farmer.

Formally, the per-acre net SCO indemnity payment can be written as:

SCO/acre =

$$\min \left[\max \left\{ \left(0.86 - \frac{Final\ Area\ Revenue}{E(Farm\ Revenue)} \right), 0 \right\}, (0.86 - Coverage\ level_{UP}) \right] * E(Farm\ Revenue) - Premium,$$

where *Coverage level_{UP}* is the coverage level chosen by the farmer for the companion insurance policy, which ranges from 50 percent to as high as 85 percent, in 5-percent increments; and *E(Farm Revenue)* is the expected (average) revenue for the farm. The higher the *Coverage level_{UP}*, the higher the *Premium* paid by the farmer.

Appendix A2: Statistical Analysis of Factors Explaining STAX Takeup

Appendix table 1 shows the results of econometric analysis for the market penetration of STAX. Two types of regression models are used in the analysis: a logistic regression and a Tobit regression. For the logistic regression, the dependent variable is the “Presence of STAX” within a county, and the independent variable is the “Concentration of Cotton Operations out of Total Crop Operations.” The *Presence of STAX* is a binary variable (i.e., the value is “0” for no STAX in the county) and “1” for STAX in the county. The Tobit model has the same independent variable as the logistic regression, but the dependent variable is the “STAX Policies per Cotton Operation” per county. The Tobit model is used instead of a traditional Ordinary Least Squares regression model because a large number of observations are valued at zero. Much of the data are clustered at low values for concentration of cotton operations and the proportion of STAX policies to cotton operations, but there are also some very high values for the proportion of STAX policies. Because of this dispersion, the dependent variable is transformed on a logarithmic scale and robust standard errors are used. The Tobit regression plotted against the data is shown in appendix figure 1.

Appendix Table 1

Regressions of STAX policies as a function of concentration of cotton operations out of total crop operations per county

	Logit Model	Tobit Model
<i>Dependent variable</i>	<i>Presence of STAX in the county</i>	<i>Log((STAX policies/cotton operations) + 1)</i>
<i>Coefficients (Estimated coefficients with standard errors in parentheses)</i>		
Intercept	-0.808 (0.130)***	-0.458 (0.039)***
Cotton operations/ total crop operations	- 13.4 (1.39)***	1.103 (0.138)***
<i>Other regression information</i>		
Sample size	635	635

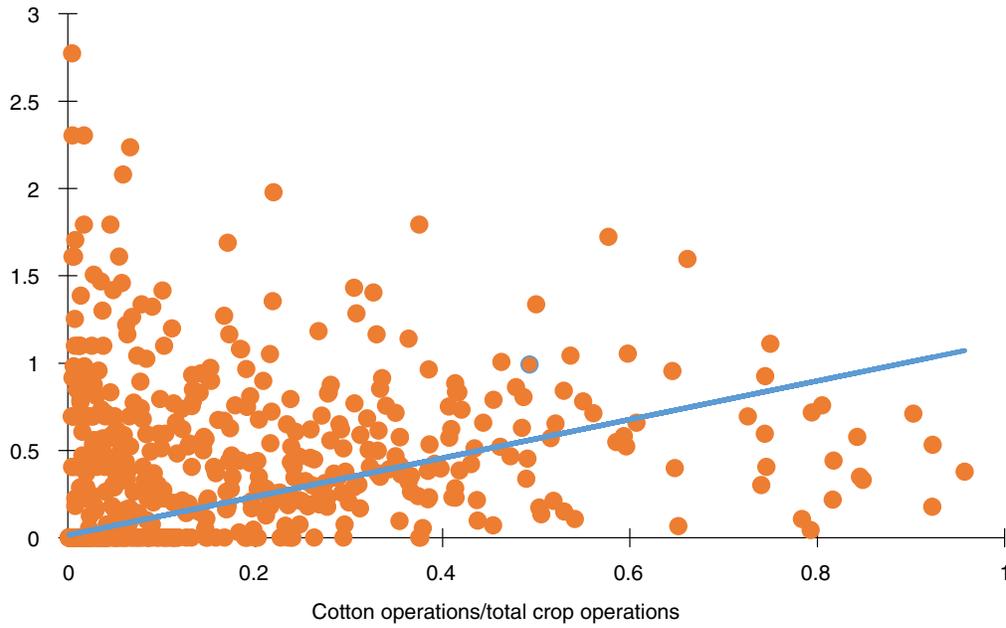
Note: *** indicates statistical significance at 0.1%. STAX = Stacked Income Protection Plan.

Source: USDA, Economic Research Service regression analysis on simulated and USDA, National Agricultural Statistics Service data.

Appendix figure 1

Tobit regression of STAX policies divided by cotton operations as a function of concentration of cotton operations out of total crop operations per county

$\text{Log}((\text{STAX policies}/\text{cotton operations})+1)$



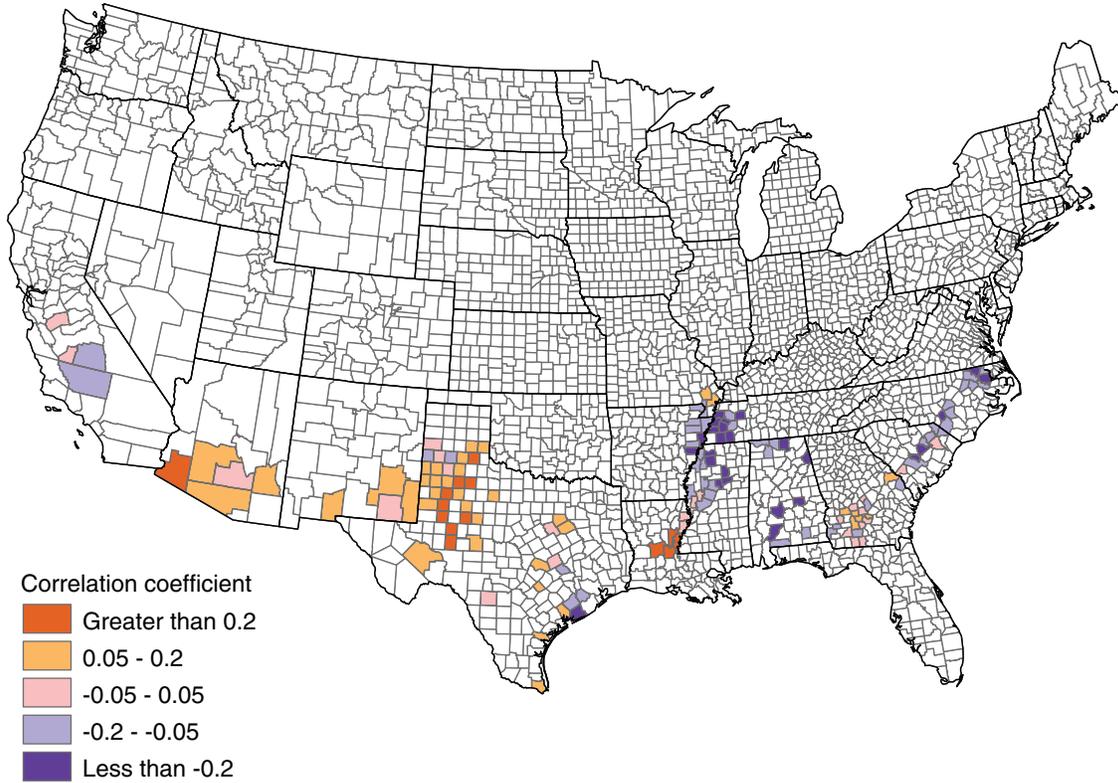
Note: STAX = Stacked Income Protection Plan.

Source: USDA, Economic Research Service regression analysis on simulated and USDA, National Agricultural Statistics Service data.

Appendix A3: Correlation Between Price and Yield for Cotton

Appendix figure 2

Correlation between the yields of each county's representative farm and the national price for cotton



Note: Blank county cells indicate lack of continuous cotton annual yield data.

Source: USDA, Economic Research Service results based on simulation model.