Risk Reduction and the 2014 Farm Bill

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Abstract

The 2014 Agricultural Act introduced several risk management programs for commodities. Price Loss Coverage (PLC) and Agricultural Risk Coverage (ARC) provide price and revenue protection, respectively, to eligible producers of covered commodities. Also in addition to existing federally-backed crop insurance policies, the Supplemental Coverage Option (SCO), a new program, provides subsidized add-on insurance coverage to producers of rice, cotton, corn, soybeans, sorghum, wheat, and spring barley. Through simulations of prices and yields, we examine the relationship between the support payments generated by these new programs and the magnitude of the risk reduction they produce, both under their current parameters as well as alternatives. The simulations also reveal the distribution of risk reduction among counties across the United States.

Introduction

The Agricultural Act of 2014, colloquially known as the 2014 Farm Act, made substantial changes to the federal programs offered to producers of agricultural commodities. The commodity title (Title I) of the 2014 Farm Bill eliminated direct payments (DP), counter-cyclical payments (CCP), and the Average Crop Revenue Election (ACRE) program. These now defunct programs have been replaced in Title I by Price Loss Coverage (PLC) and Agriculture Risk Coverage (ARC). In addition to these commodities programs, the Supplemental Coverage Option (SCO), a crop insurance add-on, was introduced under the crop insurance title (Title XI) of the 2014 Farm Bill (Effland, Cooper, and O'Donoghue, 2014).

The three eliminated programs were all introduced in different pieces of legislation over the last 20 years. DP was introduced under the 1996 Federal Agriculture Improvement and Reform Act, and CCP was introduced in the 2002 Farm Security and Rural Investment Act (2002 Farm Act). Both DP and CCP were decoupled from contemporary production. ACRE– introduced in the 2008 Food, Conservation, and Energy Act (2008 Farm Act) —paid out when both the state and farm revenue fell below 90% of the expected revenue, with payment rates determined using State-level yield aggregations. To participate in ACRE, one had to forgo CCP and agree to a 20% reduction in direct payments.

Elements of these defunct programs can be seen in the new Title I programs, PLC and ARC. Like CCP, PLC pays out when the market price falls below a preset price. Table A1 lists the target prices of CCP and the reference prices of PLC for comparison. As one can see, the reference prices PLC are higher than the target prices for CCP. Like ACRE, ARC payments are based on crop revenue falling below a threshold. Like CCPs and DPs, ARC is paid to on base (historical) acreage.

Since these three new programs focus on risk management, we investigate the possible risk reduction in crop revenue generated by these programs. Our analysis of risk reduction includes corn, soybeans, winter wheat, and upland cotton. We not only explore how much risk is reduced with the current parameters of these programs but also with alternative parameters as well. The purpose of exploring alternative parameters is to gain a better understanding of the

relationship between risk reduction and the structure of these commodity support programs. This analysis also examines the geographic distribution of the risk reduction. In particular, do counties with high revenue risk experience high risk reduction? Also how much risk reduction does each program buy and under what parameters?

Program Descriptions

Producers of covered commodities can choose between PLC and ARC, but they will be locked into their decisions over the 2014 through 2018 crop years (Effland, Cooper, and O'Donoghue, 2014). Eligible producers are enrolled into PLC by default. In order to be eligible for PLC or ARC, one must have base acres of a covered commodity and have an Adjusted Gross Income including nonfarm income of less than $900,000.

PLC and ARC pay to base (i.e., historic planted) acreage. Upland cotton is no longer a covered commodity under Title I of the 2014 Farm Act.[1] Base acres previously dedicated to upland cotton are now generic base acres, which may be planted with commodities covered under ARC and PLC. Producers have a one-time opportunity to reallocate their base acres using their 2009 - 2012 production. There is also a one-time opportunity to update yields based on the 2008 - 2012 crop years. If any yield during that period falls below 75% of the county average yield, the producer may replace the low yield with 75% of the county average yield. Payments can be reduced on an acre-by-acre basis if the producer plants wild rice, fruits, or vegetables on base acres enrolled under PLC or ARC. This payment reduction excludes wild rice, fruits, or vegetables being double-cropped with a covered commodity (FSA, 2014).

PLC pays when the reference price exceeds the market price. The PLC payment is equal to the difference between the reference price and the market price multiplied by the payment yield and 85% of the producer's base acres. As such, like the defunct CCP, PLC is decoupled from current production If the market price falls below the market assistance loan rate, the market assistance loan rate is used in place of the market price in the price difference. Producer can enroll into PLC on a crop by crop basis. Therefore, a producer may enroll into PLC for some of his crops and enroll into ARC-County for other crops.

ARC offers two different structures: individual and county. We refer to the two variants as ARC-Individual and ARC-County, respectively. Payments for both ARC-Individual and ARC-County occur if the actual revenue drops below 86% of the benchmark revenue. Depending on the variant of ARC, revenue is calculated for a given covered commodity in a county (ARC-County) or for all covered commodities grown on a farm (ARC-Individual). The benchmark revenue is the 5-year Olympic average of the yield and the 5-year Olympic average of the national price or reference price, using the higher of the two prices. For the 5-year Olympic average of yields, irrigated and non-irrigated crops are differentiated. If a payment is triggered by revenue falling below 86% of the benchmark revenue, producers are paid the difference between the actual revenue per acre and benchmark revenue per acre, which is then multiplied by 85% of the producer's base acres for ARC-County or multiplied by 65% of the producer's base

[1] Title XI of the 2014 Farm Act contains the new STAX *[spell out]* support program, which is only available to upland cotton producers as an alternative to SCO. As STAX is upland cotton specific, its analysis is outside the scope of this report.

acres for ARC-Individual. One should note that ARC-County is decoupled from current production. For example, if a producer grows soybeans on his corn base acres, then that producer will receive a payment if he is enrolled in ARC-County for corn and the county corn revenue falls below the corn benchmark revenue. For ARC-Individual payments calculations to be determined from the farm's crop yield, the farm must have sufficient production to permit calculation of average yield for the farm, else the USDA will assign average yield calculated from other sources. Payments are capped at 10% of the benchmark revenue. For our risk reduction investigation, we study ARC-County.

Producers with PLC can also enroll in the Supplemental Coverage Option. SCO is an area-based insurance that is offered in Title XI as an addition to the following crop insurance policies: Yield Protection, Revenue Protection, and Revenue Protection with Harvest-Price Exclusion. New under the 2014 Farm Act, SCO is offered for corn, cotton, rice, sorghum, soybeans, spring barley, and wheat (FCIC/RMA, 2014). Unlike PLC and ARC, the producer must pay a premium for SCO, but 65% of the premium is subsidized by the federal government. The trigger of SCO mirrors the trigger of the underlying crop insurance policy except that SCO is based on the area's production instead of the individual's production. For example, a producer with Yield Protection will receive an indemnity payment from SCO if the area yield, typically defined as the county yield, is below the trigger yield. SCO can cover losses in between the underlying policy's coverage and up to 86% of the expected yield/revenue. Since Revenue Protection is a popular federal crop insurance program, for our analysis SCO is assumed to have an underlying policy of RP with 75% coverage (RMA, 2014b). RP is a crop insurance policy that has a revenue-based trigger, which includes a harvest price option. The harvest price option allows the harvest price to be used in place of the planting price in the insurance guarantee, potentially leading to higher indemnity payments.

Discussion on Price-Yield Correlation

Crop revenue is exposed to both price risk and yield risk. Price risk is a form of systemic risk. In the agricultural economics literature, systemic risk is risk that is correlated among farmers (Miranda and Glauber, 1997). Since price is determined by domestic production, imports, as well as demand factors, no one farmer has control over price. Therefore, all farmers receive the same price for the same commodity (after adjusting for arbitrage), making price very strongly correlated across farmers. Yield risk has both systemic and idiosyncratic components (Miranda, 1991). The main source of systemic risk in yields is weather. Droughts in particular have proven to be a devastating cause of systemic losses, such as the 2012 drought in the Corn Belt (RMA, 2014b). Idiosyncratic risk is uncorrelated across farmers and has a variety of causes. For example, the use fertilizer and irrigation may decrease an individual's idiosyncratic risk. Also hail is an example of a relatively idiosyncratic risk.

The relationship between price and national average yield is generally negative although the strength of the correlation is dependent on the crop. The historical correlations for corn, soybeans, winter wheat are -0.590, -0.500, and -0.324, respectively. At the national level high prices may hedge low yields and vice-versa. However, for those counties and states which do

not reflect the national yield, this hedging effect may not exist. To see this effect or lack thereof, maps located in the Appendix show the correlations between simulated yields of each county's representative farm and the simulated prices. We suspect Agricultural Risk Coverage and the Supplemental Coverage Option would cause the greatest risk reduction in counties that do not historical follow the national average. For example, counties producing corn outside of the Corn Belt would likely see greater risk reduction than counties inside of the Corn Belt.

Measuring Risk in PLC, ARC, and SCO

Risk reduction impacts of the support payment

Table 2 shows the simulated national revenue per acre and coefficients of variation for the crops examined in this report. The coefficient of variation is a measure of risk that is used throughout this report and is referred to as CV or simply "risk".[2] This measure is calculated by dividing the standard deviation by the mean of the crop revenue. The revenue and CVs shown in table 2 under the "Base Acres" section are weighted by the base acres of each county. The revenue and CVs under the "Planted Acres" section are weighted by the planted acres of each county. For our analysis at the national level, the revenue and CV calculated with base acres are used in the PLC and ARC analysis, while the revenue and CV calculated with the planted acres are used in the SCO analysis. PLC and ARC are Title I programs in the 2014 Farm Bill, which apply payments to base acres. SCO is under Title XI, the crop insurance title, and like federal crop insurance policies, SCO policies are based on planted acres for the current crop year. The revenue and CV weighted by base acres are not shown for cotton in table 2 because ARC and PLC are not available for cotton.

Table 2: Average revenue per acre and coefficient of variation of revenue (national average given 2014 expected prices and yields)[a]

	Base Acres			**Planted Acres**			
Crop	Corn	Soybean	Winter Wheat	Corn	Soybean	Winter Wheat	Cotton
Revenue ($/acre)	671.19	506.70	275.88	664.32	498.35	261.50	498.95
CV	0.3567	0.3825	0.5429	0.3619	0.3977	0.5503	0.6384

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

[a]The results represent a weighted average of the revenues of a representative farmer in each counties for which NASS has reported yield data each year over 1975-2013, which is 1001 counties for corn, 889 counties for soybeans, and 510 counties for Winter Wheat. In the data summaries, the results for each farmer are weighted by the number of planted or base acres in the county. The different weights being used is the reason why the reported values differ between the "base acres" and "planted acres" columns.

[2] A variety of measures of risk are possible, including two-sided measures (that include data from the lower and upper tails of the distribution), such as the coefficient of variation, and one-sided measure, as value at risk (VaR). However, as our crop revenues tend to be uni-modal distributions, we expect a strong correlation between one and two sided measures of risk. Hence, we use the common coefficient of variation measure in this report.

We use our simulation approach to examine the impacts of the support payments on risk, under actual key program parameters, and examine the sensitivity these impacts to these parameters. For PLC, a key policy parameter affecting payments is the reference price (table A1), and for ARC and SCO a key parameter is the coverage rate on benchmark or expected area revenue. Changes in these parameters have implications for government costs, mean producer income, and for reduction in the producer's revenue risk. For this report, we focus on the latter impact.

Table 3 displays simulation results for the risk reduction of PLC using the actual references prices as well as hypothetical reference prices both below and above the actual reference price to demonstrate the sensitivity to the choice of reference price. All else being equal, decreasing the reference price will lower the frequency with which payments are triggered and lower the size of the payments, thus providing a lower revenue risk reduction (and vice-versa for increasing reference prices). Table 3 shows that PLC has the smallest risk reduction out of the three programs. The lowest reference price for corn causes changes in the CV less than 0.001 although increasing the reference price for corn from $3.40 to $4.00 changes the risk reduction from 0.14% to 3.55%. For soybeans the reference prices of $8.10 and $8.40 cause changes in the CV for revenue no more than .001. Respectively, at these reference prices for soybeans, revenue risk decreases by 0.02% and 0.10%. Even at 30 cents higher than the reference price in 2014 Fall Act, the risk reduction from PLC for soybeans is less than 1%. For winter wheat the changes are moderate with risk reduction ranging from 0.26% to 1.98% for the lowest to highest reference prices in table 3, respectively.

In the 2014 Farm Act, the coverage rate for ARC is 86% of benchmark revenue. Table 4 includes simulation results for not only this current coverage rate, but also coverage rates of 82% of benchmark revenue and 90% of benchmark revenue. The simulation results in table 4 illustrate the risk reduction from ARC is much higher than the risk reduction from PLC, at least under the scenario of 2014 expected prices and yields. Corn experiences very large risk reduction from ARC. At coverage rates of 86% and 90% of benchmark revenue, risk reduction for corn is over 10%. Although the risk reduction is not as high for soybeans, the risk reduction for soybeans ranges from 5.12% to 7.70% for coverage rates of 82% to 90% of benchmark revenue. Winter wheat is a higher risk crops compared to corn and soybeans, as seen in the coefficients of variation in table 2. Interestingly, the risk reduction from ARC is smaller for winter wheat compared to corn and soybeans. Even when looking at the ΔCV instead of $\%\Delta CV$, the changes in winter wheat are still smaller than the changes for corn and soybeans.

SCO currently allows for individuals to purchase coverage for up to 86% of the expected revenue\yield. Like the simulation results for ARC, the sensitivity analysis for SCO includes the current coverage rate of 86% as well as alternative coverage rates of 82% and 90%. The results in table 5 and all other simulation results for SCO in this report assume the underlying policy for SCO is Revenue Protection with 75% coverage. Although producers need to have an underlying insurance policy to purchase SCO, indemnity payments from the underlying policy are not included in this section of the report. By not including any federal crop insurance indemnity payments, this allows for a more direct comparison between SCO and the other two programs.

Although ARC generally has higher payments than SCO and PLC, table 5 illustrates that changing the coverage rate for SCO causes larger changes in the risk reduction compared to changing the coverage rate for ARC. For example in soybeans, changing the trigger from 82% of benchmark revenue to 90% of benchmark revenue for ARC results in an additional risk reduction of 2.58%.[3] However, for SCO changing the coverage rate from 82% to 90% leads to an additional risk reduction of 4.52%. This larger increase in risk reduction for SCO holds for corn and winter wheat as well. This likely stems from the nature of the underlying federal crop insurance policy paired with SCO, which in this report is Revenue Protection with 75% coverage. One should note that because producers of corn, soybeans, and wheat are able to enroll in to PLC and SCO. Even under the scenario of 2014 expected prices and yields, it is possible the risk reduction will be greater with the combination of PLC and SCO compared to ARC for these three crops.

[3] In actual practice, setting the SCO coverage rate at 85% or lower presumes that the coverage rate in the underlying traditional crop insurance program is less that the 85% coverage available for some crops in some regions.

Table 3: Simulated national average of payments and change in variability of crop revenue under PLC assuming alternative reference prices[ab]

Corn				**Soybeans**				**Winter Wheat**			
Reference Price ($/bu)	Payment ($/acre)	ΔCV[d]	%ΔCV	Reference Price ($/bu)	Payment	ΔCV	%ΔCV	Reference Price ($/bu)	Payment	ΔCV	%ΔCV
$3.40	0.38	-0.0005	-0.14	$8.10	0.03	-0.0001	-0.02	$5.20	0.35	-0.0015	-0.26
$3.70[c]	3.62	-0.0040	-1.18	$8.40	0. 18	-0.0004	-0.10	$5.50	1.29	-0.0051	-0.92
$4.00	12.16	-0.0122	-3.55	$8.70	0.54	-0.0010	-0.28	$5.80	2.96	-0.0110	-1.98

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

a Simulations assume 2014 expected price and yields.

b The results represent a weighted average of the revenues of a representative farmer in each counties for which NASS has reported yield data each year over 1975-2013, which is 1001 counties for corn, 889 counties for soybeans, and 510 counties for Winter Wheat. In the data summaries, the results for each farmer are weighted by the number of base acres in the county.

[c]Actual reference price in the 2014 Farm Act.

[d]ΔCV is CV_1-CV_0, where CV0 is the coefficient of variation of gross crop revenue and CV1 is the coefficient of variation of total gross revenue (gross crop revenue plus the PLC payment). Coefficient of variation is the standard error of the revenue divided by its mean.

Table 4: Simulated national average of payments and change in variability of crop revenue under ARC assuming alternative ARC coverage rates[ab]

	Corn			**Soybeans**			**Winter Wheat**		
Coverage Rate	Payment	ΔCV	%ΔCV	Payment	ΔCV	%ΔCV	Payment	ΔCV	%ΔCV
82%	21.33	-0.031	-8.94	9.56	-0.019	-5.12	3.44	-0.017	-3.30
86%[c]	27.63	-0.035	-10.34	13.06	-0.024	-6.45	4.10	-0.020	-3.75
90%	34.23	-0.039	-11.45	16.94	-0.028	-7.70	4.84	-0.022	-4.21

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

[a] Simulations assume 2014 expected price and yields.

[b] The results represent a weighted average of the revenues of a representative farmer in each counties for which NASS has reported yield data each year over 1975-2013, which is 1001 counties for corn, 889 counties for soybeans, and 510 counties for Winter Wheat. In the data summaries, the results for each farmer are weighted by the number of planted acres in the county.

[c] Actual ARC coverage rate in the 2014 Farm Act

[d] ΔCV is CV_1-CV_0, where CV_0 is the coefficient of variation of gross crop revenue and CV_1 is the coefficient of variation of total gross revenue (gross crop revenue plus the PLC payment). Coefficient of variation is the standard error of the revenue divided by its mean.

Table 5: Simulated national average of payments and change in variability of crop revenue under SCO assuming alternative coverage rates[abe]

	Corn			Soybeans			Winter Wheat		
Coverage Rate	Payment	ΔCV[d]	%ΔCV	Payment	ΔCV	%ΔCV	Payment	ΔCV	%ΔCV
82%	6.96	-0.016	-4.59	4.58	-0.012	-3.10	3.98	-0.021	-4.00
86%[c]	12.61	-0.026	-7.49	8.59	-0.021	-5.26	6.79	-0.033	-6.34
90%	19.80	-0.036	-10.54	13.79	-0.300	-7.62	10.01	-0.045	-8.69

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

[a] Simulations assume 2014 expected price and yields.

[b] The results represent a weighted average of the revenues of a representative farmer in each counties for which NASS has reported yield data each year over 1975-2013, which is 1001 counties for corn, 889 counties for soybeans, and 510 counties for Winter Wheat. In the data summaries, the results for each farmer are weighted by the number of planted acres in the county.

[c] Actual SCO coverage rate in the 2014 Farm Act

[d] ΔCV is CV_1-CV_0, where CV_0 is the coefficient of variation of gross crop revenue and CV_1 is the coefficient of variation of total gross revenue (gross crop revenue plus the PLC payment). Coefficient of variation is the standard error of the revenue divided by its mean.

[e] The SCO calculations assume that the underlying policy is Revenue Protection with 75% coverage rate. The SCO payments are net of the of the farmer paid SCO premium.

Relationships with Revenue Risk

Unlike the expired Direct Payments, payments from ARC, PLC, and SCO will tend to be countercyclical to crop revenue. That is, because these PLC, ARC, and SCO payments are triggered when price or revenue fall below a threshold, these payments will tend to be made when farm income falls, thus partially compensating the farmer for the decrease in gross revenue, thus reducing variability in farm revenue.[4] [5] One way to assess the efficiency of a payment in targeting revenue risk is to examine the correlation of the payment with the change in revenue risk it provides. As revenue risk varies among crops and regions, we can also use correlation analysis to examine to what extent, if any, the programs' risk reduction impacts target lower versus higher risk producers.

For each crop and program specification, to examine to what extent the payment is associated with revenue risk reduction, table 6 through table 8 present the Pearson correlation coefficients[6] between the standardized payment and the change in CV of revenue (CV of total gross revenue minus CV of gross revenue) the payment provides. The standardized payment is the payment per acre divided by the mean gross crop revenue per acre; standardizing the payment puts it on a unit-free footing, simplifying its comparison to the CV by removing scale effects. If the correlation between the standardized payment and the change in CV is closer to negative one, the payment is more closely associated with reducing revenue risk. Our expectation is that these correlations will be negative due to program design, and that the payments under a revenue program, such as ARC or SCO, will more closely target revenue risk than a program that targets only price, like PLC. However, a variety of factors could affect the measured correlations, including the level of reference prices relative to actual prices and empirical price-yield relationships.

To examine to what extent these payments target lower or higher risk producers, the tables also present that the correlation of the change in CV of revenue with the CV of gross revenue. The closer this correlation is to zero, the more uniformly the program treats producers regardless of their revenue risk. The simulated averages of each of these variables for each county are used to calculate the correlation coefficient. In the interest of brevity, the change in the CV for crop revenue with and without support will be denoted as ΔCV and the CV for gross crop revenue (revenue without support payments) will be denoted as CV_0. As with table 3 through table 5, table 6 through table 8 show the results under actual reference prices and coverage rates and under the hypothetical lower and upper values.

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[4] The SCO, ARC, and PLC program payments are not guaranteed to be countercyclical to farmer revenue; ARC and SCO are area payments, and as such, have the possibility of being triggered even if an individual farmer revenue increases, or not being triggered when the farmer's revenue falls. A triggering of a PLC payment does not mean that any particular farmer's revenue has fallen.

[5] These payments will also tend to increase mean revenue, but that effect is outside the scope of this report, which focuses on the impact of these programs on the variability of revenue.

[6] The Pearson correlation coefficient is a statistic between -1 and 1. Negative one for the correlation coefficient indicates a perfectly linear negative relationship between two variables, while positive one indicates a perfectly linear positive relationship between two variables. When the correlation coefficient is equal to zero, there is no linear relationship between the two variables.

For PLC the correlation between the standardized payment and the change in revenue risk for each crop is negative in most cases, which can be seen in table 6. The correlation coefficients for soybeans, corn, and winter wheat under the references prices in the 2014 Farm Act are -0.61, -0.78, and -0.96 , respectively. The negative correlation indicates that when the standardized payment increases, the risk in the crop revenue is likely reduced. When the reference price for corn is $4.00 and $5.80 for winter wheat, the correlation between standardized payment and ΔCV is positive. This positive correlation indicates upside risk may be present. Therefore, total gross revenue, despite being higher with the PLC payment, becomes more volatile if the PLC payments are triggered by a relatively high reference price. Interestingly, despite the positive correlation for the upper alternative reference prices, corn and winter both have strong negative correlation between the ΔCV and the standardized payment under the lower alternative reference price and the reference price in the 2014 Farm Act. The correlation for these two variables for soybeans remains moderately strong and negative for the current reference price as well as the lower and upper alternative reference prices.

Under PLC, we see a negative relationship for corn and winter wheat between CV_0 and ΔCV in table 6. For corn and winter wheat, as the reference price increases this correlation becomes slightly stronger. For corn the correlation between CV_0 and ΔCV is weak to moderate, spanning from -0.38 to -0.52 given the reference prices in table 6. Table 6 also shows that the correlation for CV_0 and ΔCV is between -0.63 and -0.67 for winter wheat for the given reference prices. However, in the case of soybeans, the correlation between CV_0 and ΔCV is positive for all three reference prices in table 6. Although this relationship is fairly weak for soybeans, low revenue risk areas are more likely to experience larger decreases in revenue risk compared to higher risk areas.

Table 7 illustrates that, as expected, ARC has more consistent patterns of correlation among the crops compared to PLC. As seen in table 7, the correlation between ΔCV and the standardized payment is the strongest for winter wheat and the weakest for corn. However, all three crops have strong negative correlation between ΔCV and the standardized payment for the coverage rates of 82% and 86% with the correlation stronger than -0.85. As with PLC, strong negative correlation between the standardized payment and ΔCV indicates that increasing the support payments with respect to crop revenue, will likely decrease the risk in crop revenue. For corn, soybeans, and winter wheat, there is a decrease in the correlation between ΔCV and the standardized payment when the coverage rate is 90%. When the coverage rate is 90%, the correlation between ΔCV and the standardized payment for corn, soybeans, and winter wheat is -0.50, -0.76, and -0.81, respectively. One possible explanation for the weakening correlation is the higher frequency of maximum payments at higher coverage rates. A higher frequency of maximum payments causes nonlinearity in the relationship between standardized payments and ΔCV, which weakens the linear relationship.

Despite the strong correlation between ΔCV and the standardized payment for ARC, the correlation between the ΔCV and CV_0 is somewhat weak. Table 7 shows that the correlation

coefficient between ΔCV and CV_0 for corn is -0.40 at the 86% coverage rate and -0.43 for soybeans at the same rate. The correlation is weaker for winter wheat at -0.32 for the 86% coverage rate. One should note that, on average, the yield variation among farms is substantially higher for wheat compared soybeans and corn. Therefore, winter wheat farm-level yields are not as closely tied to county yields compared to the yields of corn and soybeans. If farm yields are not closely tied to county yields, then risk reduction cannot be closely tied to CV_0 under a county-based revenue support program.

The correlation results for SCO for corn, soybean and winter wheat producers, seen in table 8, are more similar to ARC than PLC. The correlation between the standardized payment and ΔCV for SCO is strong and negative, and the correlation weakens as the maximum coverage increases. For example, with a coverage rate of 82% for SCO, the correlation between standardized payment and ΔCV for winter wheat is -0.96, but this correlation drops to -0.69 when the coverage rate for SCO is 90%. The cause for this drop in correlation is likely same cause as the drop in correlation for the standardized payment and ΔCV seen in table 7 for ARC. Increasing the coverage rate increases the frequency of maximum payments, which creates a nonlinearity in the trend between standardized payment and ΔCV. The nonlinearity in turn decreases the correlation between the two variables. Unlike ARC, the correlation between CV_0 and ΔCV for SCO remains the very similar across coverage rates. The correlation coefficients between CV_0 and ΔCV for SCO are -0.39, -0.45, and -0.21 for corn, soybeans, and winter wheat, respectively, at the coverage rates of 86% and 90%. Therefore, for SCO increasing the coverage rate will not increase or decrease the ability to target risk reduction for high risk areas.

Table 6: Correlations of the change in variability of revenue (ΔCV) with the payment and with the base variability of revenue: the case of PLC under alternative reference prices[abe]

Corn			Soybeans			Winter Wheat		
Reference Price ($/bu)	Correlation of %ΔCV[d] with:		Reference Price ($/bu)	Correlation of %ΔCV with:		Reference Price ($/bu)	Correlation of %ΔCV with:	
	Payment[e]	CV_0		Payment	CV_0		Payment	CV_O
$3.40	-0.75	-0.38	$8.10	-0.59	0.38	$5.20	-0.96	-0.63
$3.70[c]	-0.78	-0.45	$8.40	-0.61	0.36	$5.50	-0.96	-0.65
$4.00	0.14	-0.52	$8.70	-0.64	0.33	$5.80	0.36	-0.67

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

[a] Simulations assume 2014 expected price and yields.

[b] The results represent a weighted average of the revenues of a representative farmer in each counties for which NASS has reported yield data each year over 1975-2013, which is 1001 counties for corn, 889 counties for soybeans, and 510 counties for Winter Wheat. In the data summaries, the results for each farmer are weighted by the number of base acres in the county.

[c] Actual reference price in the 2014 Farm Act

[d] ΔCV is CV_1-CV_0, where CV_0 is the coefficient of variation of gross crop revenue and CV_1 is the coefficient of variation of total gross revenue (gross crop revenue plus the PLC payment). Coefficient of variation is the standard error of the revenue divided by its mean.

[e] The payment was standardized by dividing it by the mean gross crop revenue.

Table 7: Correlations change in variability of revenue (ΔCV) with the payment and with the base variability of revenue: the case of simulated ΔCV for ARC under alternative coverage rates[abe]

	Corn		Soybeans		Winter Wheat	
Coverage rate	Correlation of %ΔCV[d] with:		Correlation of %ΔCV with:		Correlation of %ΔCV with:	
	Payment	CV_0	Payment	CV_0	Payment	CV_0
82%	-0.90	-0.42	-0.97	-0.46	-0.99	-0.34
86%[c]	-0.87	-0.40	-0.95	-0.43	-0.99	-0.32
90%	-0.50	-0.41	-0.76	-0.41	-0.81	-0.30

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

[a] Simulations assume 2014 expected price and yields.

[b] The results represent a weighted average of the revenues of a representative farmer in each counties for which NASS has reported yield data each year over 1975-2013, which is 1001 counties for corn, 889 counties for soybeans, and 510 counties for Winter Wheat. In the data summaries, the results for each farmer are weighted by the number of base acres in the county.

[c] Actual coverage rate in the 2014 Farm Act

[d] ΔCV is CV_1-CV_0, where CV_0 is the coefficient of variation of gross crop revenue and CV_1 is the coefficient of variation of total gross revenue (gross crop revenue plus the PLC payment). Coefficient of variation is the standard error of the revenue divided by its mean.

[e] The payment was standardized by dividing it by the mean gross crop revenue.

Table 8: Correlations change in variability of revenue (ΔCV) with the payment and with the base variability of revenue: the case of SCO under alternative coverage rates[abe]

	Corn		**Soybeans**		**Winter wheat**	
Coverage rate	Correlation of %ΔCV[d] with:		Correlation of %ΔCV with:		Correlation of %ΔCV with:	
	Payment	CV_0	Payment	CV_0	Payment	CV_0
82%	-0.90	-0.39	-0.96	-0.46	-0.96	-0.22
86%	-0.87	-0.39	-0.94	-0.45	-0.94	-0.21
90%	-0.63	-0.39	-0.78	-0.45	-0.69	-0.21

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

[a] Simulations assume 2014 expected price and yields.

[b] The results represent a weighted average of the revenues of a representative farmer in each counties for which NASS has reported yield data each year over 1975-2013, which is 1001 counties for corn, 889 counties for soybeans, and 510 counties for Winter Wheat. In the data summaries, the results for each farmer are weighted by the number of base acres in the county.

[c] Actual coverage rate in the 2014 Farm Act

[d] ΔCV is CV_1-CV_0, where CV_0 is the coefficient of variation of gross crop revenue and CV_1 is the coefficient of variation of total gross revenue (gross crop revenue plus the PLC payment). Coefficient of variation is the standard error of the revenue divided by its mean.

[e] The payment was standardized by dividing it by the mean gross crop revenue.

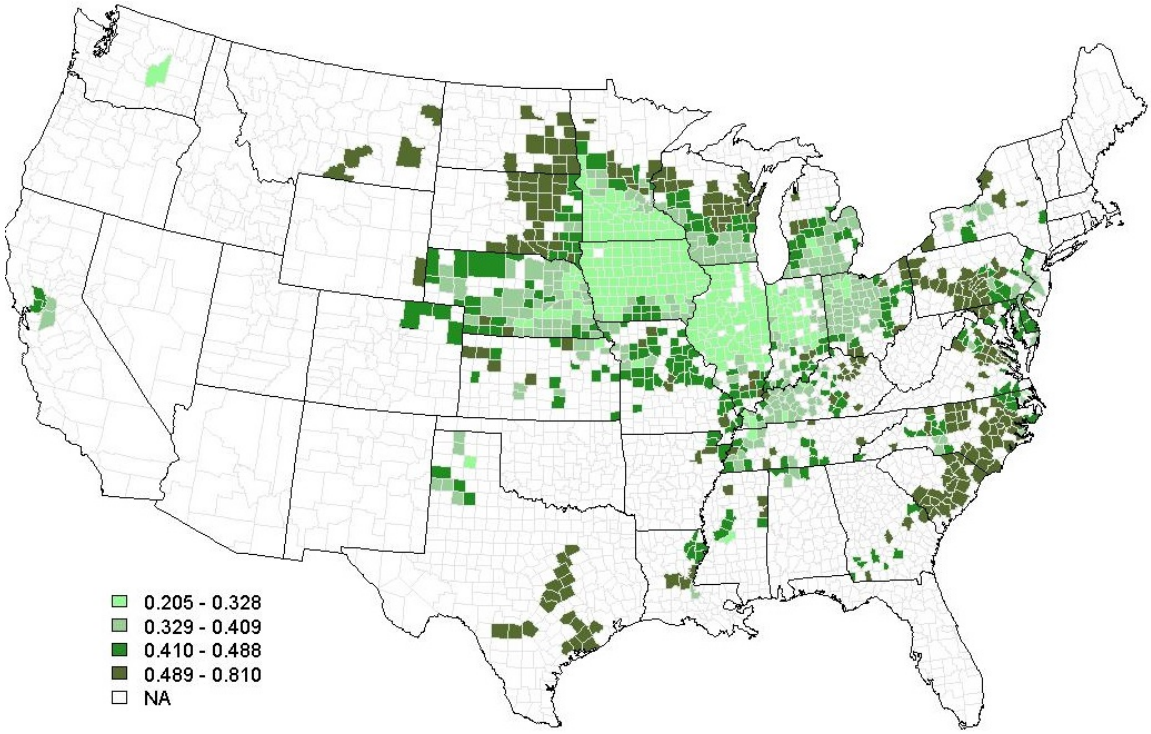
Mapping Changes in Risk provided by the Support Payments

The next part of the analysis explores the how risk reduction at the county-level varies across the United States. Corn, soybeans, and winter wheat have four maps each. The first map depicts the coefficient of variation of gross corn revenue, denoted as CV_0. The colors used for the map are divided by the quartiles of the distribution of simulated values of the CV_0. For example, in figure 1 the lightest green corresponds to the counties with CV_0s below the 25^{th} percentile. Therefore, these counties are the least risky with respect to corn revenue without support payments among counties in the simulation. The counties colored with the darkest green are the counties with CV_0s above the 75^{th} percentile. Hence, these dark green counties are the most risky counties with respect to corn revenue without support payments. The next three maps are the change in the coefficient of variation, denoted as ΔCV, for PLC, ARC, and SCO, where ΔCV is the CV of total gross revenue (gross revenue plus the support payment) less CV_0. For these maps, the program parameters (e.g., reference price, maximum coverage rate) are set at the actual values in the 2014 Farm Act. As before the colors on the maps are divided by quartiles. The lightest green corresponds to those counties where the ΔCV is below the 25^{th} percentile, i.e. these counties have the lowest risk reduction. The darkest green counties are counties where the ΔCV is above the 75^{th} percentile. On both the CV_0 and ΔCV maps white counties indicates counties that did not grow the crop of interest continuously for the period 1975-2013. As in the earlier section of the report, the simulations assume 2014 expected prices and yields.

In figure 1 a pattern emerges for the CV_0s of corn revenue. Most of the counties in Iowa and Illinois are low risk compared to the rest of the country. Indiana and southern Minnesota also contain a large portion of the corn-growing counties that have low revenue risk. Not surprisingly these low risk areas are where the majority of corn is grown in the United States, and the counties comprise the Corn Belt. Generally, as one moves farther away from the Corn Belt, corn revenue becomes more risky. There are high risk counties for corn revenue throughout the United States. Such areas are in Texas, the Carolinas, and the Dakotas.

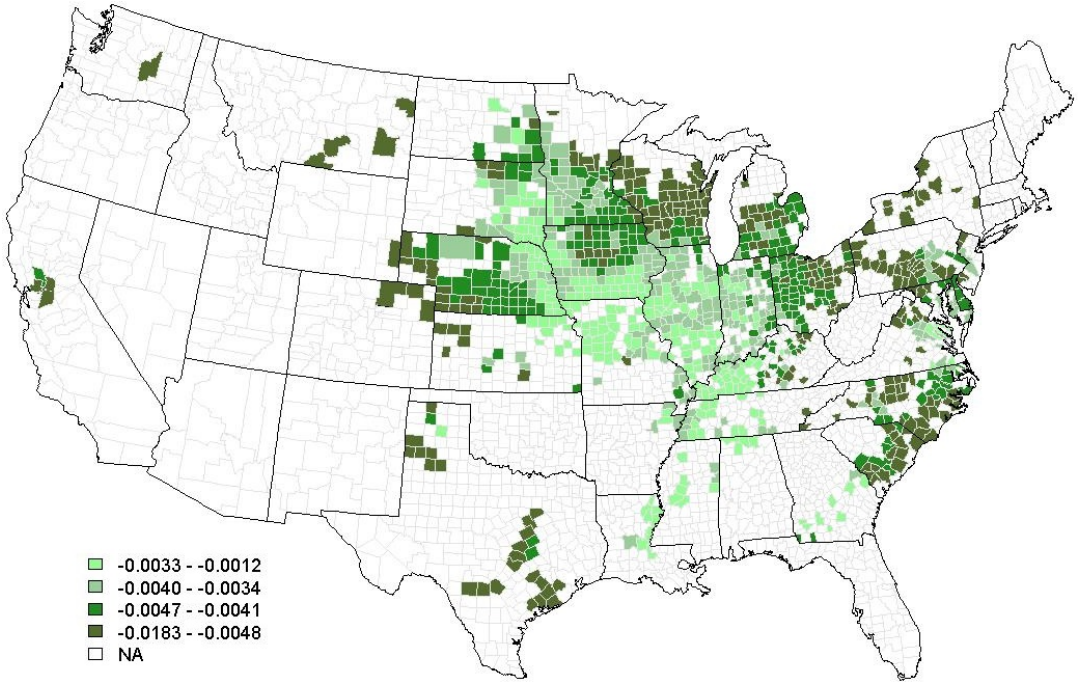
As seen in figure 2, for corn revenue with PLC the highest risk counties do not necessarily have the highest risk reduction. This result is confirmed by the correlations in table 3. In fact, several of the low risk counties in Iowa have large risk reductions caused by PLC. However, there are also high risk counties in Texas and the Carolinas that have higher risk reduction compared to the rest of the country under PLC. Figure 3 shows that with corn ARC payments, the majority of high risk reduction counties are found on the periphery of the Corn Belt in states, such as South Dakota and Ohio. High risk reduction can also be found in high risk counties of South Carolina and Pennsylvania, which are also high risk reduction areas for PLC. The risk reduction pattern for SCO, seen in figure 4, is similar to the pattern for ARC.

Figure 1: Risk in corn gross revenue, measured by the CV.



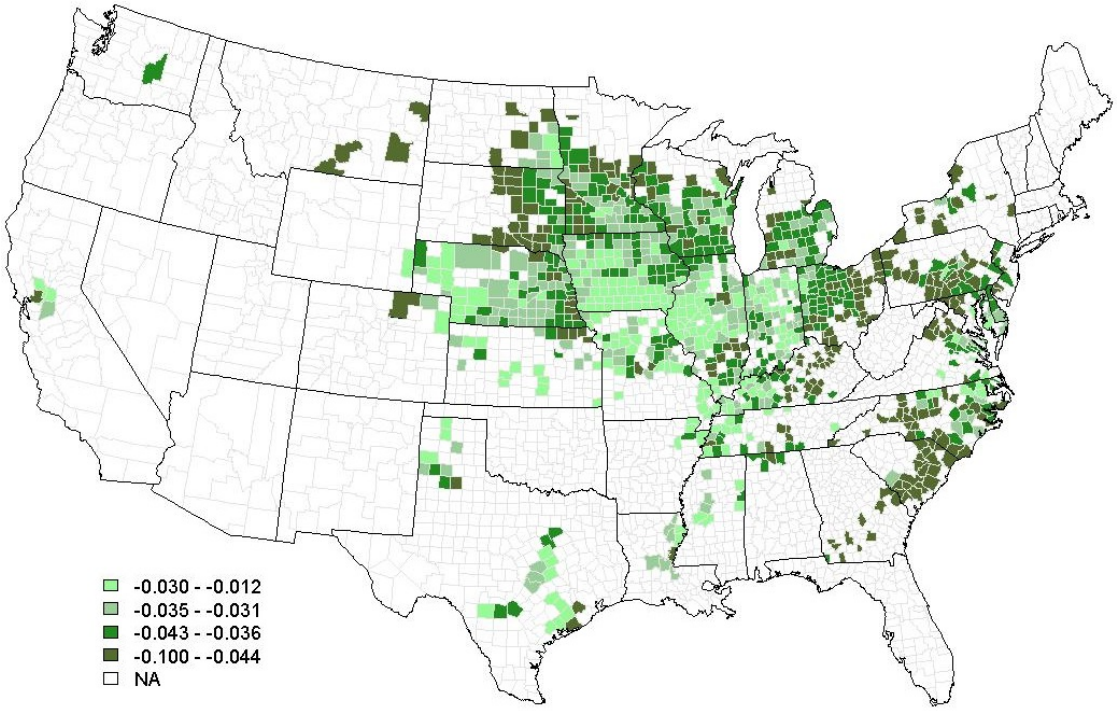
Source: USDA, Economic Research Service results based on simulation model

Figure 2: Change in the risk for corn revenue with PLC with the reference price at $3.70



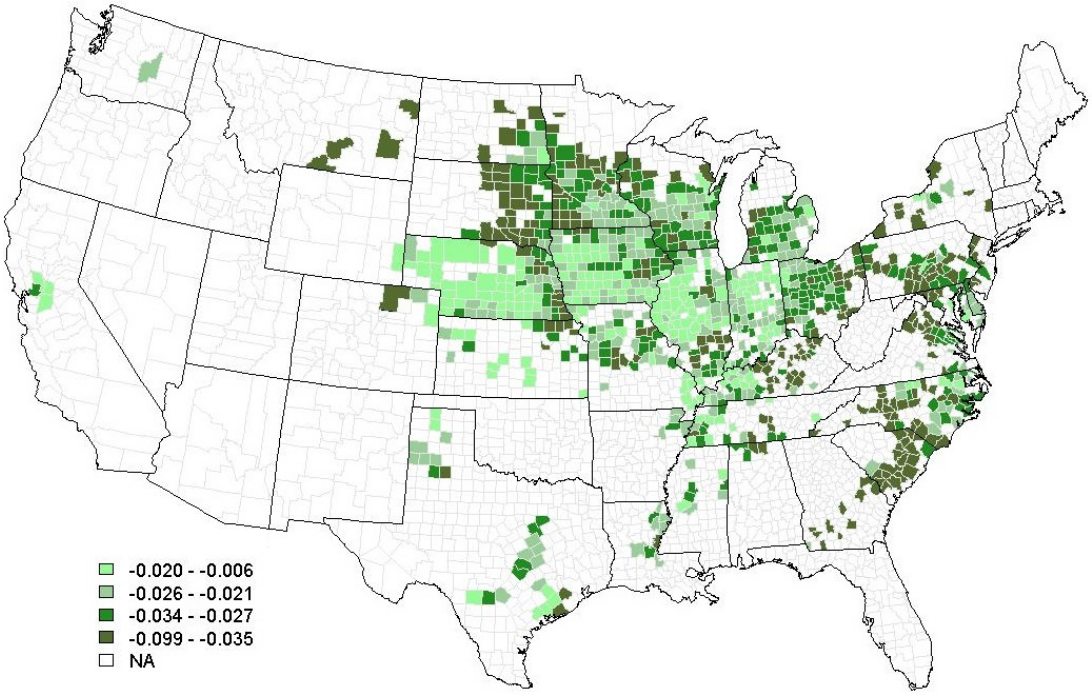
Source: USDA, Economic Research Service results based on simulation model

Figure 3: Change in the risk for corn revenue with ARC, where the coverage rate is 86% benchmark revenue.



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

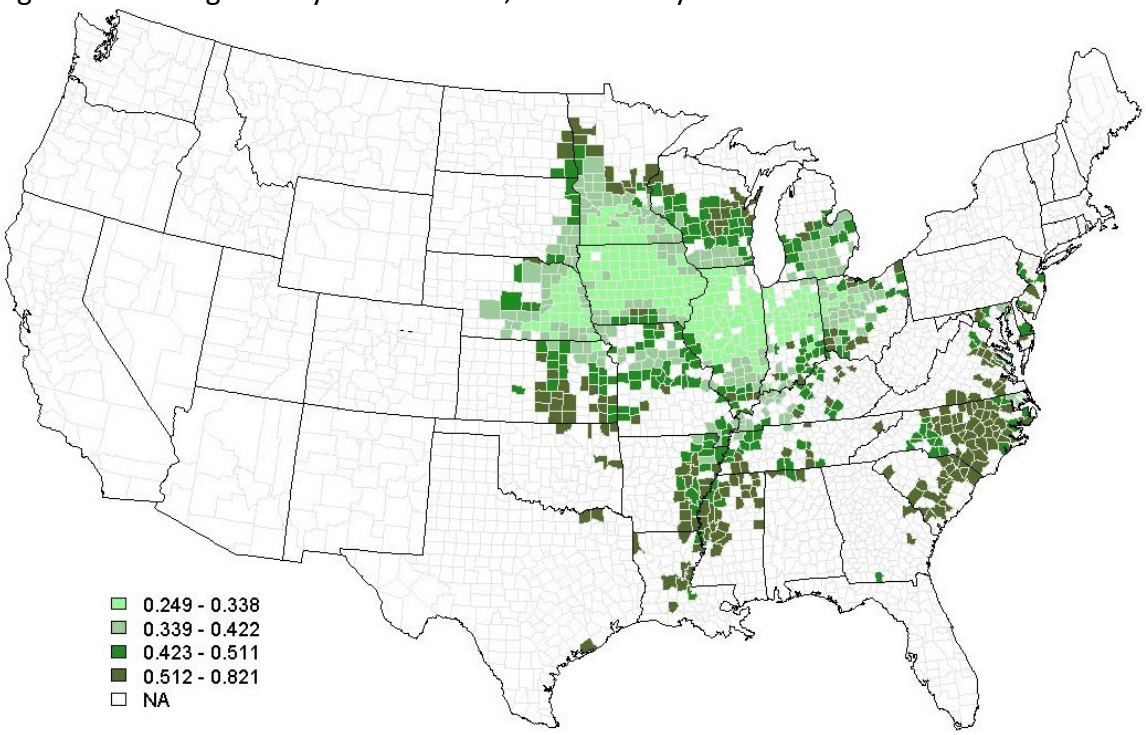
Figure 4: Change in the risk for corn revenue with SCO, where the coverage rate is 86% of expected revenue



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

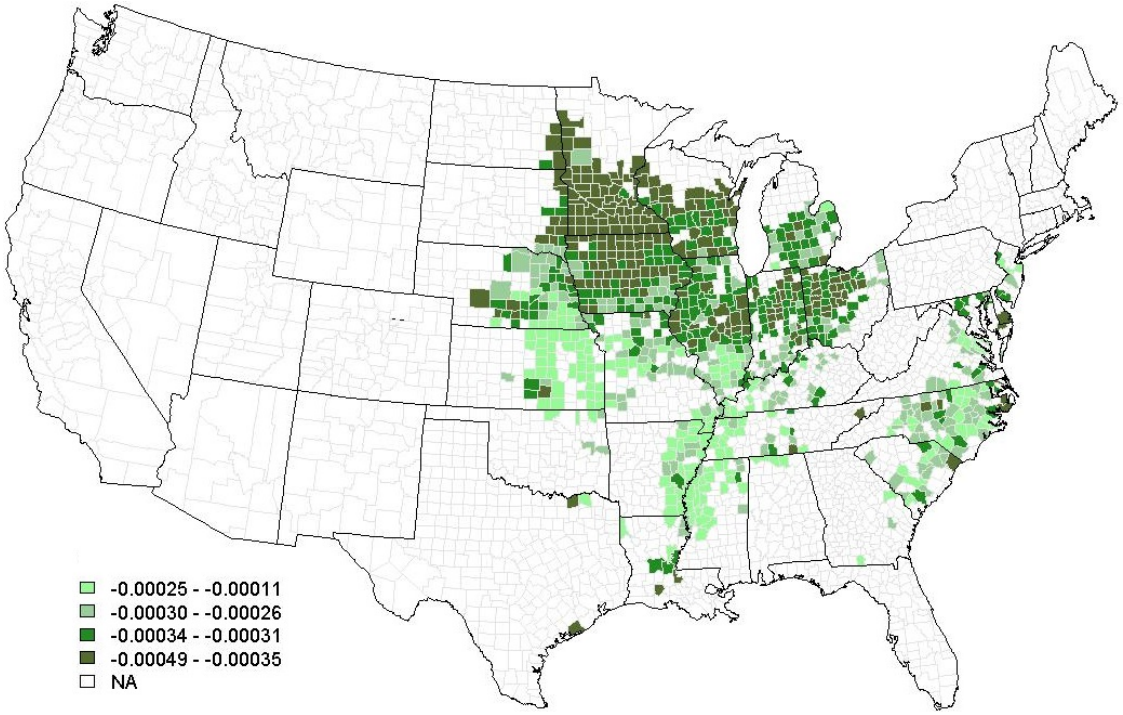
Figure 5 illustrates that the pattern for soybean revenue risk is even more pronounced than for corn revenue risk. For soybean revenue risk there is a band of low risk counties from eastern Nebraska through Indiana. Emanating outward from these counties, soybean revenue tends to increase in riskiness. Soybean revenue in the Carolinas is higher risk compared to the majority of soybean-producing counties. High risk counties can also be found in Arkansas and Mississippi near the Mississippi River. Figure 6 shows the effect of PLC on soybean revenue risk. As seen in table 3 and confirmed by figure 6, there is a weak relationship of high risk areas for soybean revenue experiencing lower risk reduction and low risk area experiencing higher risk reduction by comparison. Figure 7 and figure 8 illustrate that for soybeans ARC and SCO tend to reduce more risk in high risk counties compared to PLC. This high risk reduction with ARC and SCO can be seen in the Arkansas and Mississippi counties near the Mississippi River. However, some low risk counties in Nebraska also experience high risk reduction in the simulation.

Figure 5: Risk in gross soybean revenue, measured by the CV.



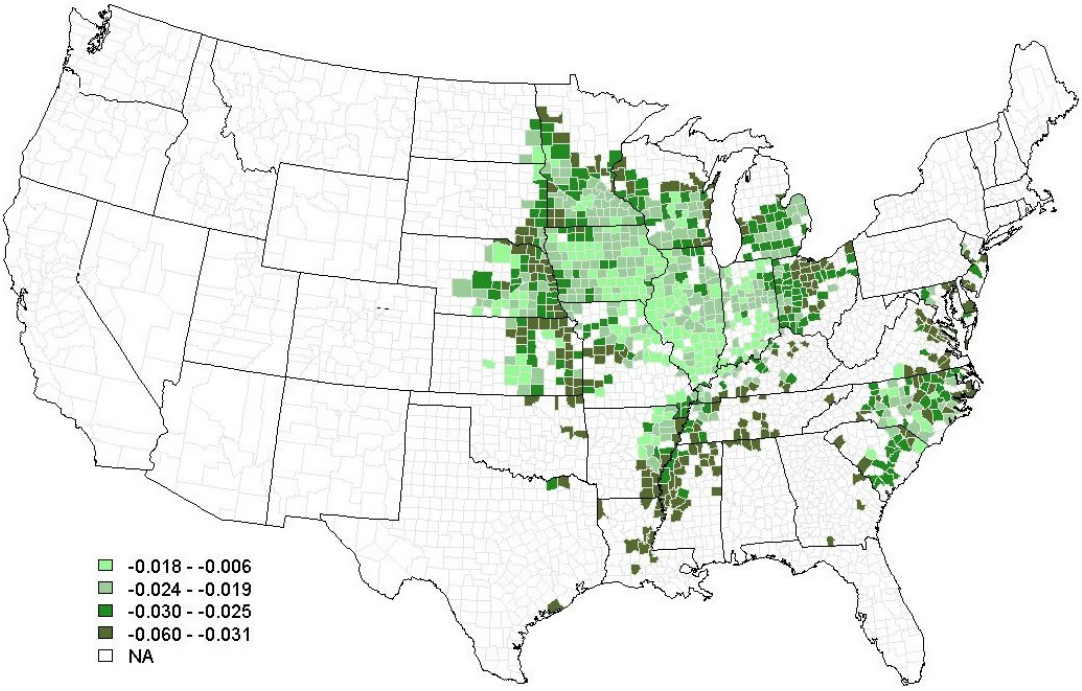
Source: USDA, Economic Research Service results based on simulation model

Figure 6: Change in the risk for soybean revenue for PLC with the reference price at $8.40.



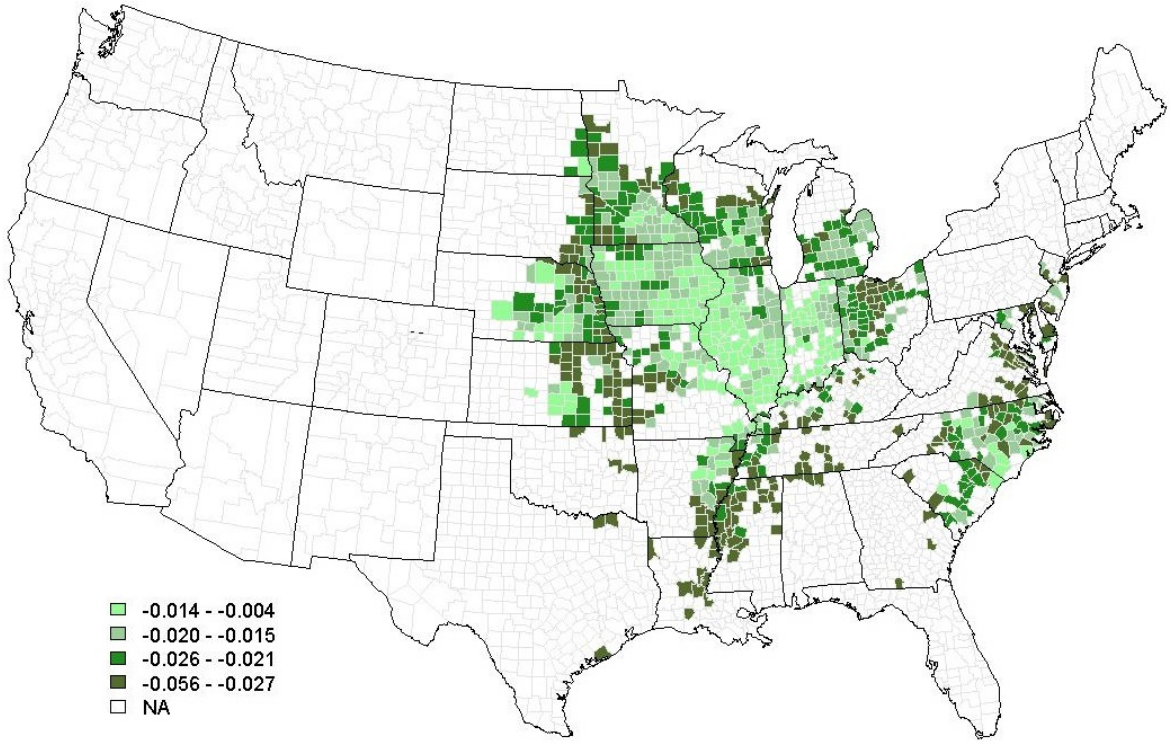
Source: USDA, Economic Research Service results based on simulation model

Figure 7: Change in the risk for soybean revenue with ARC, where the coverage rate is 86% benchmark revenue.



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

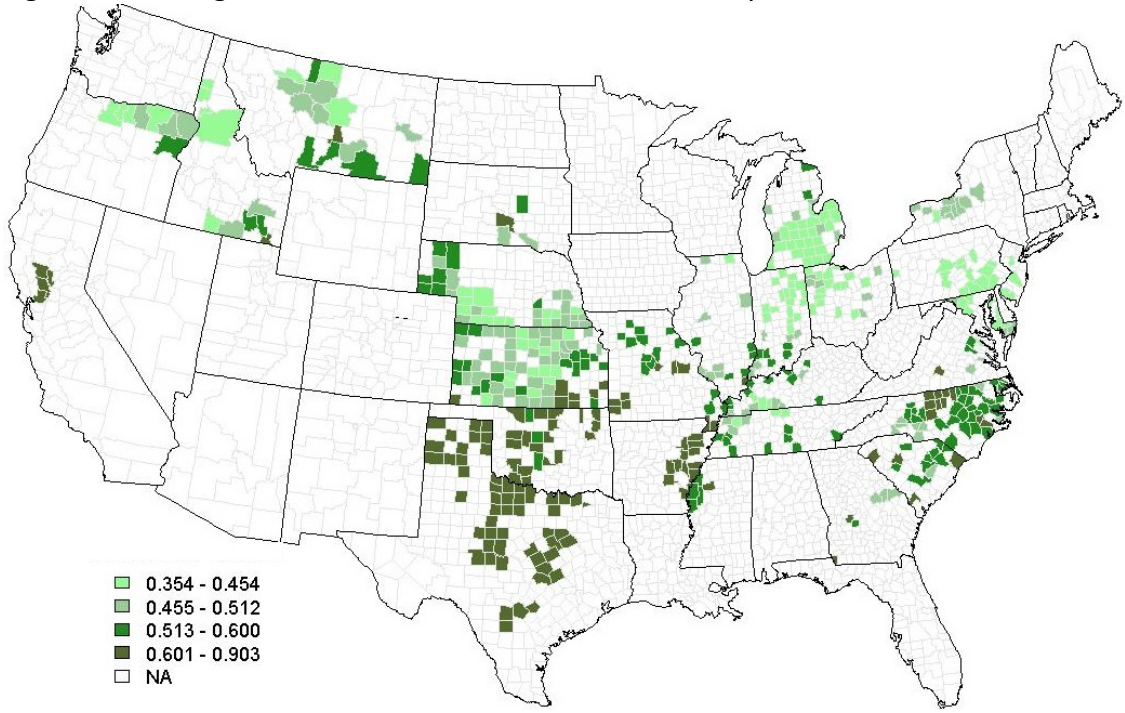
Figure 8: Change in the risk for soybean revenue with SCO, where the coverage rate is 86% of expected revenue



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

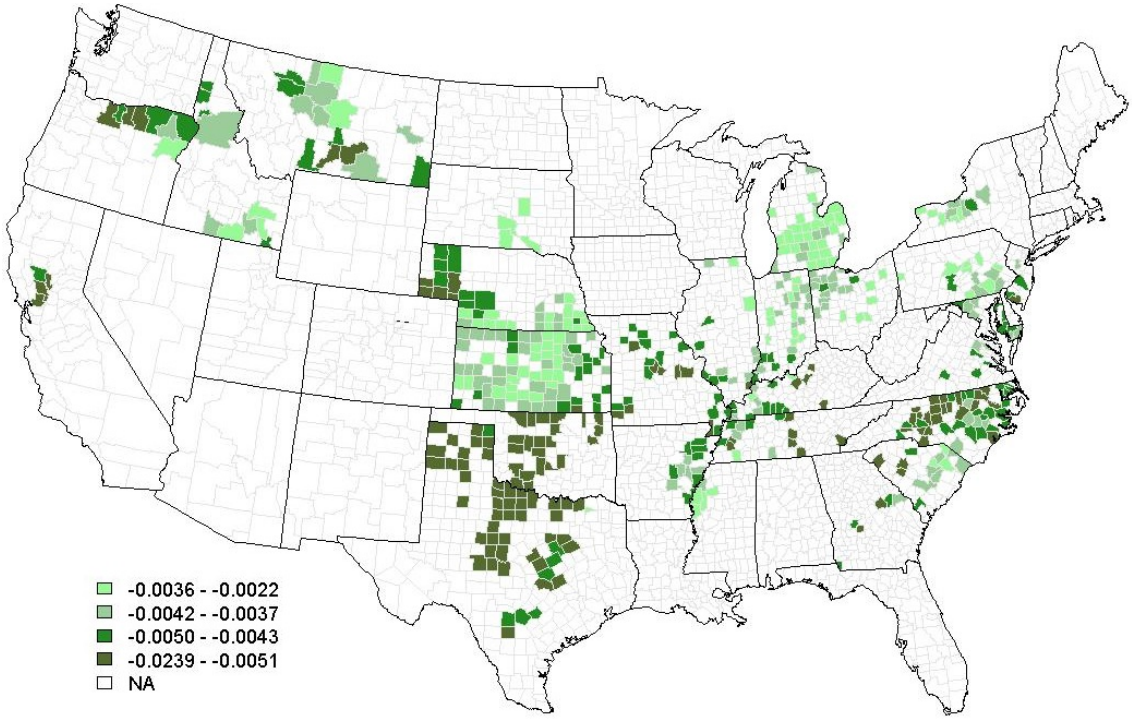
Figure 9 illustrates that the production of winter wheat in the simulation is rather dispersed compared to the production of corn and soybeans. Kansas and Michigan are comparatively low risk, while winter wheat revenue in Oklahoma and Texas tends to be higher risk. Unlike corn and soybeans, PLC for winter wheat, shown in figure 10, has a very strong tendency to reduce the most risk in counties with high revenue risk. Therefore, most counties in Kansas and Michigan experience a rather small reduction in revenue risk compared to counties in Texas and Oklahoma. ARC and SCO do not present such a clear pattern with regards to reducing revenue risk, which is made evident in figure 11 and figure 12, respectively. Although the low risk counties in Michigan experience a small risk reduction, many low risk counties in Kansas have high risk reduction, while some of the high risk counties of Texas experience low risk reduction.

Figure 9: Risk in gross winter wheat revenue, measured by the CV



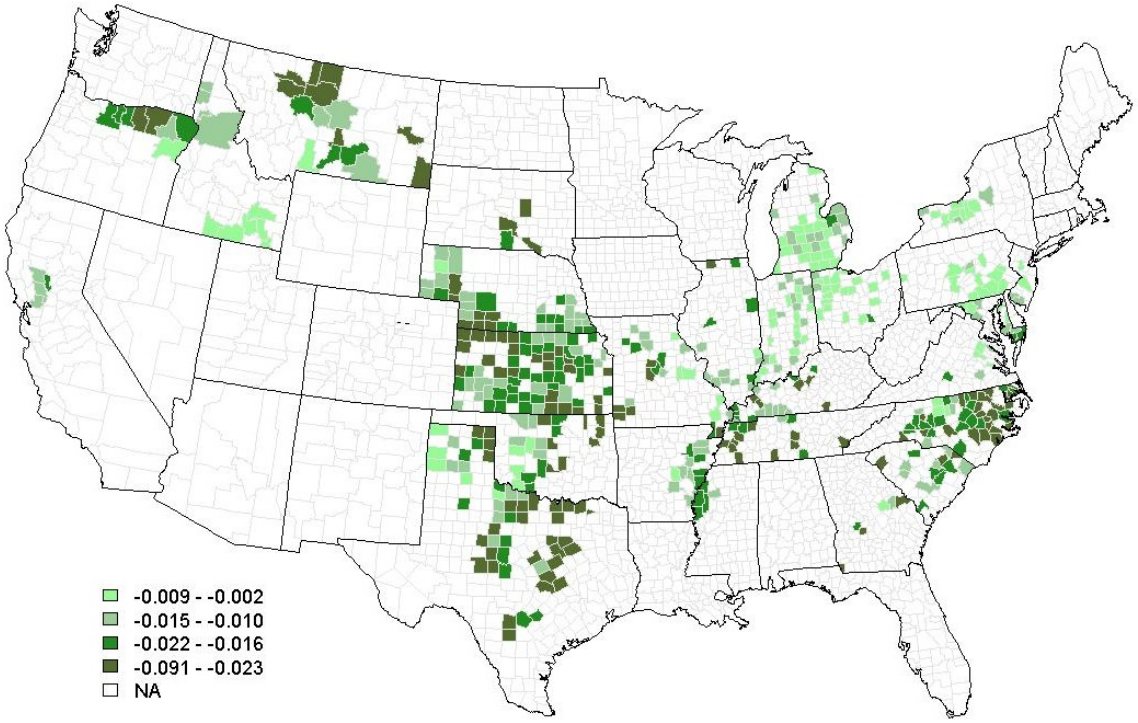
Source: USDA, Economic Research Service results based on simulation model

Figure 10: Change in the risk for winter wheat revenue for PLC with the reference price at $5.50.



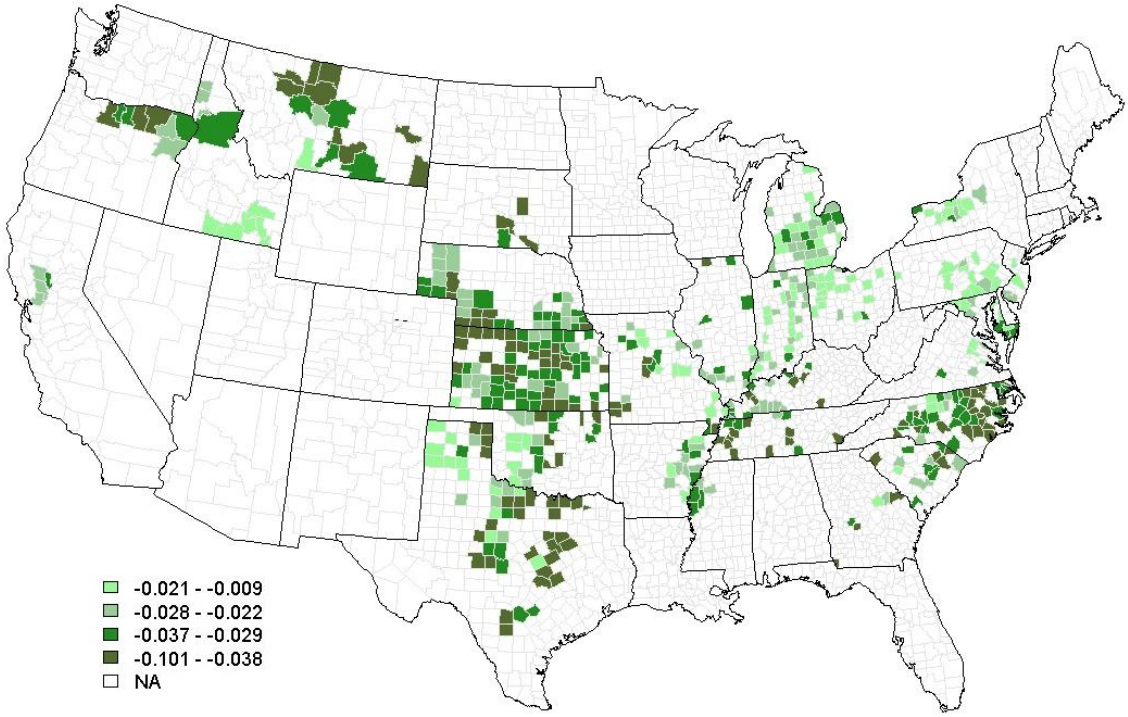
Source: USDA, Economic Research Service results based on simulation model

Figure 11: Change in the risk for winter wheat revenue with ARC, where the coverage rate is 86% benchmark revenue



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

Figure 12: Change in the risk for winter wheat revenue with SCO, where the coverage rate is 86% of expected revenue.



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

Conclusion

The magnitude of risk reduction from these new federal programs is dependent not only the structure of the program, but also the crop and the parameters of the program. For PLC the current references prices lead to extremely varied results among corn, soybeans, and winter wheat. In particular, for soybeans the percentage in risk reduction is less than a tenth of risk reduction for corn and winter wheat. Also for corn and soybeans, PLC does not necessarily provide higher risk reduction for counties with high revenue risk. For ARC and SCO as the coverage rate increases, the correlation between the standardized payment and ΔCV decreases although this correlation does remain strong. For corn and soybeans, ARC and SCO tend to have higher risk reduction for high risk counties and lower risk reduction for low risk counties, while the risk reduction among counties is more mixed for wheat.

One caveat to these simulation results is that only counties with continuous production were included, which may have introduced a selection bias. Counties that sporadically grow a crop may be higher risk than the counties represented in the simulation. Therefore, high risk counties may be underrepresented. In addition, the results can be sensitive to the assumption of the expected prices and yield used in the simulation, and for ARC, the assumption of season average prices in prior years that feed into the calculation of the revenue guarantee.

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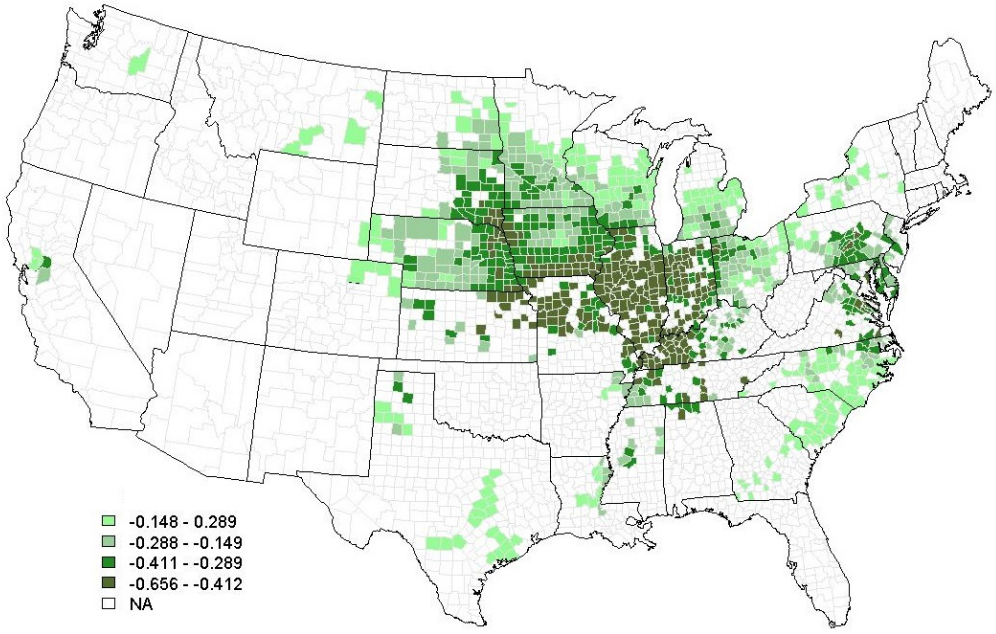
Appendix

Figure A1: Correlation between the yields of each county's representative farm and the national price for corn



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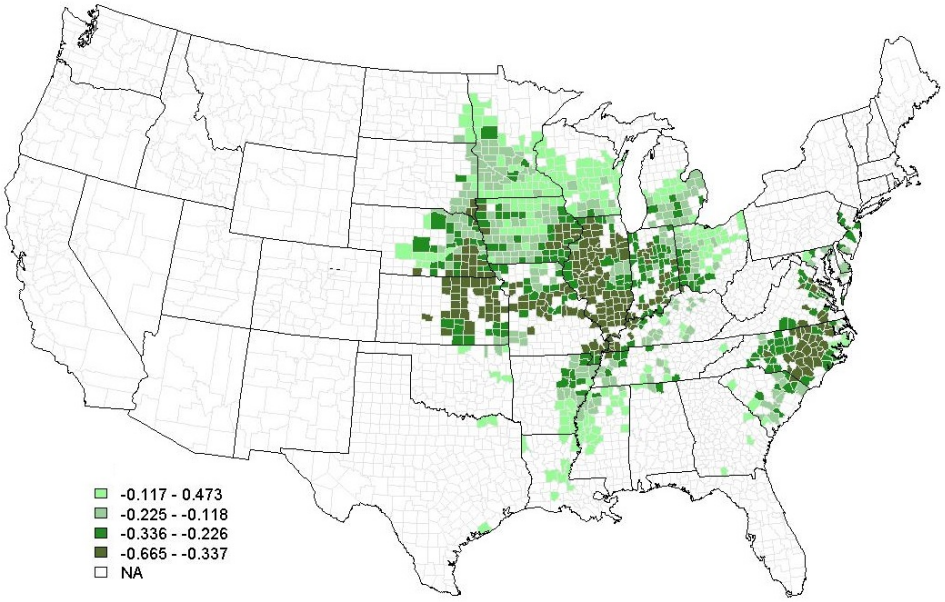
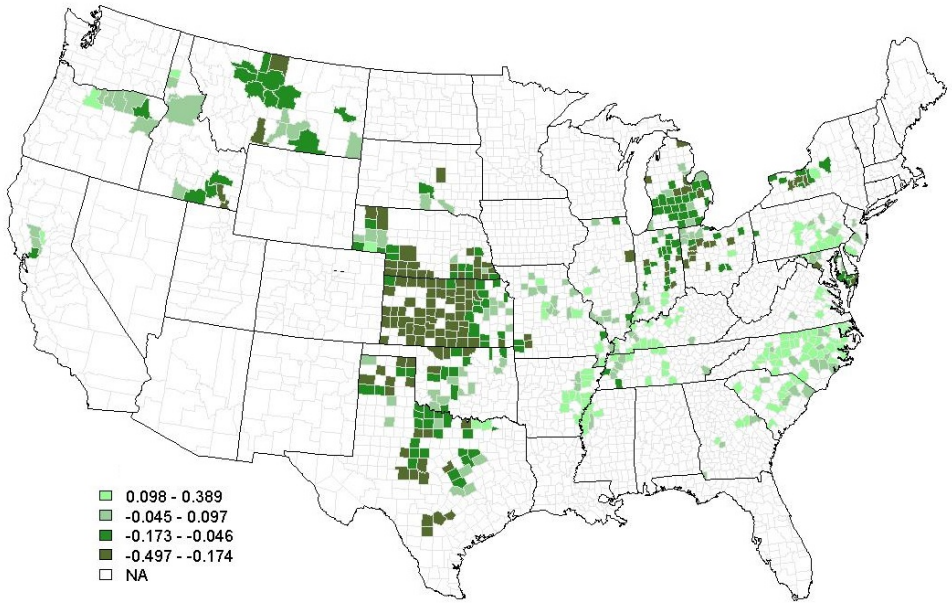
Source: USDA, Economic Research Service results based on simulation model

Figure A2: Correlation between the yields of each county's representative farm and the national price for soybeans.



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

Figure A3: Correlation between the yields of each county's representative farm and the national price for winter wheat



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

Table A1: Legislative Prices in Title I of the Farm Act, by Covered Commodities

Covered Commodity	Unit	PLC Reference Price (2014 farm Act)[a]	CCP Target Price (2008 Farm Act)[b]
Wheat	Bushel	5.50	4.17
Barley	Bushel	4.95	2.63
Oats	Bushel	2.40	1.79
Peanuts	Pound	0.2675	0.2475
Corn	Bushel	3.70	2.63
Grain Sorghum	Bushel	3.95	2.63
Soybeans	Bushel	8.40	6
Dry Peas	Pound	0.1100	0.0832
Lentils	Pound	0.1997	0.1281
Large Chickpeas	Pound	0.2154	0.1281
Small Chickpeas	Pound	0.2015	0.1036
Canola	Pound	0.2015	0.1268
Flaxseed	Bushel	11.2800	0.1268
Other Oilseeds	Pound	0.2015	0.1268
Rice (Long Grain)	Pound	0.1400	0.105
Rice (Med Grain)	Pound	0.1400	0.105
Upland Cotton	Pound	NA	0.7125

[a]Source: Agricultural Act of 2014.
[b]Source: Food, Conservation, and Energy Act of 2008. Table reflects final updates of target prices.