Crop Insurance Subsidies:

How Important are They?

Erik J. O'Donoghue*

Abstract: In 1994, some 56 years after initial authorization, the Federal crop insurance program remained characterized by low enrollment levels. In 1994 and 2000, Congress introduced major pieces of legislation that expanded the program and increased premium subsidies. Enrollment jumped, transforming the Federal crop insurance program from a minor program into one of the major pillars of support for US crop farmers, covering over 200 million acres by 1995. The quantity of crop insurance demanded has often been tied to premium subsidy levels. How important are the subsidies? This study shows that between 2007 and 2012, a period that bookends a change in policy that increased premium subsidies to growers, the subsidies appeared to induce farmers to enroll more land, but that the effect on coverage levels appears more pronounced. At the national level, it appears likely that changes in the price of crop insurance altered the demand for insurance and that the effect was more pronounced for corn and soybean producers than for wheat growers.

*U.S. Department of Agriculture, Economic Research Service.
eodonoghue@ers.usda.gov

Introduction

Over the last 25 years, the federal crop insurance program has grown significantly. In 1992, producers covered roughly 82 million acres under crop insurance policies, with total premiums (including subsidies) amounting to nearly 759 million dollars—just over 1.2 billion dollars in 2012 dollars. If actuarially fair, the subsidy levels provide a rough estimate of the expected government outlays for the program (note, however, that this does not include administrative costs) and in 1992, premium subsidies totaled 197 million dollars—approximately 322 million dollars in 2012 dollars. By 2012, producers had enrolled more than 282 million acres while total premiums had grown to over 11 billion dollars and the premium subsidies had increased to almost 7 billion dollars. These subsidies appear to be one of the major reasons for the change in participation. While premium subsidies grew due to their explicit linkages to the policies demanded (i.e., if a grower alters the insurance coverage selection, the premium subsidy rate can change, and the total level of subsidies will change as a result) Congress also introduced several policy changes that directly affected subsidy rates. These policy changes provide an opportunity to explore causal links between premium subsidies and the demand for crop insurance.

During 2013 and early 2014, fiscal concerns dominated public discussions as policymakers worked on both a budget and a successor bill to the Food, Conservation, and Energy Act of 2008. Due to its recent growth in popularity amongst producers and surging commodity prices (which appear to be on the way down now), the levels of subsidies being paid by the government for the Federal Crop Insurance program have become significant – enough so that proposals were made to reduce the level of subsidies (Office of Management and Budget) and limit the level of support available to producers based on income (Coburn-Durbin Senate Amendment 953 and Shaheen-Toomey Senate Amendment 926).

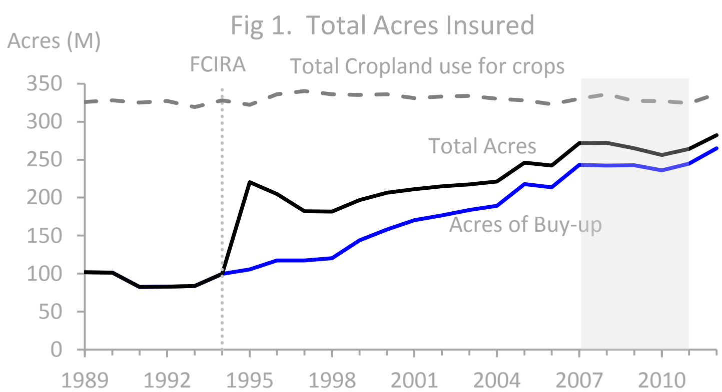
Such proposals raise many questions for policymaking. Most pressingly, how do subsidies affect the demand for crop insurance?

Previous work has studied how the crop insurance demand varied with changes in the price of participation. Most of this work has focused on years before the implementation of the Agricultural Risk Protection Act [ARPA] in late 2000, and many of which explored the economic conditions prior to the 1994 Federal Crop Insurance Reform Act [FCIRA] to better understand the low participation in the crop insurance program. These studies typically found that the level of crop insurance premiums or premium rates did not affect the quantity demanded of crop insurance greatly (Shaik et al., 2008; Goodwin et al., 2004; Serra et al., 2003; Coble et al., 1996; Goodwin, 1993; Gardner and Kramer, 1986).

Some researchers also explored the extent to which subsidies affected the level of coverage adopted, conditional on adoption. Using 1990 survey data, Smith and Baquet (1996) noted that while the rates did not appear to affect enrollment in the crop insurance program, they did appear to influence the overall decision of how to use the crop insurance program among Montana wheat producers once enrolled in crop insurance.

It is typically thought that these earlier studies took place during a time when adverse selection was a serious problem in the U.S. – where only those producers who believed they will receive indemnities enrolled (for example, perhaps they produce in areas prone to disasters) (Glauber, 2004; Goodwin, 1993). With adverse selection, even if producers receive subsidies, they would only be interested in joining if the subsidy was high enough. Researchers concluded that perhaps the subsidies were not high enough to overcome the adverse selection problem in order to get producers to join. Policymakers agreed and concluded that the program would not become a prominent tool without either increasing premium subsidies or forcing enrollment (Glauber, 2004), leading to the introduction of the Federal Crop Insurance Reform Act of 1994.

When FCIRA went into effect, participation in the Federal crop insurance program immediately jumped, more than doubling the acres enrolled from roughly 100 million acres in 1994 to more than 220 million acres in 1995, and beginning an upward trend of increased participation by producers. Producers enrolled the majority of these newly participating acres under the new catastrophic risk protection endorsement (CAT) policy that only covers catastrophic losses; as a result, in 1995 fewer than 48 percent of all acres were enrolled in buy-up policies (see figure 1; note that the shaded area represents the time period covered in the current



study).

The next major change in policy occurred in 2000 when Congress passed the Agricultural Risk Protection Act (ARPA) which codified *ad hoc* premium reductions introduced in 1998 and again in 1999 into law. Perhaps because producers now had more information about their costs of enrollment, farmer participation continued to both increase and shift towards a heavier reliance on buy-up policies. By 2002, total acres enrolled had increased to 217 million acres, with nearly 85 percent of them covered by buy-up policies. Given the high degree of enrollment that started after the implementation of FCIRA and continued through the 1990s and into the 2000s, it no longer appears that adverse selection should be a driving force prohibiting enrollment in the U.S. crop insurance program. Given this change in the environment, do premium subsidies continue to alter grower decisions concerning the federal crop insurance program (including both enrollment and coverage level decisions)?

In a working paper, Babcock and Hart (2005) explored the effect of the changes in subsidy rates brought about by ARPA on the level of enrollment for revenue and yield policies. They explored the Nation's producers of corn, soybeans, and wheat as ARPA increased subsidies – especially for higher levels of coverage. They concluded that the subsidies played an important role in changing the decisions of producers – particularly with respect to adopting higher levels of coverage after the passage of ARPA (similar to the earlier Smith and Baquet paper).

Nevertheless, this research remains dated as it explores events that happened more than ten years ago while the policy environment has continued to change. For this reason, I explore the most recent notable change to subsidies and whether these changes altered the quantity demanded of crop insurance. In the 2008 Farm Bill, first implemented in 2009, policymakers increased the subsidies for enterprise units (EUs).

When farmers enroll a crop in a crop insurance policy, they have many different choices available to them, including type of insurance, level of coverage, type of unit to insure, etc. The unit designation comes in four types: basic, optional, enterprise, and whole farm. These units define the way coverage on the farm can be divided. Each unit can be insured under a different insurance policy, allowing the producer to customize their insurance coverage to the various parts of their operation.

Basic units aggregate all the tracts of land the producer owns and/or cash rents within a county. Any land under a crop share arrangement creates a separate unit – one for each landlord.

Optional units are available when the land operated within a county either (a) has tracts that lie in different townships or (b) is being used in very different ways (e.g., irrigated in one tract, not irrigated in another). If the operator chooses not to divide a basic unit into optional units, they will generally become eligible for a 10 percent premium discount.

Enterprise units are a third option where the grower can lump all the acres of a single crop within a county into a single unit, regardless of who owns the land or what type of lease arrangements have been made (cash versus share). To qualify as an enterprise unit, two or more basic units must exist and be combined into a single enterprise unit. Because enterprise units combine multiple basic units, premiums tend to be lower.

The lowest premiums are available for growers who select the whole farm unit. This fourth choice means that the producer lumps all crops and all units within a county together under one policy.

Prior to the spring of 2009, all producers received the same subsidy rate no matter what unit structure they chose. Because enterprise and whole farm unit structures command lower premiums (since are insuring over larger pieces of land that would otherwise be insured separately and therefore making it less likely to incur a loss substantial enough to require compensation), these producers would receive a lower dollar amount of subsidy. In the 2008 Farm Bill, Congress passed legislation ensuring that a grower would receive the same dollar amount of subsidy regardless of the type of unit selected. As a result, the effective subsidy rates changed dramatically (table 1).

Table 1. Effective subsidy rates by level of coverage after 2008 Farm Bill

	Coverage level (percentage of loss covered)							
Unit	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**
	Premium Subsidy Rate (percentage of premium covered by Federal Government)							
Basic	67	64	64	59	59	55	48	38
Optional	67	64	64	59	59	55	48	38
Enterprise	80	80	80	80	80	77	68	53
Whole Farm	80	80	80	80	80	80	71	56

Source: U.S. Department of Agriculture, Risk Management Agency, 2012 Commodity Insurance Fact Sheet

One reason to suspect that the subsidies matter to the choices producers make is the growth over this time frame of the use of enterprise units. For the states explored in this study, in 2008 the total number of acres insured using enterprise units were roughly 11 million. Growers took advantage of the change in subsidies enacted in the 2008 Farm Bill by more than quadrupling the number of acres insured using enterprise units in 2009, increasing to more than 52 million acres (fig. 2).

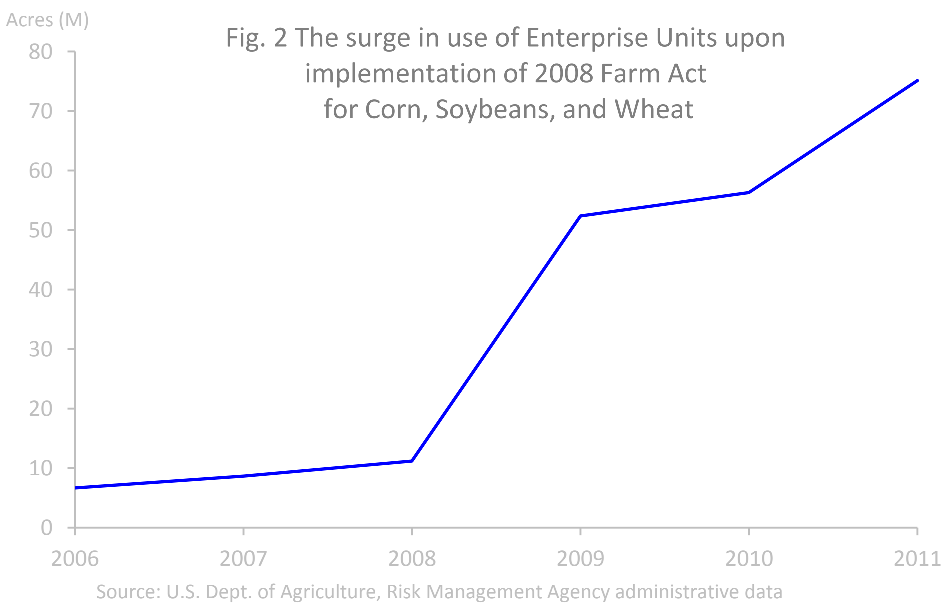


Fig. 2 The surge in use of Enterprise Units upon implementation of 2008 Farm Act for Corn, Soybeans, and Wheat

Not only did the use of enterprise units increase, but the various changes to the crop insurance program over time appeared to induce producers to enroll roughly 283 million acres in crop insurance by 2012, representing approximately 84 percent of all cropland used for crops (table 2). 84 percent of acres planted to corn, soybean, and wheat each were enrolled in crop insurance, making up 68 percent of all acres enrolled in the crop insurance program (a share that has declined over time as the program has expanded to include a wider variety of crops). 265 million of all enrolled acres were covered by buy-up policies in 2012, representing nearly 94 percent of all acres covered under the federal crop insurance program. The early ineffectiveness of the program combined with its surge in growth after the introduction of various subsidies led Smith and Glauber (2012) to declare that "[i]t is likely that most crop insurance products would not exist in the absence of subsidies."

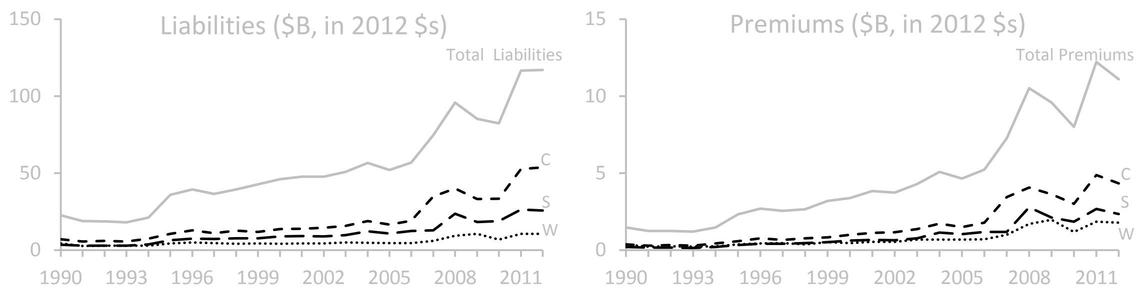
Table 2. Changes in crop insurance enrollment over time

Year	*Acres Enrolled (millions)* *Share of total planted of particular crop*				
	Total	Corn	Soybean	Wheat	Top 3 crops' share of total acres enrolled
1990	101	26 35	17 29	36 47	78
1995	221	60 85	51 82	58 84	76
2000	206	57 72	55 74	46 74	77
2005	246	63 77	58 81	45 79	67
2007	272	75 80	51 79	47 78	64
2012	283	81 84	65 84	47 84	68

Source: Risk Management Agency, Summary of Business, 1990, 1995, 2000, 2005, 2007, and 2012 and National Agriculture Statistics Service, *QuickStats*.
Note: 2007 and 2012 are italicized since they are the years we are looking at explicitly in this study.

Note, however, that the share—or even number of acres enrolled—is not the only way to measure participation in the crop insurance program. Other measures include (but are not necessarily limited to) the share of total crop value under a policy (the liability), and the level of total premiums demanded (see fig. 3; note that the figure contains levels of liabilities and total premiums, all normalized to 2012 dollars). Regardless of the measure used, crop insurance participation grew significantly across the Nation over this time frame. This rise in participation coincided with the increase in subsidies. How important were the subsidies?

Fig 3. Crop Insurance Participation Growth: Alternate Measures, normalized to 2012 dollars



Note the scale of the y-axes – a factor of 10 difference between Liabilities and Premiums. C = corn; S = Soybeans; W = wheat
Source: Risk Management Agency, Summary of Business files, 1990- 2012

The current paper follows this line of questioning and explores a variety of measures of crop insurance demand. This study contributes to a better understanding of how the crop insurance subsidies affect the quantity demanded by following Babcock and Hart's lead to examine the subsidies directly while using various measures of demand in the vein of Goodwin (1993). While these two studies as well as others provided significant insights on the impacts of premium subsidies, policy changes have abounded and the crop insurance program has undergone multiple significant changes. This study builds on previous studies by examining a wider range of crops and regions within a single study while examining a more recent change in policy. Care is taken to address causality and results help to better understand how producers' decisions change with changes to the Federal crop insurance program, providing crucial information to policymakers, program managers, and to better understand how risk management programs work in general.

The Importance of Subsidies (How Price Affects the Quantity Demanded)

As mentioned earlier, there are many ways to measure participation in the crop insurance program. In this study, five different measures are used: the level of total premiums, the level of premiums per acre, the level of liability per acre, total acres enrolled, and the number of acres enrolled in buy-up coverage.

Acre enrollment has consistently been one of the most commonly used measures in previous studies. While not all studies use the same exact variable specification, the idea has been to capture how much land producers have enrolled in the federal crop insurance program for a particular crop. However, such a variable does not take into account land quality. For example, an acre of marginal land that cannot produce much would be counted equally to an acre of highly productive cropland. To further complicate matters, land that is more likely to have crop failure take place is more likely to be enrolled in crop insurance. For example, one might expect a corn acre in South Dakota to be more likely to be covered than a corn acre in Iowa where the growing season is much more consistent over time. Furthermore, there is no ability to measure intensity of use of the crop insurance program. An acre enrolled in CAT is counted the same as an acre enrolled in 65 percent coverage, and the same as an acre enrolled in 85 percent coverage. While the program is being used differently in all three scenarios, acreage measures cannot discern between the various uses.

Therefore, while worth using as an overall measure of participation, it is important to note its shortcomings and explore other measures as well. To begin to address the intensity of use concern, a related measure captures the number of acres insured with buy-up coverage. While also suffering from the land quality critique, this measure focuses on those farmers who are using the crop insurance program more rigorously as part of their risk management strategy as opposed to simply opting for CAT coverage to, say, allow them to be eligible for disaster support should it become necessary. Note, however, that the difference between buy-up acres enrolled and total acres enrolled has diminished over time. While there will be some additional information in the buy-up acres measure, it is not clear whether the additional information present will provide significant insights.

A third measure is the sum of total premiums. Assuming that the total premium is actuarially fair, this should provide a good measure of the intensity of use of the program. If a higher level of insurance coverage is selected, the premium will adjust accordingly. If more acres are enrolled, the sum of all the total premiums will increase. Furthermore, land quality is taken into account since higher quality land would command a higher premium. A potential drawback from using this measure is that it does not take into account the size of the county. If subsidies affect the quantity demanded of crop insurance, then we might see much larger changes in larger counties than in smaller counties due solely to the size difference when using this measure. Therefore, to account for county size, a fourth variable that measures the level of total premiums per acre is used.

The last measure, the level of liability per acre, provides a measure of the value of the crops covered by the crop insurance policies. This provides an alternative measure of the quantity of insurance demanded by producers. It differs from premiums per acre because total premiums take into account the probability of an adverse event that lowers output and/or prices; hence total premiums are a fraction of total liabilities and, for a given increase in coverage, premiums rise at different rates than liabilities.

Note that these last three variables are intended to capture the quantity of crop insurance demanded. Large price movements can cause these variables to change dramatically from year to year. For this reason, these measures, throughout the report and the analysis, are defined in real terms, controlling for price movements. To do this, prices are normalized to 2012 prices so that if the value of premiums or liabilities changed over time, it would be due to the underlying changes in the quantity of crop insurance demanded and would not be attributed to price changes.

Moreover, once the price movements are taken into account, these last three variables also allow us to compare different insurance policies on the same scale. While different types of policies certainly have different characteristics (e.g., yield based policies versus revenue based policies), the fact that they are priced in an actuarially fair manner allows direct comparisons amongst different policy types. Essentially, the different policies are normalized so they can be compared on the same scale – the dollar.

Methodology and Data

The model aims to explore the relationship between crop insurance demand and the price of crop insurance. Since the price of crop insurance is reduced by the amount of subsidy, as the subsidy increases, the price of crop insurance that the farmer pays decreases. This model focuses on how changes in the level of the subsidy affect the demand for crop insurance.

The regression model

A separate regression is estimated for each crop and region that examines changes over time using two periods, one before the 2008 Farm Act that increased the effective subsidy rate of enterprise units using 2007 data and one after the Farm Act, using 2012 data. For each crop-region combination, the model relates the change in a measure of crop insurance demand, ΔY_c, for county c to a set of variables including ΔS_c that measures the change in subsidy, a set of county-specific time-varying controls, and a set of regional-by-year fixed effect controls described below.

(1) $$\Delta Y_c = \alpha \Delta S_c + \beta \Delta X_c + \delta w_{r(c)} + u_c$$

ΔY_c represents the change in crop insurance demand from 2007 to 2012, measured one of five ways: total premiums, premiums per acre, liabilities per acre, total acres enrolled in crop insurance, and total acres enrolled in buy-up crop insurance policies (i.e., any policy that is not CAT coverage). ΔS_c denotes the change in subsidies induced by the 2008 Farm Act. This is measured as total subsidies divided by total enrolled acres to get a county average per-acre subsidy rate for both 2007 and 2012, which is then differenced. Both of these sets of variables are first logged and then differenced, meaning that the coefficient on ΔS_c can be interpreted as an elasticity (and recall, all values are in 2012 dollars).

ΔX_c contains controls that vary over time, including the lagged change in the number of acres of a particular crop in the county, the change in a 3 year measure of lagged returns to crop insurance measured as total indemnities divided by total premiums paid by the farmer, and the difference in a one year lagged, actual-versus-expected revenue, differenced over time. These last two sets of variables are designed to capture the general state of the economy for producers in the years (or year) leading up to the period examined. For example, if the returns to crop insurance increased in the years leading up to 2012 (relative to how the returns moved in the years leading up to 2007), producers may view crop insurance more favorably in 2012 and may be more likely to enroll in crop insurance in 2012 versus in 2007 (and vice-versa). Similarly, how producers fared in 2011 versus 2006 may affect crop insurance enrollment in 2012 versus 2007. For instance, suppose (on average) producers experienced losses in 2011 but gains in

2006. This suggests that the actual revenues in 2011 lay below the expected revenues while the revenues in 2006 lay above the expected revenues. Differencing the two would generate a negative value, suggesting that the producer may be more willing to adopt crop insurance in 2012 than back in 2007 (having recently experienced a relatively large loss). In other words, the larger the value of the variable, the less likely producers would enroll in crop insurance in 2012 relative to 2007, while the smaller the variable, the more likely it would be. The mean and variance of yield histories for each county, detrended and normalized to a base year's (2011's) yield of the relevant crop, are also included to capture differences in the potential riskiness of the crop across space. Because RMA issued separate prices for yield coverage than for revenue coverage up until 2011, and the prices were determined at different times of the year, it is possible that this had the potential to sway producers in the choice of policy (and hence, perhaps, their demand for crop insurance). To control for this, the analysis includes a variable measuring the change in the (lagged) ratio of yield to yield and revenue policies measured by their total premiums.

The regression analysis also includes regional-by-year fixed effects ($w_{r(c)}$) that generate comparisons amongst counties within regions that were created based upon soil and climatic attributes (crop reporting districts). Note that this is a fixed effect that captures trends that can vary by region. Any time-varying changes that differ across space will be captured by these variables, such as weather, and price movements not picked up by other variables (yield movements should be picked up by the mean and variance variables).

Implicit in equation (1) is a county level fixed effect that drops out of the equation due to differencing. This fixed effect accounts for land quality. Finally, the error, u_c, captures other unobserved factors affecting crop insurance demand, such as within-region weather variations.

Producers have traditionally had a large number of alternative methods to deal with risk, including various Congressionally legislated programs, which might affect producers' willingness to consume crop insurance. This study explores a timeframe that falls between two farm bills, meaning the farm programs may have meaningfully changed over the span of the study. However, most of the programs that help to mitigate risk tend to provide support when prices are low (for example, counter-cyclical payments, marketing loan benefits, etc.). Commodity prices remained quite high over this time frame. The bulk of payments between 2007 and 2012 came in the form of Direct Payments, which did not change substantially from the 2002 to the 2008 farm bill. New programs, however, have the potential to alter the demand for crop insurance. Two such programs did come into being with the passage of the 2008 Farm Bill. The first, the Average Crop Revenue Election (ACRE) program, was a revenue based program armed with both county and individual farm level triggers. The program aimed to help guarantee revenue levels while producers had to forgo a percent of the payments they would otherwise receive from the Direct and Countercyclical Program (DCP). Given the complexity of the program, however, few producers enrolled, and we can safely assume that ACRE did not affect crop insurance participation to a great degree. In contrast, the Supplemental Revenue Assistance Payments Program (SURE) had the ability to alter crop insurance enrollment since eligibility for program assistance required enrollment in the crop insurance program. However, this program went into effect in 2009 and only covered losses through September of 2011. Since this study primarily uses data from 2007 and 2012, producers did not have SURE available to them in either of these years.

Since the rest of the programs available to producers remained fairly constant over time, the differencing that takes place would essentially eliminate the variables from the analysis.

Therefore, these major alternative methods of dealing with risk, namely the programs that help support producers, were not included in the analysis. This reasoning also holds for the *ad hoc* disaster assistance that was typically provided by Congress to producers when large scale crop losses occurred. The probability of receiving *ad hoc* disaster assistance did not change over this time frame, so it too would drop out of the analysis and therefore was not included.

Endogeneity concerns

Using the change in average subsidies per acre at the county level from 2007 to 2012 poses a problem because this subsidy rate is defined in part by the policy the producer selects. The endogeneity of the variable could result in biased coefficient estimates. Furthermore, causality is not clearly established. It could be the case that the producer chooses a particular quantity of insurance to consume, which drives the level of subsidy the producer receives, or it could be that the change in subsidy rates causes the producer to consume a different level of insurance.

To ameliorate this concern, we adopt an instrumental variables (IV) approach. Instrumenting the change in subsidies from 2007 to 2012 with the change in subsidies from 2006 to 2011 allows me to both deal with the endogeneity problem as well as provide a clear path of causation. When faced with the decision of what policy to enroll in for the 2012 crop year, the 2011 crop year has already taken place, so any decisions made in 2011 should not affect 2012 subsidies. Therefore, the decision for the 2011 crop year, and its change from 5 years previous (2006), can be considered exogenous to the decision about the change in quantity demanded of crop insurance from 2007 to 2012. Furthermore, since this instrument is based on historical data, it is clear that the quantity of insurance period of interest purchased in 2012 (and its change from

2007) cannot have an effect on the change in the quantity demanded between 2006 and 2011. Hence, this procedure allows me to address both the endogeneity and the causation concerns.

The analysis therefore takes a two-stage least squares (2SLS) approach. The instrument is then used in the first stage of the 2SLS regression (along with all the other exogenous variables) to create the instrumental variable ΔS_c^{IV} used in the second stage:

$$\Delta Y_c = \tilde{\alpha}\Delta S_c^{IV} + \tilde{\beta}\Delta X_c + \tilde{\gamma} Z_c + \tilde{\delta} w_{r(c)} + u_c$$

Data

Individual, county, and national level data from various sources are used in the analysis. County level data were used to estimate state level responses to changes in the price of crop insurance on participation in the federal crop insurance program. Risk Management Agency (RMA) administrative data that contain all individual federal crop insurance policies taken out by producers provides individual policy, county, and national level information by crop from 1989 through 2012 for variables such as the number of acres insured, the acres of buy-up insured, the level of total liability insured, the levels of total premiums, government subsidies, and indemnities paid out, and what type of practice was used to grow the crop (irrigated or non-irrigated) that were used in the report. The individual policy-level data was aggregated to the county level by crop type and practice for the regression analysis while the national level data was used for descriptive purposes. National Agricultural Statistics Service (NASS) surveys (available through NASS's web-tool "QuickStats") provided county level data on the total acres planted from 1989 through 2012 and crop yields from 1966 through 2012. Finally, NASS Agricultural Census files, which aim to cover all farms in the United States, were used to obtain county level characteristics, including the average amount of land in farms, the median age of the operator, and operator gender; the county level characteristics were calculated using the individual operation level data available from the Census.

The study explores crop insurance for corn, soybeans, and wheat. For corn, the states covered included several in the Corn Belt (IL, IN, IA, and OH), in the Northern Plains (KS, NE, and SD), and to the north in the Lake States (MI, MN, and WI). Together, these 10 states included the top nine states (and ten of the top 11) in 2006 in terms of planted acres of corn, covering roughly 79 percent of all acres planted to corn and accounting for approximately 84 percent of all corn production. For consistency, the same states were used for soybeans. These 10 states covered roughly 69 percent of planted acres and close to 77 percent of all soybean production. For wheat, the states included Northern Plains states (KS [winter wheat], NE [winter wheat], ND [spring wheat], and SD [spring wheat]) and winter wheat in the Southern Plains states (OK and TX). Altogether, these 6 states included the top 4 states in terms of planted acres (and 6 of the top 9) in 2006 in terms of planted acres of wheat, capturing roughly 61 percent of all planted acres and almost 45 percent of total wheat production.

Construction of variables

All variables are created at the county level for each crop. Total premiums, liabilities, acres enrolled, acres enrolled in buy-up policies, and subsidies all come directly from the Risk Management Agency for the various years. However, since the model aims to measure the change in crop insurance demand due to the change in policy, we want to control, as best we can, for changes in prices and yields that took place over this time frame. Therefore, the 2006 levels of total premiums, liabilities, and subsidies were multiplied by the ratio of 2012 expected prices and yields (i.e., expected revenues) to 2006 expected revenues (akin to putting everything in 2012 real terms).

Changes in the acres planted to the relevant crop were calculated from planted acres data collected by the National Agricultural Statistics Service (NASS) for the years 2006 and 2011. Lagged years (2006 and 2011) of these variables were used to ensure the exogeneity of the independent variable.

The mean and variance of the yields are calculated using NASS yields collected from 1975 through 2012. For each county, yields are first detrended using a simple linear model, regressing the 37 years' worth of data on a year variable. Following the study of Goodwin and Ker (1998) who found that the standard deviations of the yield tend to be proportional to the level of the average yield, we created normalized yields using the intercept, slope, and residuals from the linear regression in the following manner:

(2) $$\overline{y_t} = y_{2012} * \left(1 + \frac{e_t}{y_t}\right)$$

where $\overline{y_t}$ denotes the normalized yield for time t, e_t represents the residual from the regression, and y_t is the predicted yield stemming from the linear regression. With 37 years' worth of data, equation (2) generates 37 normalized yield observations for each county, allowing us to calculate a separate mean and variance for each county. Since the regression equation explores changes in subsidies chosen, we need to use changes in the mean and variance (otherwise the variable would drop out due to the differencing). Therefore, the mean and variance for both 2006 and 2011 is calculated and differenced for the analysis.

Dividing the indemnities received by the premiums paid by producers for each insurance plan for the appropriate crop. The total is the acre-weighted sum of all plans for each of the three years preceding 2007 and 2012 (e.g., for 2007, the years 2006, 2005, and 2004 were used). The returns for the three years were then averaged (divided by 3) to obtain two, three-year average returns to crop insurance for each crop in each state (one for the years leading up to 2007; a second for the years leading up to 2012). These were then differenced for use in the regression.

If producers experienced losses in the year prior to either 2007 or 2012, they may have been more inclined to enroll in crop insurance in the following year. For example, if a farmer fared worse in 2011 relative to 2006, they might find crop insurance more attractive in 2012 than in 2007. Therefore, to construct such a variable, the actual and expected revenues were calculated for 2006 and 2011. Actual revenues were generated using NASS price and yield data. Expected revenues were generated using the predicted yields from the detrending linear regression process discussed above and national level futures commodity prices (assuming away basis differences between counties). After constructing the actual and expected revenues for both 2006 and 2011, the actual and expected revenues were differenced for each year. This difference is each year's gain/loss (actual relative to expected) for each year. The resulting gain/loss for 2006 was then subtracted from that of 2011 to obtain a measure of relative gain/loss over time.

Finally, a 2006 crop insurance ratio was used in the analysis, constructed from RMA data from the Summary of Business. The total premium of all yield based policies were summed and divided by the sum of all yield and revenue policy premiums for 2006. This variable attempts to control for the possibility that producers selected policies in order to "chase the prices." Prior to 2011, RMA issued separate prices for yield and revenue policies – and these prices were issued at different times of the year, which could sway producers about the choice of their policy, which might end up having implications for how producers participated in the Federal crop insurance program. Since this was not the case in 2011, only the 2006 level was included in the analysis

Summary Statistics

The data in this study has been cut several different ways – exploring each of the three crops (corn, soybeans, and wheat) across all the states and regions examined, it also includes a region-by-crop analysis, and finally it includes what should probably be taken as rough estimates (with low power due to a limited number of observations for each state) of a state-by-crop analysis to explore how any results might differ at the different levels of aggregation. Providing summary statistics for each of these scenarios would be prohibitively expensive in terms of space. Therefore, table 3 below contains summary statistics for the entire sample of data collected for corn. This will provide a general sense of the data. Variables that will provide some intuition as to how the variables are changing and that have a clean interpretation are the only ones included. I do not include the majority of the variables used in the actual regression in the summary statistics table since the difference of logged variables is not intuitive for the reader.[1] Note also that the premiums, subsidies, and liabilities are adjusted for increases in both prices and yields. Since the bulk of insurance plans are revenue-based plans, premiums can increase due to price increases (inflation), yield increases (productivity increases), and changes in demand. To isolate the effect of changes in demand due to the changes in subsidies, both price and yield changes must be accounted for. As an example, 2007 total premiums are multiplied by both 2012 expected prices and yields and divided by 2007 expected prices and yields. While this is akin to generating real prices in 2012 dollars, it also adjusts yields so that the resulting differences in premiums and liabilities over time isolate the effect of the subsidy increase.

Table 3. Select County Level Summary Statistics for Corn Producers

[1] Results for any set of variables are available upon request.

Variable Name	Description	Mean (Std Dev)	Min	Max
Premium_07	Total Premium 2007	5,034,068 (3,998,238)	52,510	28,496,329
Premium_12	Total Premium 2012	4,400,444 (3,207,530)	245,914	29,028,178
Prem_acre_07	Premium/acre 2007	65.61 (14.30)	22.36	124.72
Prem_acre_12	Premium/acre 2012	54.28 (11.88)	18.51	102.76
Liab_acre_07	Liability/acre 2007	17,840,649 (13,352,464)	309,213	99,825,177
Liab_acre_12	Liability/acre 2012	15,379,055 (9,380,761)	1,337,500	64,300,500
Ins_acres_07	Insured acres of corn 2007	77,135 (59,236)	687	351,143
Ins_acres_12	Insured acres of corn 2012	83,137 (58,975)	6,557	341,684
Buyup_07	Acres of buy-up 2007	77,135 (59,236)	687	351,143
Buyup_12	Acres of buy-up 2012	83,137 (58,975)	6,557	341,684
Sub_acre_07	Subsidy/acre 2007	36.59 (8.01)	15.57	73.89
Sub_acre_12	Subsidy/acre 2012	33.49 (8.67)	13.65	75.85
Corn acres_07	Acres planted to corn 2007	94,182 (64,084)	1,300	397,000
Corn acres_12	Acres planted to corn 2012	97,110 (64,514)	8,500	368,000
Rev_diff	Expected revenues minus actual revenues, differenced between 2011 and 2006	79 (130)	-300	530
Yield mean	Change in mean yield 2006 to 2011	0.49 (0.80)	-2.9	3.4
Yield variance	Change in yield variance 2006 to 2011	-29 (37)	-181	127
3_yr_return 2007	Average of previous 3 years indemnities to premiums paid ratio, 2007	1.39 (1.32)	0	7.66
3_yr_return 2012	Average of previous 3 years indemnities to premiums paid ratio, 2012	1.28 (1.30)	0	9.34

While in nominal dollars the total premiums demanded of crop insurance increased over time (from 3.2M to 4.4M dollars) – after adjusting for both price and yield changes, the level of premiums actually dropped from 5M down to 4.4M dollars. In other words, when accounting for changes in the price of corn, the level of total premiums was higher in 2007 than in 2012 (a statistically significant difference). One potential reason is that the subsidies introduced for enterprise units could have induced a higher level of adoption of enterprise units which, due to their spreading of risk across townships and/or practices within a county, command a lower premium. However, since the price and yield changes are adjusted for, this would seem to suggest that overall, growers participated less in the crop insurance program in 2012 than in 2007.

Using this method to adjust the relevant values, premiums, liabilities, and subsidies all decreased from 2007 to 2012. Despite the fact that the per-acre premiums and subsidies dropped (at least nominally) over this time frame, the subsidy per dollar of premium did increase. For corn producers in 2007, a dollar of total premium incurred 56 cents worth of subsidies. In 2012, this had increased to 62 cents of subsidy per dollar of total premium. Meanwhile, the average number of acres planted to corn increased only slightly from approximately 94,000 acres per county to 97,000 acres. Continuing the trend towards increased coverage, the average number of acres of corn insured under crop insurance rose modestly from 77,000 to 83,000 acres. Note that the smallest county in 2007 had only 687 acres of corn insured (all of which was in buy-up policies).

The variable "Rev-diff," which measures the expected revenues minus actual revenues, provides a sense of how the farmer fared relative to expectations (of prices and yields) at the time of planting. This change over time shows that producers in 2011 did better than in 2006 on average, although some clearly did worse evidenced by the minimum score of -300. Also exploring the lagged years (2006 and 2011), mean corn yields increased slightly over this six year period while the yield variance dropped from 2006 to 2011. Finally, while not statistically significantly different from each other, the average of the previous three years (lagged) returns dropped modestly for 2012 relative to 2007, which may suggest that producers might have been more primed to enroll in crop insurance in 2007 relative to in 2012 (i.e., the returns to enrolling in the insurance program appeared to have decreased modestly).

Results and Discussion

Changes in subsidies enacted through the 2008 Farm Act appear to have changed the quantity demanded of crop insurance. However, the effect due to changes in subsidies appears to differ across crop type and location. Because of the large number of regressions run, this paper cannot contain all the results. The first couple of tables show the different methods being used for a single region, to get a sense for how the results differ by specification while later tables only contain the results for the main independent variable of interest.

Table 4 shows four different specifications' results for Midwest corn, using total premiums as the dependent variable. The first two columns show results using an ordinary least squares (OLS) approach, the first without and the second including region-by-year fixed effects. The third and fourth columns show results for the instrumental variables technique to deal with the endogeneity concern, again with and without fixed effects.

Table 4. Regression Results for Midwestern Corn

	Dependent Variable = Δ ln(Premiums)			
Variable	OLS, no FEs	OLS, FEs	2SLS, no FEs	2SLS, FEs
Δ ln(subsidy/acre)	0.94***	1.03***	0.99***	1.11***
	(0.03)	(0.05)	(0.04)	(0.08)
Δ ln (corn acres)	0.25***	0.21***	0.25***	0.21***
	(0.06)	(0.06)	(0.06)	(0.06)
3-yr avg. Return to	-0.01	-0.01	-0.01	-0.01
Insurance	(0.01)	(0.01)	(0.01)	(0.01)
Mean of Yield	-0.04***	-0.05***	-0.04***	-0.04**
	(0.01)	(0.01)	(0.01)	(0.015)
Variance of Yield	0.001***	0.001***	0.001***	0.001***
	(2E-4)	(3E-4)	(0.0002)	(0.0004)
Revenue	-9E-5	-9E-5	-6E-5	-0.0001
Difference	(6E-5)	(8E-5)	(6E-5)	(0.0001)
Δ Insurance	0.0008**	0.002***	6E-4	0.0014**
Ratio	(0.0004)	(0.0005)	(4E-4)	(0.0006)
Region-by-year FE's	No	Yes	No	Yes
N	322	322	322	322
Adj. R^2	0.87	0.91	0.86	0.90

*** denotes statistical significance at the 1% level; ** denotes statistical significance at the 5% level

One of the most statistically significant variables is that of the change in the per-acre subsidy. It is positive and, since both it and the dependent variable (change in total premiums) are in logs, the coefficient represents an elasticity of demand. Since the coefficient lies just above 1 for the specifications with region-by-year fixed effects, it suggests that in the Midwest the quantity demanded of crop insurance, as measured by the total premium, is mildly price elastic. A one percent change in the price of crop insurance leads to a little more than one percent change in the quantity demanded of crop insurance. And the association is positive as well, meaning that an increase in the subsidy (meaning the price the producer sees goes down) leads to an increase in the quantity demanded (and vice versa). Note that the coefficients for the subsidies are highest for the 2SLS with fixed effects, suggesting that the OLS results may not be capturing the entire effect of the change in subsidies.

For the Midwest, there were 322 observations and the adjusted R^2 ranged from 0.87 to 0.91 for the OLS and from 0.86 to 0.90 for the 2SLS specifications. These suggest a high degree of fit. It should also be noted that the F-value for the first stage of the Midwestern 2SLS regressions is 69, thereby eliminating concerns of a weak instrument (Stock and Yogo, 2005).

Regarding the rest of the independent variable coefficients, across all four specifications, they all remain consistent in sign, have the expected sign, and magnitudes remain fairly constant. As planted corn acreage changes, so do the total premiums. In other words, if more acres are planted, total premiums increase, suggesting that if new land is planted to corn, total premiums would increase. The three year average return to insurance shows a negative relationship with total premiums. However, the small magnitude and statistical insignificance suggest that the relative returns to crop insurance (year over year) do not play a large role in determining whether growers will participate (or more heavily participate) in the crop insurance program.

The yield mean variable shows that as the average yields increase over time, producers require less crop insurance – the yield increases perhaps help to offset potential losses, although the magnitude remains small. The yield variance measure, however, commands a positive coefficient, suggesting that as yields become more variable, producers are more willing to enroll in crop insurance to manage the riskiness associated with more variable yields.

The revenue-difference variable (measuring the difference between expected revenues and actual revenues for 2006 and 2011, which is then differenced) attempts to control for the relative difference in outcomes for the years prior to those studied. In other words, if producers did worse in 2006 than in 2011, they might be more prone to insure in 2007 than in 2012. Results suggest a negative, but very small in magnitude, relationship with total premiums. Finally, the change in the insurance ratio (ratio of yield to revenue based insurance policies) to control for the possibility that producers "chased the prices" suggests a very small, positive coefficient.

Table 5 shows the results using the 2SLS approach and all five of the dependent variables developed for the analysis. Again, one of the most consistently statistically significant variables is the change in the subsidy/acre variable. It is consistently positive and, for Midwestern corn, shows elasticities that differ depending on the dependent variable being examined. As noted above, total premiums appear to show the most elastic responses while the elasticities for liabilities and acres insured (both total and with buy-up coverage) remain low. This should not be too surprising given the subsidies directly affect the total premium and the total premium can change dramatically based on the policy chosen. Liability per acre, on the other hand, will not change nearly as dramatically even when purchasing increased coverage on land previously insured. Because the liability variable is a per-acre measure, it can be negative if the increased subsidies induced farmers with lower liabilities per acre to enroll in crop insurance. A negative value could come about if higher subsidies make it more attractive for producers with lower liabilities per acre to enroll land. The negative values in the table suggest this sort of outcome, although they are of relatively modest magnitude and remain statistically insignificant, suggesting that any effect is small. The number of acres insured and covered with buy-up policies also appeared to respond positively based on the increased subsidies. While these specifications had statistically significant subsidy/acre coefficients, suggesting that the acres insured increased with increases in the subsidies per acre, the overall magnitude of the effect remained small.

Table 5. Regression Results for Midwest Corn - All Five Dependent Variables

2SLS with region-by-year FEs

Variable	Total Premiums	Total Premium/Acre	Total Liability/Acre	Acres Insured	Buy-up Acres Insured
Δ ln(subsidy/acre)	1.11***	0.86***	-0.18	0.25***	0.30***
	(0.08)	(0.04)	(0.10)	(0.07)	(0.08)
Δ ln (corn acres)	0.21***	0.05	0.01	0.16***	0.11
	(0.06)	(0.03)	(0.08)	(0.06)	(0.07)
3-yr avg. Return to	-0.01	-0.01***	0.01	0.002	0.002
Insurance	(0.01)	(0.004)	(0.01)	(0.007)	(0.008)
Mean of Yield	-0.04**	-0.06***	-0.06***	0.02	0.02
	(0.015)	(0.007)	(0.02)	(0.01)	(0.01)
Variance of Yield	0.001***	0.0002	0.001**	0.001**	0.0007
	(0.0004)	(0.0002)	(0.0004)	(0.0003)	(0.0004)
Revenue	-0.0001	-2E-5	5E-5	-8E-5	-5E-5
Difference	(0.0001)	(4E-5)	(1E-4)	(8E-5)	(9E-5)
Δ Insurance	0.0014**	0.0004	-6E-4	0.001**	0.003***
ratio	(0.0006)	(0.0003)	(7E-4)	(0.0005)	(0.0006)
Region-by-year FE's	Yes	Yes	Yes	Yes	Yes
N	322	322	322	322	322
Adj. R^2	0.90	0.98	0.79	0.50	0.61

***Denotes statistical significance at the 1% level; **denotes significance at the 5% level

Table 6 holds the results for the various regions and multiple crops using the 2SLS instrumental variable approach with region-by-year fixed effects. Note that due to the difficulty of presenting 40 regressions' worth of results across the 3 crops, 4 regions, and 5 dependent variables, table 6 only holds the coefficients for the subsidy per acre variable from each of the regressions.

Table 6. Regression Results for All Regions (only reporting main variable: change in log subsidy/acre)

	2SLS with region-by-year FEs				
Variable	Total Premiums	Total Premium/Acre	Total Liability/Acre	Acres Insured	Buy-up Acres Insured
			Corn		
Midwest	1.11***	0.86***	-0.18	0.25***	0.30***
(IL, IN, IA, OH)	(0.08)	(0.04)	(0.10)	(0.07)	(0.08)
Lake	1.21***	0.95***	0.24	0.29***	0.63***
(MI, MN, WI)	(0.09)	(0.05)	(0.13)	(0.10)	(0.13)
N. Plains	0.89***	0.98***	0.28	-0.08	0.04
(KS, NE, SD)	(0.13)	(0.04)	(0.16)	(0.13)	(0.13)
			Soybeans		
Midwest	1.02***	0.93***	-0.14	0.09	0.23**
(IL, IN, IA, OH)	(0.08)	(0.03)	(0.08)	(0.08)	(0.10)
Lake	1.28***	0.82***	0.23**	0.46***	0.56***
(MI, MN, WI)	(0.11)	(0.04)	(0.10)	(0.11)	(0.13)
N. Plains	1.36***	1.02***	0.19	0.39**	0.44***
(KS, NE, SD)	(0.15)	(0.03)	(0.15)	(0.15)	(0.15)
			Wheat		
S. Plains	1.14***	0.87***	-0.31***	0.35**	0.27
(OK, TX)	(0.16)	(0.03)	(0.11)	(0.13)	(0.17)
N. Plains	0.53***	0.76***	0.27**	-0.23	-0.25
(KS, NE, ND, SD)	(0.11)	(0.03)	(0.13)	(0.14)	(0.14)

***Denotes statistical significance at the 1% level; **denotes significance at the 5% level

Again, the effect on premiums is much greater than the effects on either the liability or the acre measures. The Lake States region appears to have among the consistently highest demand response to increases in the subsidies per acre through the enterprise units. And corn and soybean producers appear, on average, to have higher responses than wheat producers. Corn and soybean producers also have very similar results, which makes sense given these producers are often the same individuals.

Note that liabilities per acre at the regional level appear, for the most part, to be positive. So despite the Midwest corn and soybeans and Southern Plains wheat specifications reflecting a negative coefficient on the liability per acre, the rest remain positive. All remain small, suggesting an inelastic response to subsidy changes. With the exception of the Northern Plains wheat region, all the acre coefficients are positive, yet small, suggesting a relatively inelastic response to changes in the subsidy per acre. It appears that acreage enrolled does not respond greatly to changes in subsidies, but changes in participation through increased coverage of already enrolled acres appears to be close to or slightly greater than unit elastic for many of the regions and crops.

Table 7 below shows results for when all the regions are lumped together (to generate a "National" average response to changes in subsidies) for corn, soybeans, and wheat, again focusing only on the subsidy variable.

Table 7. Subsidy Coefficients from Regression Results for Corn, Soybeans, and Wheat, all States

	Dependent Variable				
Crop	Δ ln(Premiums)	Δ ln(Prem/Acre)	Δ ln(Liability/Acre)	Δ ln(Acres)	Δ ln(Buy-up Acres)
Soybeans	1.11***	0.91***	0.10	0.21***	0.31***
Corn	1.01***	0.92***	0.15**	0.11**	0.31***
Wheat	0.53***	0.76***	0.01	-0.18	-0.29**

***Denotes significant at the 1% level; **denotes significance at the 5% level

Soybeans show the largest effects when lumping all states and regions together with the lone exception of the liability per acre measure. However, for the most part, the results are almost identical to those for corn. The change in total premiums is affected the most, with an elasticity of roughly 1.1 for soybeans and slightly lower for corn, suggesting that total premiums demanded by producers increased by 1.1 percent for each percent increase in subsidy. Liabilities were much smaller and, in the aggregate, show almost no response to increases in subsidies. The elasticity for total acres is also less than one for the three crops, ranging from -0.18 to 0.21. While statistically significant for corn and soybeans, the magnitude for all three is relatively small, with roughly a 1 percent increase in subsidies per acre translating to a 0.2 percent increase (for soybeans) in the number of acres enrolled in crop insurance. While farmers appear to be enrolling more land due to the subsidy increase, the effect is small. The coefficient on the buy-up acres tends to be higher for corn and soybeans, suggesting that, in the aggregate, the increase in subsidies had a greater effect on causing producers to enroll more acres in buy-up programs rather than enroll new land. However, again, the estimates remain well below the unit elastic value of 1. For wheat, the coefficient is more negative and statistically significant at the 5 percent level, but the level is small, suggesting a very small change due to subsidies.

Table 8 explores how the producers in different states reacted differently to the policy change. Rather than looking at the entire group of states as a whole, the tables contain results of individual regressions for each crop run at the state level. However, because the data is now limited to states only, there are fewer observations per state. Only states with at least 70 observations were included in the tables below. While somewhat arbitrary, 70 represents a more or less natural cut of the data. For example, wheat had two of the six states with at least 70 observations, and the other four had observations ranging between 20 and 42. While not as clean a cut of the data, for corn, half of the states used in the study had 70 or more observations for corn while the other half ranged from a low of 41 to high of 68. For soybeans, 4 states had at least 70 observations while the other six in the study had the number of observations ranging from 34 to 65. These tables show the results of all the regressions for corn, soybeans, and wheat respectively – again using county level data, with the results below only reporting the subsidy variable.

Table 8. Subsidy Coefficients from Regression Results

State	Δ ln(Premiums)	Δ ln(Prem/ Acre)	Δ ln(Liabilities/ Acre)	Δ ln(Acres)	Δ ln(Buy-up Acres)
			Dependent Variable		
			Corn		
IN	1.12***	0.91***	-0.42***	0.21	0.26
NE	1.13***	1.08***	0.14	0.05	0.11
IA	1.02***	0.93***	-0.20	0.08	0.16
KS	0.98***	0.99***	0.22	-0.002	0.06
IL	0.95***	0.83***	-0.29**	0.12	0.08
			Soybeans		
IA	1.27***	0.86***	-0.53***	0.42***	0.59***
IN	1.08***	1.02***	-0.05	0.06	0.19
MN	1.00***	0.83***	-0.09	0.14	0.18
IL	0.92***	0.92***	-0.13	-0.004	0.27**
			Wheat		
KS	1.12***	0.93***	-0.10	0.20	0.24
TX	0.76***	0.84***	-0.07	0.13	0.17

***Denotes significance at the 1% level; ** at the 5% level

Again, the patterns remain the same at the state as they exhibited at the other levels of aggregation, with the total premium measures typically changing the most when subsidies changed, with liabilities per acre often negative, and the acre measures showing small coefficients and tending to be statistically insignificant, suggesting small effects if any.

Recall that the states shown above are those with more observations – these states tend to have more production of the commodity and are found in the heart of major production areas in the country for their respective crops. For example, Kansas is in the heart of the wheat belt, while Iowa represents the heart of the corn belt, and so on. As a result, it is more likely that producers in these states would exhibit more similar behavior than those producers found in less agriculturally dominant states, despite growing different crops. And this is borne out in the results in table 8 – most of the coefficients look quite similar to each other across the states and crops. Kansas wheat and IN corn are particularly close across the board, for example. The variation in coefficients seen at the regional level is, in contrast, greater – likely due to the inclusion of a wider range of states.

Liabilities per acre typically appears to command a negative sign, suggesting that the subsidies may have encouraged those with lower liabilities per acre to participate in the crop insurance program, driving down the average liability per acre. However, note that most of these coefficients remain statistically insignificantly different from zero and the coefficients remain, for the most part, below 0.2 in magnitude, suggesting a fairly strongly inelastic response to the change in subsidies.

While most of the acre coefficients remain statistically insignificantly different from zero, most command positive signs. In a couple states (KS corn and IL soybeans), the coefficient on the number of acres of crop insurance appears to have decreased (negative sign on the coefficient). These coefficients have been quite small (-0.002 or smaller), suggesting that the actual effect of subsidies in these states on the number of acres enrolled in the crop insurance is close to zero. Moreover, the elasticities for buy-up acres remains positive across all states, suggesting that the subsidies may have caused an overall shift towards more land enrolled at higher levels of coverage.

Implications

Policymakers have proposed changing subsidy levels for crop insurance either to make the program more efficient and to generate savings, or to increase the program scope and increase the importance of the crop insurance program, making it the primary Farm Bill safety net for producers. For example, the President's budget called for cuts in premium subsidies for all policies subsidized over 50 percent and an additional cuts for those revenue programs with harvest price options. Alternatively, Congressional proposals tend not to introduce cuts and the latest Farm Act actually increased the budget for the Federal crop insurance program. If budgets and/or policies concerning subsidies change, it will be important for program managers and policymakers to understand how this will affect the program, its budget, and the outcomes that producers will face. Many new programs that interact with crop insurance have come into being and those attempting to understand how the programs will interact with crop insurance means understanding how growers respond to potential changes in the crop insurance program.

If increasing the scope of the program is of interest to program managers and policymakers, results suggest that drawing in acres previously not enrolled in crop insurance may be prohibitively expensive. The highest coefficient found for acreage enrollment was 0.46 for the Lake States producers growing soybeans. Even though this was the largest coefficient, it lies well below the unit elastic mark, suggesting that a considerable increase in subsidies would need to take place in order to achieve high levels of additional enrollment, since for every one percent increase in the subsidies per acre would only induce a 0.46 percent increase in acreage enrollment. On the flip side, this suggests that cutting subsidies may not alter acreage enrollment substantially, although it would appear to have a more substantial effect on the level of coverage selected by producers on the acres that remained in the program.

To explore these ideas in a bit more detail, table 9 contains estimated responses to a theoretical 5 percent change (in this case increase, but since it is linear in nature, the magnitude could be thought of as a decrease if this were a cut instead) in subsidies. The estimates provide a "national" picture of how producers would react to such a change regarding the levels of total premiums, liabilities, and acres enrolled.

Table 9. Estimated Response to a Theoretical 5 Percent Change in Premium Subsidies, evaluated at 2012 levels

	Total Premiums ($M)	Premiums/Acre ($/acre)	Liabilities/Acre ($/acre)	Total Acres (1,000s)	Acres Buy-Up (1,000s)
			Soybeans		
2013 Totals	*2,492*	*36.94*	*412.02*	*67,459*	*64,428*
5% Change	138	1.68	2.06	708	999
			Corn		
2013 Totals	*4,685*	*55.27*	*666.28*	*84,770*	*81,571*
5% Change	237	2.54	5.00	466	1,264
			Wheat		
2013 Totals	*1,981*	*40.78*	*241.59*	*48,585*	*45,891*
5% Change	52	1.55	0.12	-437	-665

Note that these estimates are roughly linear in nature in a neighborhood around the measures of participation, so a 5% change in subsidies would have roughly 5 times the change in crop insurance participation as would a 1% change in subsidies. However, due to the nonlinearities in the log-log specification, these estimates only hold for relatively small neighborhoods around the values being examined. For example, while relatively confident in an estimate of a 5% increase (to the extent we can be confident of any results of course), estimates for larger changes would be considered less reliable.
This table uses nationwide data from the RMA Summary of Business for total premium, liability, and acreage levels for Crop Year 2013 as of March 17, 2014 to construct the estimates above.

For example, if policymakers wanted to increase the scope of the program by introducing a 5 percent increase in the subsidies per acre, soybean producers in the states examined would demand 138 million dollars more in total premiums while increasing total liabilities per acre by roughly 2 dollars and would demand coverage for 708 thousand more acres than otherwise. For corn, a 5 percent increase in subsidies per acre would increase total premiums by 237 million dollars and total acres enrolled by 466 thousand. However, to put this in perspective, these seemingly large changes are relatively small compared to total demand. For example, total premiums for corn producers totaled over $4.5 billion in 2013, while total acres enrolled came to almost 85 million acres.

Wheat producers would also be affected, demanding policies worth 52 million dollars more although results suggest that these farmers would decrease the acres enrolled by 437 thousand. Again, while this is a seemingly large number, it results from a rather large increase in the subsidy per acre rate and total wheat acres enrolled exceed 48 million, making the change a change of less than 1 percent of total acres for the 5 percent change in the subsidy. Also note that the estimated change in total acres is not statistically significantly different from zero.

Again, these show that changes in subsidies do not have a large effect on acreage enrollment in the program. Presumably because the bulk of acres used to plant corn, soybeans, and wheat are already enrolled in crop insurance, the cost of inducing those growers who are not already enrolled in the program to participate is relatively high and may not be cost effective. This also suggests that cutting costs by reducing subsidy rates may not have a large effect on acreage enrollment. However, the effect of subsides on enrolling acres in higher levels of coverage does appear to be more sensitive to the subsidy rate, and cutting subsidies may cause producers as a whole to rely less on the crop insurance program for risk management purposes.

Recent Events

This study explores how changes in the price of crop insurance affect producers' demand, treating the 2008 Farm Act as an experiment. The new Farm Act in 2008 provided producers with increased subsidies for those who chose to use enterprise units as part of their insurance policy. However, in this time frame, many of the programs had continued from the previous Farm Act, suggesting growers had a wide variety of programs available to them to help them face the many risks associated with agricultural production. With the advent of the 2014 Farm Act, many of the traditional Title I programs have been whittled back or eliminated (e.g., Direct Payments, the ACRE program, and the SURE program have all been repealed and/or not reinstated) while the focus has been placed directly on the crop insurance program – and even some of the programs in place currently work with the crop insurance program (e.g., Agriculture Risk Coverage, Supplemental Coverage Option, and the Stacked Income Protection Plan). Even before the 2014 Act was put in place, crop insurance was becoming a pivotal program for producers. In fact, despite the major drought of 2012, Congress did not deliver any *ad hoc* disaster assistance legislation to support farmers, likely because 84 percent of all cropland was covered by crop insurance policies with the vast majority of that acreage in buy-up coverage. In contrast, a mere 8 years earlier in 2000, only about 60 percent of all acres planted were covered with crop insurance with less than half of those acres covered with buy-up.

The heavier reliance on the crop insurance program suggests that the estimates found in this report may reflect an upper bound on producers' responses to changes in the price of insurance. Therefore, if premium subsidies were to be altered, the overall producer response may be less than that suggested in this report. If so, to induce changes in producers' responses, it may require even larger changes in the subsidies offered.

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