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# The Demand for Crop Insurance: How Important are the Subsidies?

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**Abstract:** In 1994, some 56 years after initial authorization, the Federal crop insurance program remained characterized by low enrollment levels. Many argued for increased coverage and subsequent major pieces of legislation in 1994, and 2000 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 ascribed to the levels of subsidies offered to producers. How important are the subsidies, and what might happen to enrollment if support for subsidies were to change? This draft shows that between 1997 and 2002, premium 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 did little to alter the demand for insurance as subsidy changes did not appear to change the demand for crop insurance uniformly across either crops or locations.

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The views expressed are those of the author and should not be attributed to the Economic Research Service or USDA.

## **Introduction**

Over the last 20 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) reaching just under 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. Over this time frame, total subsidies had grown to just under 7 billion dollars. These premium subsidies appear to be one of the major reasons for this change in participation.

In 2013, fiscal concerns are at the forefront of public discussion as the first round of budgetary cuts of the Budget Control Act of 2011 is currently being implemented. While a Farm Bill has yet to be passed, legislators continue to work on the successor bill to the Food, Conservation, and Energy Act of 2008, with a continuing dialogue on the sequestration process. Substantial changes have been proposed for Title I support programs including proposals to eliminate ACRE, the Direct and Counter-cyclical (DCP) program, and SURE. Some provisions call for new shallow-loss programs that would supplement the crop insurance program by helping producers cover their deductible. Other proposals include reducing crop insurance subsidies and lowering the amount paid to insurance companies in efforts to save \$4 billion over 10 years (Nixon, 2013). Still others propose reductions in the level of subsidies available to farmers with an adjusted gross income above \$750,000 and capping premium subsidies at

\$50,000 per recipient (Coburn-Durbin Senate Amendment 953 and Shaheen-Toomey Senate Amendment 926).

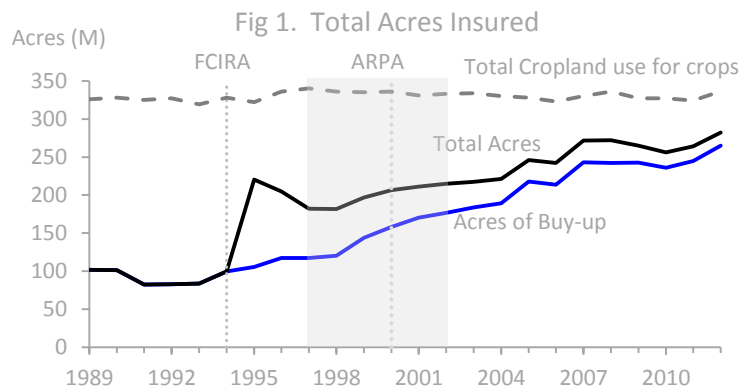
Such changes to the farm programs and federal crop insurance program raise many questions for policymaking. For example, what would happen to producer enrollment in the federal crop insurance program if the subsidies for premiums were cut?

Previous work has studied how the quantity demanded of crop insurance varied with changes in the price of participation. However, the bulk of this work has focused on years prior to 2000 (i.e., prior to the implementation of the Agricultural Risk Protection Act [ARPA] and many of which were prior to the implementation of the 1994 Federal Crop Insurance Reform Act [FCIRA]) to better understand the low participation in the crop insurance program. Many of those studies found that the quantity demanded of crop insurance was not affected much by the level of crop insurance premiums or premium rates (Shaik et al., 2008; Goodwin et al., 2004; Serra et al., 2003; Coble et al., 1996; Goodwin, 1993; Gardner and Kramer, 1986).

Many of these findings may be attributed to the problem of adverse selection – 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). Researchers posited that adverse selection in the federal crop insurance program prior to 1995 created a pool of insured individuals that then caused the premium rates to increase (particularly if actuarially fair since indemnities continued to be paid out). Higher premium rates made it more expensive for other farmers to participate and effectively priced them out of the program. That essentially created a downward spiral as prices continue to escalate and farmers continue to leave the program; eventually the program would cease to exist without some outside (in this case, federal) support. 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 CAT policy—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).

Between 1997 and 1998, enrollment remained relatively constant with some minor shifts in the overall enrollment portfolio. While the total acreage enrolled decreased by just over a quarter million acres, buy-up acreage increased by more than 2 million acres. Late in 1998 after most, if not all, producers would have had to make their crop insurance enrollment decisions, the federal government introduced a premium reduction program that would reduce producers' premiums by an additional 25 percent (Babcock and Hart, 2005). Due to the late

implementation, this had a minor (if any) effect on crop insurance participation. This program was once more implemented in 1999, again late in the crop insurance sign-up period (Babcock and Hart, 2005). This time, the 25 percent reduction in premiums appears to have induced a large increase in enrollment. Acres enrolled jumped from 182 to 197 million acres and the shift from CAT to buy-up policies continued with an increase of 24 million acres in buy-up. In contrast to the low buy-up levels in 1995, acres covered with a buy-up policy now accounted for roughly 73 percent of all acres enrolled.

In 2000, Congress passed the Agricultural Risk Protection Act (ARPA) which codified these *ad hoc* premium reductions 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 jumped to 217 million acres, with nearly 85 percent of them covered by buy-up policies.

New premium rates and surcharges were introduced in 2003 and the program continued to evolve over the years with the introduction of new types of insurance and expanded coverage to include more crops (Babcock and Hart, 2005). By 2012, producers had enrolled 282 million acres, representing roughly 84 percent of all cropland used for crops. 265 million of these enrolled acres were covered by buy-up policies, 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 posit that “[i]t is likely that most crop insurance products would not exist in the absence of subsidies.”

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. Following up on that logic, a working paper by Babcock and Hart (2005) examined the effect of subsidy rates (as opposed to either premium levels or premium rates) on the level of enrollment for revenue and yield policies. They based their study around ARPA and 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.

The current paper follows this line of research 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, producers in the late 1990s and early 2000s operated in a much different environment than those who operated in earlier years. Policy changes abounded and the crop insurance program underwent multiple significant changes. This study aims to update earlier studies and attempt to cast the findings in the light of today's policy environment where the tools farmers have to manage risk have evolved.

## **Who Uses Crop Insurance?**

When the federal crop insurance program was started in the late 1930s, policymakers aimed the program at wheat production, the largest crop in terms of acreage being grown at that time. Today, producers of corn, soybeans, and wheat—the three largest crops produced in the U.S.—are the largest consumers of crop insurance. Together, these three crops accounted for 80 percent of all acres enrolled in the program in 1997. Including cotton and sorghum raised the level to nearly 90 percent of all acres enrolled. Over time, with new types of policies being offered and the inclusion of more crops into the program, the share of acres enrolled by these major crops fell as participation in the federal crop insurance program continued to increase. By 2012, corn, soybeans, and wheat made up roughly 68 percent of all acres enrolled, increasing to 75 percent when including cotton and sorghum (see table 1).

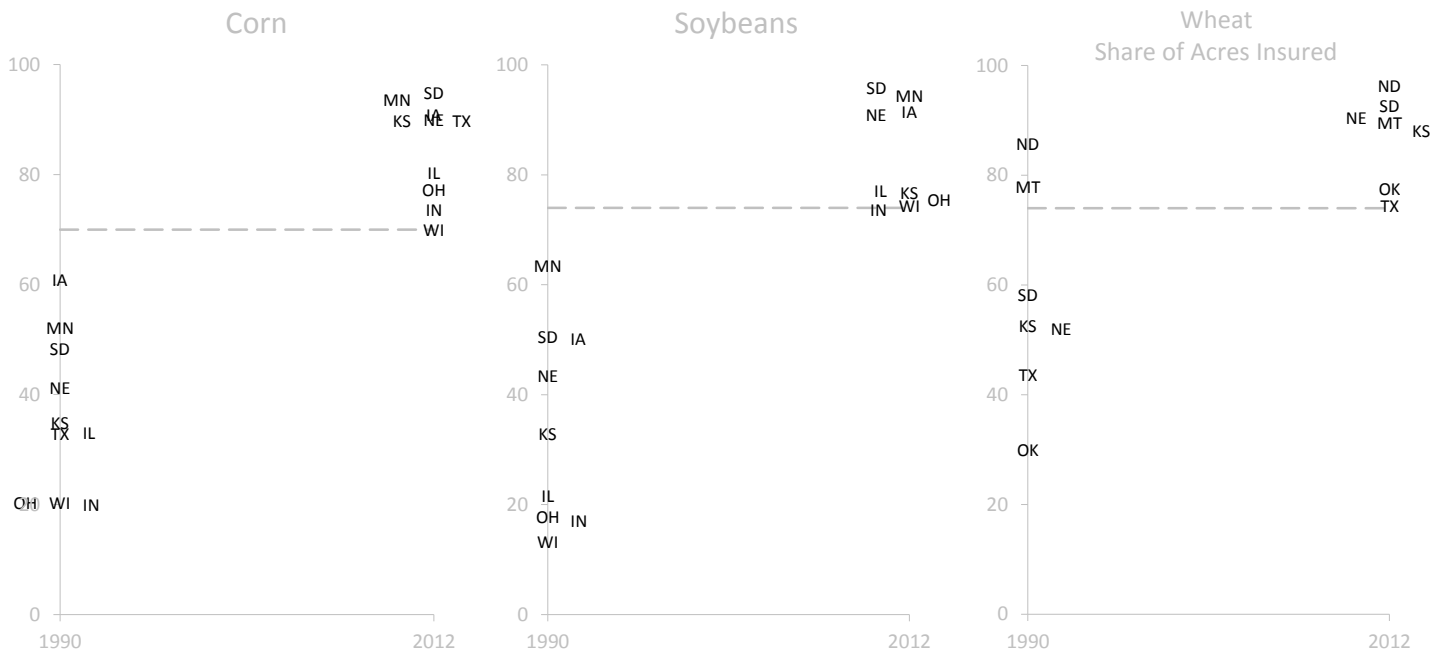
Across states, the share of land enrolled in crop insurance varied widely (see fig. 2 for a view of 1990 and 2012 shares of insured acres by crop. Note that fig. 2 only uses 1990 and 2012 shares – the endpoints – this is to highlight the changes from 1990 to 2012; actual changes varied from the straight line depicted – in some instances dramatically, but here the emphasis is placed on the difference between the starting and ending points and being able to make general comparisons across states and crops). For example, in 1990, producers in Iowa enrolled more than 60 percent of all corn acres into the program. By 2012, that share had jumped to 91 percent. In contrast, producers in Indiana were slower to participate, enrolling only 20 percent of their acres in 1990 and reaching a high of less than 74 percent by 2012. Of the states examined, only Wisconsin enrolled a smaller share of acres (just over 70 percent in 2012). Of the states examined, producers in Minnesota and South Dakota had the highest level of participation, covering roughly half of all corn acres in 1990 and reaching nearly 95 percent by 2012.

Table 1. Changes in crop insurance enrollment over time

Year	Total	<i>Acres Enrolled (millions)</i>		<i>Share of total planted</i>	
		Corn	Soybean	Wheat	Share of top 3 crops
1990	101	26 <sub>35</sub>	17 <sub>29</sub>	36 <sub>47</sub>	78
1997	182	49 <sub>61</sub>	44 <sub>63</sub>	51 <sub>73</sub>	79
2002	215	59 <sub>75</sub>	56 <sub>76</sub>	46 <sub>77</sub>	75
2012	283	81 <sub>84</sub>	65 <sub>84</sub>	47 <sub>84</sub>	68

Source: Risk Management Agency, Summary of Business, 1990, 1997, 2002, 2012

Figure 2. Share of Acres Insured in 1990 and 2012



Source: Calculations based on data from the Risk Management Agency, Summary of Business Files, 1990 and 2012

This figure depicts the change in the share of acres insured from 1990 to 2012 for the states examined in this report. Not all the labels are on the axes where their true values lie – they have been “jittered” to allow the reader to read them. Note the wide range of insurance adoption across states in 1990. By 2012, the range is substantially narrowed. The dotted line depicts the share of acres insured of the state with the lowest share in 2012 to enable comparisons to the shares adopted in 1990. Of the states examined, in 1990 almost all the states had at least 40 percent of their wheat acres insured while more than half of the states had less than 40 percent of their corn and soybean acres insured. By 2012, all states had at least 70 percent of their respective crops insured.

In general, producers appeared more likely to enroll their corn acres than their soybean acres in the earlier years covered in the figures. Soybean coverage exhibited a larger degree of variation, with Wisconsin farmers covering just over 20 percent of their soybean acres in 1990 while South Dakota producers covered almost half of their acres. By 2012, however, the pattern of coverage appears to have converged to the pattern seen with corn, suggesting that farmers began to use the crop insurance program much more rigorously than previously.

Wheat producers appeared to fall between corn and soybean farmers in terms of enrolling their acres. For example, in the Plains states in 1990, Kansas producers covered 53 percent of the wheat acres planted with crop insurance policies. By 2012, 88 percent of all wheat acres were covered under an insurance policy.

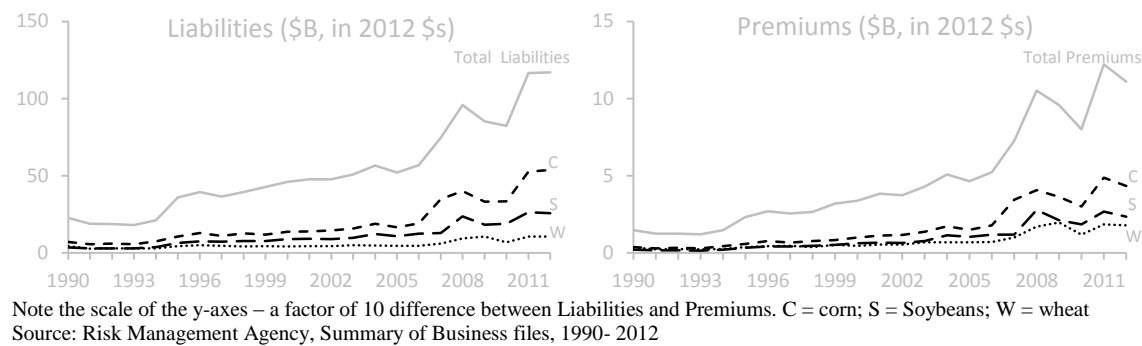
Producers in North Dakota, in contrast, appear to have taken advantage of crop insurance to a greater degree. In 1990, 86 percent of all wheat acres planted were covered and by 2012, producers insured 96 percent of all wheat acres in North Dakota.

Overall, producers have more heavily invested in crop insurance. Among the states examined, the share of insured acres has grown considerably. For corn, the lowest share of acres insured within a state rose from roughly 20 percent of all acres to 70 percent. For soybeans, the lowest share rose from approximately 15 to almost 75 percent, and for wheat, the share rose from nearly 30 percent to roughly 75 percent.

However, the share, or even number of acres enrolled, is not the only way that participation in the crop insurance program can be measured. 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



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

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

The most commonly used variable in previous studies, total acres enrolled, measures how much land producers have covered under the crop insurance program. While a valid measure, one problem with this measure is that the land quality is not taken into account. 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 Illinois where the growing season is much more consistent over time (and this appears to be supported by the data). 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. Clearly the program is being used differently in all three scenarios, but the acre measure cannot discern between the three different uses.

Therefore, while this measure is worth using, it is important to note its shortcomings and explore other measures as well. A related measure is the number of acres insured with buy-up coverage. This also suffers from the land quality critique, but begins to parse out the intensity of use by focusing 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). This measure still cannot measure the intensity of use within the buy-up category, but does separate out those only using CAT.

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.

The last measure, the level of total liability, 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 total premiums 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, total premiums rise at different rates than liabilities.

Note that these last two 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 2002 prices so that if the value of total 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, since they are all valued in 2002 dollars.

Moreover, once the price movements are taken into account, these last two 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. This means that, despite the fact that during the timeframe of this study the insurance program changed its focus from providing primarily yield based policies to providing mostly revenue based policies, since all policies are priced actuarially fairly, we can use the value of the policies (priced in 2002 dollars) as an accurate measure of the quantity demanded of crop insurance.

### *The Importance of ARPA*

To understand how prices affect the quantity demanded of crop insurance, it is necessary to generate a causal link between prices and demand. First, this necessitates finding variation in prices. With respect to the federal crop insurance program, by law the prices are set to maintain actuarial fairness and, as a result, the underlying pricing mechanisms do not change much over time. Correlational studies, such as those that use cross-sections (e.g., examining farmers in different states in a single year), have difficulty making this link because everyone faces the

same underlying prices (adjusted for risk), so the connection between prices and quantity demanded cannot be examined. Therefore, this study exploits the variation in prices due to a change in policy that introduced a price change through subsidization of the total premiums. Second, since this study uses the introduction of the premium subsidies as the source of price variation, it becomes necessary to carefully examine the relationship between the demand for crop insurance and the level of subsidies to determine appropriate causality. For example, if we see a change in subsidy levels, is this due to the policy change or is it possibly due to a change in demand (or even commodity prices) unrelated to the new policy? Without a causal analysis, there can be no understanding of how legislation might affect outcomes.

The change in policy explored for this study comes from the introduction of ARPA which increased the subsidy rates of crop insurance policies (table 2). Subsidy rates jumped, causing crop insurance to become cheaper for producers, with the largest jumps coming at higher levels of coverage. For example, while subsidies increased by 12 percentage points for coverage at 50 percent of yields and 100 percent of prices, it increased by 31 percentage points for coverage at 75 and 80 percent of yields and 100 percent of prices. Although this took place in 2000, over ten years ago, it remains the most recent direct, across the board change to premium pricing for which data are available (in 2008, enterprise unit premium subsidies were increased, which represents a new type of policy that lowered premiums for a subset of policies, and provides another avenue to explore subsidy changes, it does not apply to all producers and policies; and in 2012, RMA adjusted premiums for a number of crops in certain parts of the country provides another good experiment to explore, but the data are not yet available to analyze). Furthermore, few, if any, studies exist exploring the effect of ARPA on the quantity demanded of crop

insurance. The literature remains rather dated, making the exploration of ARPA an advance in our knowledge on how subsidies affect crop insurance demand.

Table 2. Subsidy levels pre- and post-ARPA for varying yield coverage levels at 100 percent of price coverage, (%)

<i>Cov. Level</i>	50	55	60	65	70	75	80	85
Pre-ARPA	55	46	38	42	32	24	17	13
Post-ARPA	67	64	64	59	59	55	48	38

Note: While this table shows subsidy levels for a yield-based coverage, ARPA required that the premium subsidy for other policies, such as revenue insurance, will generally be equal to those shown above.

Source: Kelley, 2001

ARPA represents a policy change that has the potential to affect all producers. This allows for the examination of how the quantity of crop insurance demanded actually changed by measuring the change in quantity demanded in relation to the change in subsidies across the country. Not surprisingly, the change in quantity demanded varied for different crops and across regions. Regression analysis is used to explore this issue.

## 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 model is estimated for each crop and state that examines changes over time using two periods, one before the 2000 introduction of ARPA using 1997 data and one after ARPA, using 2002 data. For each crop-state combination, the model relates the change in a measure of crop insurance demand,  $\Delta Y_c$ , for county  $c$  to a set of variables including  $\Delta S_c$  that

measures the change in subsidy, a set of county-specific time-varying controls, and a set of regional-fixed effect controls described below.

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

$\Delta Y_c$  represents the change in crop insurance demand from 1997 to 2002, measured one of four ways: total premiums, total liabilities, 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).  $\Delta S_c$  denotes the change in subsidies brought about by ARPA. This is measured as total subsidies divided by total enrolled acres to get a county average per-acre subsidy rate for both 1997 and 2002, which is then differenced. Both of these sets of variables are first logged and then differenced, meaning that the coefficient on  $\Delta S_c$  can be interpreted as an elasticity.

$\Delta X_c$  contains controls that vary over time, including the 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, all in 2002 dollars, 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 affairs 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 2002 (relative to how the returns moved in the years leading up to 1997), producers may view crop insurance more favorably in 2002 and may be more likely to enroll in crop insurance in 2002 versus in 1997 (and vice-versa). Similarly, how producers fared in 2001 versus 1997 may affect crop insurance enrollment in 2002 versus 1997. For example, suppose producers experienced losses in both 1996 and 2001. This suggests that the actual revenues in both years lay below the expected revenues. If the difference between actual and expected revenues was greater in 2001 than in 1996, we might

expect more producers to enroll in crop insurance in 2002 than in 1997 simply due to the fact that they experienced higher losses in 2001 than in 1997.

Time invariant county level controls are included in the vector  $Z_c$  to control for cross-sectional variation in crop insurance demand unrelated to changes in the subsidy levels. Controls include the median land in farms to capture a measure of farm size, the median age of farmers and the square of the median age of farmers to capture potential risk averseness that may differ with age, the total acres run by female operators to control for the potential that males and females react to risk differently, and the mean, variance, and coefficient of variation of yield histories for each county, detrended and normalized to a base year's (2002) yield of the relevant crop to capture differences in the potential riskiness of the crop across space (more details lie below). All of these variables are measured at the county level.

The regression analysis also includes regional fixed effects 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, variance, and coefficient of variation of yield 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.

As mentioned earlier in the report, 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. However, this study

explores a timeframe that falls within the framework of a single farm bill, meaning these programs do not meaningfully change over the span of the study. As a result, if the programs were controlled for, 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 1996 to 2002 poses a problem because this subsidy rate is defined in part by the policy the producer chooses to select. In other words, it is endogenous and this variable likely will be correlated with the error term, resulting in biased coefficient estimates. Furthermore, it is not clear from this specification how causation runs. 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 1996 to 2002 with the change in subsidies from 1995 to 2001 allows me to both deal with the endogeneity problem as well as provide a clear path of causation. By the time the decision to purchase crop insurance rolls around for crop year 2002, the decision has obviously already been made for the past (2001) crop year. Therefore, the

decision for the 2001 crop year, and its change from 6 years previous (1995), can be considered exogenous to the decision about the quantity demanded of crop insurance in 2002. Furthermore, since this instrument is based on historical data, it is clear that the quantity of insurance period of interest purchased in 2002 (and its change from 1996) cannot have an effect on the change in the quantity demanded between 1995 and 2001. 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  $\Delta S_c^{IV}$  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 2002. 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), to the north in the Lake States (MN and WI), and in the Southern Plains (TX). Together, these 10 states included the top eight states (and ten of the top 12) in 1996 in terms of planted acres of corn, covering roughly 78 percent of all acres planted to corn and accounting for approximately 82 percent of all corn production. For consistency, the same states were used for soybeans with the exception of TX which did not produce substantial levels of soybeans in enough counties to warrant inclusion. These 9 states covered roughly 70 percent of planted acres and close to 75 percent of all soybean production. For wheat, the states included Northern Plains states (KS, NE, ND, and SD), a Lake state (MN), a Mountain state (MT), and Southern Plains states (OK and TX). Altogether, these 8 states included the top 6 states (and 8 of the top 10) in 1996 in terms of planted acres of wheat, capturing roughly 73 percent of all planted acres and approximately 60 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 RMA

administrative data. 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 1996 levels of total premiums, liabilities, and subsidies were multiplied by the ratio of 2002 expected prices and yields (i.e., expected revenues) to 1996 expected revenues (akin to putting everything in 2002 real terms).

The median land in farms, age of farmers, and the total acres run by female operators all come from county level summary statistics based on the individual level 1997 Census of Agriculture. These variables control for cross-sectional heterogeneity across counties, and are not measured as differences (for example, the age of the operator, if differenced, would simply become a constant of 5 since 5 years lie between 1997 and 2002; however, if older producers react differently to risk than younger ones, counties with different aged populations may obtain different outcomes).

Changes in the acres planted to the relevant crop come from planted acres data collected by the National Agricultural Statistics Service (NASS) for the years 1996 and 2001. Lagged years of these variables were used to ensure the exogeneity of the independent variable.

The mean, variance, and coefficient of variation of the yields are calculated using NASS yields collected from 1975 through 2002. For each county, yields are first detrended using a simple linear model, regressing the 27 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 regression in the following manner:

$$(2) \quad \bar{y}_t = y_{2002} * \left(1 + \frac{e_t}{y_t}\right)$$

where  $\bar{y}_t$  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 27 years' worth of data, equation (2) generates 27 normalized yield observations for each county, allowing us to calculate a separate mean, variance, and coefficient of variation for crop yields for each county.

The three-year returns to crop insurance variable was constructed by dividing the indemnities by the premium paid by the producer for each insurance plan for the relevant crop and summing them together, weighted by their share of total acres enrolled in each plan. This is done for each of the three years preceding 1997 and 2002 (e.g., for 1997, the years 1996, 1995, and 1994 were used). The returns for the three years were then averaged to obtain two, three-year average returns to crop insurance for each crop in each state (one for the years leading up to 1997; a second for the years leading up to 2002). These were then differenced and used in the regression.

Finally, if a producer experienced a loss in the year prior to that examined, they may be more inclined to enroll in crop insurance in the following year. To observe this over time, if a farmer fared worse in 2001 relative to 1996, they might find crop insurance more attractive in 2001 than in 1997. Therefore, to construct such a variable, the actual and expected revenues were calculated for 1996 and 2001. 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 1996 and 2001, they were differenced. Call the difference the gain/loss for the year. The resulting gain/loss for 1996 was then subtracted from that of 2001 to obtain a measure of relative gain/loss over time.

### Summary Statistics

The data in this study has been cut several different ways – exploring the entire dataset which includes all three crops (corn, soybeans, and wheat) across all the states examined, it also includes exploring the three crops separately while including all the states relevant to the analysis, and finally it includes a state-by-crop analysis. This means that 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. This will provide a general sense of the data.

Table 3. Summary Statistics for All Variables

Variable Name	Description	Mean (Std Dev)	Min	Max
$\Delta \log(\text{croprate9601})$	Change in log of crop subsidy/acre between 1996 and 2001	0.49 (0.27)	-1.1	1.5
$\Delta \log(\text{croprate9702})$	Change in log of crop subsidy/acre between 1997 and 2002	0.52 (0.27)	-1.4	2.2
$\Delta \log(\text{totprem\_acre})$	Change in log of the total premium/acre	0.81 (0.95)	-4.4	7.2
$\Delta \log(\text{liab\_acre})$	Change in log of the total liability/acre	0.38 (0.25)	-1.4	2.4
$\Delta \log(\text{ins\_acres})$	Change in log of total insured acres	0.22 (0.80)	-4.8	5.7
$\Delta \log(\text{ins\_acres65})$	Change in log of buy-up acres	0.61 (0.92)	-4.6	7.8
$\Delta \log(\text{3yr\_return})$	Change in log of 3 year returns to crop insurance	0.10 (1.09)	-4.3	4.9
med_lif	Median land in farms in county	398 (431)	25	5,109
med_age	Median age of farmer in county	52 (2.7)	44	64
tot_femacres	Total number of acres run by female operators in county	15,060 (24,733)	475	525,365
irr	Dummy variable for whether acres are irrigated or not	0.26 (0.44)	0	1
rev_diff	Expected revenues minus actual revenues, differenced between 2001 and 1996	18 (48)	-286	212

Starting with the cross-sectional control variables, the median land in farms in the county for this set of data was 398 acres, with a minimum of 25 and a maximum of over 5,000. The median age of the farmer was 52 years, with a minimum of 44 and a maximum of 64 for these crop farms. The average number of acres run by female operators was just over 15,000 in a county, however at least one county had over 500,000 acres run by female operators. Roughly one quarter of acres of corn, soybeans, and wheat in this dataset was irrigated.

Expected revenues minus actual revenues provides a sense of how the farmer fared compared to how he expected to fare. This change over time shows that producers in 2001 did better than in 1996 on average, although some clearly did worse evidenced by the minimum score of -286. The change in the log of the overall subsidy per acre (combining corn, soybeans, and wheat) showed a positive change for 1996-2001 as expected, a change that was only slightly smaller than that of the 1997-2002 time frame. The change in the log of the total premium per acre was the largest of the four main dependent variables measuring the change in quantity demanded of crop insurance, followed by that of buy-up acres, liability, and finally, total acres. The change in the log of the 3 year returns to crop insurance showed a small increase from 1996 to 2001, suggesting that crop insurance had become, at least marginally, more attractive to producers.

Because some of these summary statistics don't mean a whole lot when combining corn, soybeans, and wheat all together (for example, subsidy per acre or variables such as the mean and variance of the crop yields), tables A1, A2, and A3 contain further summary statistics for the individual crops in the appendix.

## **Results and Discussion**

Changes in subsidies enacted through ARPA appear to have changed the quantity demanded of crop insurance, particularly at the higher levels of coverage. However, results do appear to differ across space. Given the number of regressions run, not all the results are contained in tables in this paper. The first couple of tables show the different methods being used for a single state, to get a sense for how the results differ by specification. Table 4 shows the results for Iowa corn, examining total premiums as the dependent variable. This table contains results for four specifications – two using ordinary least squares (OLS), both with and without regional level fixed effects, and two using the instrumental variables technique, relying on a nonlinear two-stage least squares methodology again with and without fixed effects.

Table 4. Regression Results for IA Corn

Variable	Dependent Variable = $\Delta \ln(\text{Premiums})$			
	OLS, no FEs	OLS, FEs	2SLS, no FEs	2SLS, FEs
$\Delta \ln(\text{subsidy/acre})$	1.12*** (0.19)	1.13*** (0.19)	1.40*** (0.24)	1.42*** (0.25)
$\Delta \ln(\text{corn acres})$	0.21 (0.76)	0.05 (0.88)	-0.25 (0.78)	-0.33 (0.89)
3-yr avg. Return to Insurance	-0.07 (0.08)	-0.12 (0.09)	-0.07 (0.08)	-0.14 (0.09)
Median Land in Farms	-0.002 (0.001)	-0.001 (0.002)	-0.002* (0.0014)	-0.002 (0.002)
Median Age	-0.06 (0.07)	-0.80 (0.98)	-0.11 (0.07)	-0.99 (1.00)
(Median Age) <sup>2</sup>	0.001 (0.001)	0.01 (0.01)	0.0017* (0.001)	0.01 (0.01)
Total Acres on Female-run Farms	2E-6 (2E-5)	-1E-6 (2E-5)	1E-6 (2E-5)	-7E-7 (2E-5)
Irrigated Dummy	0.20 (0.15)	0.17 (0.15)	0.29* (0.15)	0.25* (0.15)
Var	0.01* (0.005)	0.002 (0.007)	0.01** (0.005)	0.003 (0.007)
Mean of Yield	-8E-4 (3E-4)	0.0002 (0.0004)	-0.0001 (0.0003)	0.0003 (0.0003)
Variance of Yield	0.001 (0.003)	-0.001 (0.003)	0.002 (0.003)	-0.001 (0.003)
Revenue Difference	-0.004 (0.005)	-0.003 (0.005)	-0.005 (0.005)	-0.005 (0.006)
$\Delta \text{Yield:Rev Ins Ratio}$	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Corn:Soy Ratio	No	Yes	No	Yes
Regional FE's	200	200	200	200
N	0.39	0.40	0.19	0.11
Adj. R <sup>2</sup>				

\*\*\* denotes statistical significance at the 1% level; \*\* denotes statistical significance at the 5% level; \* denotes statistical significance at the 10% level

The most statistically significant variable is that of the change in the per-acre subsidy. It is positive and, since both it and the dependent variable (total premiums) are in logs, represents an elasticity of demand. Since the coefficient is above one, it suggests that in Iowa the quantity demanded of crop insurance, as measured by the total premium, is price elastic. A one percent change in the price of crop insurance leads to a 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 Iowa, there were 200 observations and the adjusted  $R^2$  ranged from 0.40 for the OLS specifications down to 0.11 for the non-linear 2SLS specifications. While this seems low, recall that the methods are likely to create low  $R^2$  – because of the differencing that is taking place over a relatively short period of time and because we employ regional fixed effects, both of which work to eliminate variability in the data and lower the overall fit.

Table 5 shows the results using the 2SLS approach and all four of the dependent variables developed for the analysis. Again, the variable most consistently statistically significant is the subsidy/acre variable. It also is consistently positive and for Iowa corn, shows elasticities that differ depending on the dependent variable being examined. As noted above, total premiums appear to show elastic responses, as do the number of acres insured with buy-up coverage. 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. Total liability, on the other hand, will not change nearly as dramatically even when purchasing increased coverage on land previously insured. The number of acres insured and covered with buy-up policies also appeared to respond positively based on the increased subsidies.

Table 5. Regression Results for IA Corn - All Four Dependent Variables

Variable	Nonlinear 2SLS, with FEs			
	Total Premium/Acre	Total Liability/Acre	Acres Insured	Buy-up Acres Insured
$\Delta \ln(\text{subsidy/acre})$	1.42*** (0.25)	0.22*** (0.04)	0.82*** (0.23)	1.13*** (0.25)
$\Delta \ln(\text{corn acres})$	-0.33 (0.89)	-0.05 (0.15)	-0.31 (0.82)	-0.48 (0.88)
$\Delta$ 3-yr avg. Return to Insurance	-0.14 (0.09)	-0.01 (0.01)	-0.15* (0.08)	-0.13 (0.09)
Median Land in Farms	-0.002 (0.002)	-0.0003 (0.0003)	-0.001 (0.001)	-0.002 (0.002)
Median Age	-0.99 (1.00)	-0.06 (0.17)	-0.77 (0.92)	-1.19 (0.98)
(Median Age) <sup>2</sup>	0.01 (0.01)	0.001 (0.002)	0.008 (0.009)	0.01 (0.01)
Total Acres on Female-run Farms	-7E-7 (2E-5)	-2E-7 (4E-6)	6E-6 (2E-5)	9E-6 (2E-5)
Irrigated Dummy	0.25* (0.15)	0.02 (0.03)	0.26* (0.14)	0.39*** (0.15)
Var	0.003 (0.007)	-0.0005 (0.001)	0.0001 (0.007)	-0.001 (0.007)
Mean of Yield	0.0003 (0.0003)	0.00004 (0.0001)	0.0004 (0.0003)	0.0004 (0.0004)
Variance of Yield	-0.001 (0.003)	0.0005 (0.0006)	-0.002 (0.003)	-0.001 (0.003)
Revenue Difference	-0.005 (0.006)	0.001 (0.001)	-0.004 (0.005)	0.001 (0.01)
$\Delta$ Yield:Rev Ins Ratio	-0.01 (0.01)	0.001 (0.002)	-0.007 (0.01)	-0.01 (0.01)
Corn:Soy Ratio	Yes	Yes	Yes	Yes
Regional FE's	200	200	200	200
N	0.19	0.14	0.08	0.12
Adj. R <sup>2</sup>				

\*\*\* denotes statistical significance at the 1% level; \*\* denotes statistical significance at the 5% level; \* denotes statistical significance at the 10% level

Table 6 below shows the results for the entire group of states examined for corn, soybeans, and wheat, focusing only on the subsidy variable. For this specification, crop fixed effects were included to control for combining all three different crops in the analysis.

Table 6. Subsidy Coefficients from Regression Results for Corn, Soybeans, and Wheat, all States

Crop	Dependent Variable			
	$\Delta \ln(\text{Prem/Acre})$	$\Delta \ln(\text{Liability/Acre})$	$\Delta \ln(\text{Acres})$	$\Delta \ln(\text{Buy-up Acres})$
Wheat	1.65	0.05	0.81	0.46
Corn	1.36	0.07	0.62	0.38
Soybeans	0.98	-0.10	0.37	-0.05
All	1.36	-0.01	0.59	0.29

Wheat shows the largest effects across the board for all of the states examined in this paper. The change in total premiums is affected the most, with an elasticity of over 1.6, suggesting that total premiums demanded by producers increased by 1.6 percent for each percent increase in subsidy. Liabilities were much smaller and, in the aggregate, show almost no response to increases in subsidies. Crop insurance liabilities represent the total dollar amount the insurance policy covers when zero yield or revenue occurs while the premium takes into account the probability of a yield or revenue shock. Therefore, liability will not increase at the same rate that the total premium does, and will typically be lower. The elasticity for total acres is also less than one for the three crops, ranging from just under 0.4 to 0.8, meaning a 1 percent change in subsidies would cause an increase of 0.8 percent more wheat acres being covered under some form of crop insurance policy. The coefficient on the buy-up acres tends to be smaller, suggesting that, in the aggregate, the increase in subsidies had a lower effect on causing producers to enroll more acres in buy-up programs.

Looking at all the crops together, the coefficient for total premiums shows the same elasticity as that of corn – a one percent change in subsidies would induce a 1.3 percent change in the quantity demanded of total premiums. The coefficient for liabilities per acre is very close to zero, suggesting little aggregate effect on the demand for increased liabilities. Demand for total acres and buy-up acres insured remains inelastic with a one percent change in subsidies inducing a 0.3 to 0.6 percent change in demand.

The next three tables (7, 8, and 9) explore 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. 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 7. Subsidy Coefficients from Regression Results for Corn

State	Dependent Variable			
	$\Delta \ln(\text{Premiums})$	$\Delta \ln(\text{Liabilities})$	$\Delta \ln(\text{Acres})$	$\Delta \ln(\text{Buy-up Acres})$
TX	2.75	-0.12	2.56	1.18
MN	2.25	0.32	1.25	1.83
WI	1.83	0.50	0.62	1.00
IA	1.42	0.22	0.82	1.13
IL	1.39	-0.67	1.28	-1.52
IN	1.26	-0.28	1.28	0.81
NE	1.19	-0.02	0.39	-0.14
SD	1.19	0.39	-0.01	1.10
OH	1.07	0.25	0.36	0.72
KS	0.09	0.03	-0.82	-0.80

Table 8. Subsidy Coefficients from Regression Results for Soybeans

State	Dependent Variable			
	$\Delta \ln(\text{Premiums})$	$\Delta \ln(\text{Liabilities})$	$\Delta \ln(\text{Acres})$	$\Delta \ln(\text{Buy-up Acres})$
IA	1.95	-0.06	1.20	1.16
SD	1.84	0.33	0.73	0.11
OH	1.68	0.03	0.75	0.34
WI	1.64	0.35	0.64	0.70
IN	1.57	-0.34	1.63	0.68
KS	1.36	0.86	-0.17	1.12
MN	0.41	0.06	-0.17	-0.34
NE	0.24	0.13	-1.09	-0.60
IL	0.21	-0.22	-0.34	-0.58

Table 9. Subsidy Coefficients from Regression Results for Wheat

State	Dependent Variable			
	$\Delta \ln(\text{Premiums})$	$\Delta \ln(\text{Liabilities})$	$\Delta \ln(\text{Acres})$	$\Delta \ln(\text{Buy-up Acres})$
NE	4.13	0.21	2.98	4.13
TX	2.06	0.20	1.11	1.62
KS	1.76	0.42	0.69	1.11
OK	1.76	0.62	0.72	0.34
SD	1.12	0.54	0.47	0.10
MT	0.42	0.11	-0.06	-0.45
ND	-0.42	0.24	-1.67	-0.94

Total premiums typically have changed the most when subsidies changed, followed by acres and buy-up acres. Total liabilities appear to have changed the least when subsidies changed. This suggests that if producers are bringing in new acres while the liabilities don't change much, either the new acres are marginal land, meaning the liability is relatively low, or they are putting the new land under low coverage levels, or both.

Although producers on average tended to participate to a greater extent in the crop insurance program, the degree to which they altered their participation differed across both crop type and location. Moreover, while crop insurance demand generally increased when subsidies went up, for some crops and states, the liability per acre demanded of crop insurance appeared to drop when subsidies increased. Because we are looking at a county aggregate demand, and the regression coefficients represent an average across the state (for the state level regressions) what could be happening is that the addition of marginal land or land with lower coverage levels, while increasing the total amount of land, drives down the liability per acre since this is an average calculated across the various counties within the state.

In a few states, the coefficient on the number of acres of crop insurance appears to have decreased as well. For the most part, these coefficients have been relatively small, generally less than -0.2, suggesting that the actual effect of subsidies in these states on the number of acres enrolled in the crop insurance is close to zero. Also, in a number of states, the elasticity for buy-

up acres is also less than zero. Almost all of these coefficients lie between 0 and -1, suggesting an inelastic response. The sign, however, suggests that in these cases, the increase in subsidies has led to a decrease in top level coverage. In some of these cases, the elasticity for the total acres is positive, suggesting that the subsidies may have caused an overall shift towards more land enrolled at lower levels of coverage. However, in the majority of cases in soybeans and wheat, however, the signs for both acres and buy-up acres is negative. Generally these coefficients are not that large, lying between 0 and -1, but some of them do lie outside this range. It is possible that the change in crop insurance subsidies may be altering the decisions of producers, perhaps inducing them to switch from one crop to another. For example, Nebraska shows a decline in acres covered and in acres covered by buy-up policies for soybeans, but shows large increases in acres covered for wheat. It is possible that producers shifted from covering their soybeans to covering their wheat. Also, note that these coefficients reflect the change in insurance demanded by producers as a result of the change in subsidies – and that this does *not* necessarily reflect the total demand for insurance. Total demand may have increased, but may have increased for other reasons than those studied here. The marginal (not total) effect of the change in crop insurance subsidies, in some of these states for some crops, may have been to decrease the level demanded of crop insurance.

#### *Regional differences (by Crop and State)*

Crop insurance subsidies impacted producers of different crops in various locations in different ways. For example, amongst corn producers, those in Texas responded most heavily to the increased subsidies on 2 of the 4 measures of crop insurance demand used. For these producers, changes in their demand for crop insurance caused their premiums to increase by

almost 3 percent for each one percent increase in the subsidy rate, suggesting that the price of crop insurance mattered to producers in Texas. Given that premiums are set to be actuarially fair, this suggests that the producers in Texas increased the quantity demanded for higher levels of coverage when subsidies increased. Despite this, the level of liabilities per acre of these producers appeared to drop slightly, suggesting the possibility of marginal land or land covered by lower levels of insurance coming into play. The total acres enrolled in crop insurance also increased the most amongst the states examined, while the total acres covered by buy-up coverage was second only to those producers in Minnesota. Kansas corn producers, in contrast, had a very limited premium response to the changes in subsidies – smallest among the states examined. Amongst the soybean producers, Iowa producer showed the largest response to the subsidy changes when examining the total premiums per acre and the total acres under buy-up policies while total acres also had a coefficient above one, suggesting an elastic response and total liabilities per acre remained close to zero. Illinois, surprisingly, had one of the lowest responses to the change in crop insurance subsidies, with small negative responses for 3 of the 4 demand variables.

Nebraska exhibited the largest response to the change in subsidies amongst wheat producers, with an elasticity above 4 for both premiums per acre and buy-up acres. Responses for the change in premiums per acre tended to lie above 1 with the exception of Montana and North Dakota. The coefficients for the liabilities per acre were typically small, and a wide range was exhibited for the change in total acres and the change in acres covered by buy-up policies

### *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 3 percent cuts in premium subsidies for all policies subsidized over 50 percent and an additional 3 percent cuts for those revenue programs with harvest price options. Alternatively, Congressional proposals tend not to introduce cuts. Some language has been proposed to limit the level of subsidies received by an individual producer, making benefits contingent on adjusted gross income, and tying environmental compliance requirements to crop insurance benefits.

Using ARPA as a means to measure farmer responsiveness to changing subsidy rates for crop insurance, the estimated responses can show how the levels of total premiums, liabilities, and acres enrolled might change for both a 1 and a 5 percent change in the subsidy rates (table 10).

Table 10. Predicted Changes to Total Crop Insurance Demand if Changes Were Made to Total Premium Subsidies, evaluated at 2012 levels

	Total Premiums (\$M)	Liabilities (\$M)	Total Acres (1,000s)	Acres Buy-Up (1,000s)
<i>Corn</i>				
<i>2012 Totals</i>	<i>4,330</i>	<i>53,643</i>	<i>81,456</i>	<i>76,115</i>
1% Change	59	38	505	310
5% Change	294	188	2,525	1,548
<i>Soybeans</i>				
<i>2012 Totals</i>	<i>2,351</i>	<i>25,655</i>	<i>65,186</i>	<i>59,621</i>
1% Change	27	-26	241	-33
5% Change	134	-128	1,206	-163
<i>Wheat</i>				
<i>2012 Totals</i>	<i>1,788</i>	<i>10,607</i>	<i>46,545</i>	<i>42,353</i>
1% Change	30	5	377	214
5% Change	148	27	1,885	1,071

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 we would be relatively confident in our estimate of a 1% or 5% cut, or even a 10% cut (insofar as we can be confident of any of our results, of course), we would be more skeptical about our estimate for a 25% and very skeptical about our estimate of change in participation for the effect of a 50% cut in subsidies.

This table uses nationwide data from the RMA Summary of Business for total premium, liability, and acreage levels for Crop Year 2012 as of September 23, 2013 to construct the estimates above.

For example, if a 1 percent cut was instituted, corn producers in the states examined would demand 59 million dollars fewer in total premiums and would demand coverage for 38 million dollars less in total liabilities than otherwise. Results suggest that these producers would also drop coverage for 505 thousand fewer acres, 310 thousand of which would be buy-up acres. In other words, if crop insurance prices were to increase, producers would demand fewer policies at the higher levels of coverage. 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 billion in 2012, while total liabilities exceeded \$53 billion.

Soybean producers would exhibit a smaller response to a 1 percent cut in subsidies, demanding only 27 million dollars less in total premiums. If subsidies were decreased, results suggest that total liabilities and total acres of soybeans enrolled (both total and those under buy-up policies) could increase.

Wheat producers would also be affected, demanding policies worth 30 million dollars less and 5 million dollars fewer in liabilities. For these farmers, the number of acres insured would drop by 377 thousand acres for a 1 percent decrease in subsidies, 214 thousand of which would be from buy-up acres.

While some states show large responses to a change in the subsidy rate, across the Nation the overall demand for crop insurance remains relatively constant across a range of measures of crop insurance demand, regardless of the changes in price (at least the changes with respect to those experienced with ARPA). Total premiums as a measure of crop insurance demand shows the largest response to the change in subsidies, followed by the changes in total acres. This National phenomenon likely occurs since producers in different states respond differently to crop insurance price changes and these different responses can at times offset each other. Combined with the varying sizes of the states in terms of agricultural output, while regional changes may take place, the overall demand for crop insurance appears to be relatively immune to fairly small price movements.

### *Recent Events*

This study explores how changes in the price of crop insurance affect producers' demand, treating the 2000 ARPA Act as an experiment. In 2000, producers were operating under the 1996 Farm Bill which contained a large number of programs to support crop producers; crop

insurance, while a growing program, still only played a minor role in the set of tools available to producers. Today, many of the Title I support programs are being whittled back or eliminated and much of the focus is being placed directly on the crop insurance program. For example, Congress did not deliver any *ad hoc* disaster assistance legislation to support farmers despite the major drought of 2012, 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, in 2000, roughly 60 percent of all acres planted were covered with crop insurance with less than half of those acres covered with buy-up.

Producers rely more heavily on the crop insurance program than they have at any time in the past, which suggests that their demand for crop insurance could be less likely to change with changes in the price of insurance. Therefore, if the premium subsidies were to be changed, the overall producers' response could be smaller than what the empirical results found in this report suggest. The results found in this report would therefore likely represent an upper bound of the responsiveness of producers to changes in crop insurance prices. If this is the case, then small changes in premium subsidies likely will not have major impacts on producer demand for crop insurance coverage.

## Appendix: Summary statistics for major variables, by crop

Table A1. Major Variable Summary Statistics, Corn

Variable Name	Description	Mean (Std Dev)	Min	Max
$\Delta \log(\text{croprate9601})$	Change in log of corn subsidy/acre between 1996 and 2001	0.52 (0.28)	-0.64	1.5
$\Delta \log(\text{cornrate9702})$	Change in log of corn subsidy/acre between 1997 and 2002	0.61 (0.28)	-1.2	2.2
$\Delta \log(\text{totprem\_acre})$	Change in log of the total premium/acre	0.76 (0.90)	-3.8	5.7
$\Delta \log(\text{liab\_acre})$	Change in log of the total liability/acre	0.34 (0.25)	-1.1	1.7
$\Delta \log(\text{ins\_acres})$	Change in log of total insured acres	0.19 (0.77)	-3.3	4.9
$\Delta \log(\text{ins\_acres65})$	Change in log of buy-up acres	0.56 (0.88)	-3.3	5.1
Mean_yield	Mean of yield	124 (39)	14	218
Var_yield	Variance of yield	483 (314)	27	2,024
$\Delta \text{cropins\_ratio}$	Change in ratio of yield to revenue insurance policy demand	-42 (28)	-100	52

Table A2. Major Variable Summary Statistics, Soybeans

Variable Name	Description	Mean (Std Dev)	Min	Max
$\Delta \log(\text{soyrate9601})$	Change in log of soybean subsidy/acre between 1996 and 2001	0.43 (0.26)	-1.1	1.5
$\Delta \log(\text{soyrate9702})$	Change in log of soybean subsidy/acre between 1997 and 2002	0.48 (0.27)	-1.4	1.4
$\Delta \log(\text{totprem\_acre})$	Change in log of the total premium/acre	1.21 (0.93)	-3.2	7.2
$\Delta \log(\text{liab\_acre})$	Change in log of the total liability/acre	0.46 (0.23)	-0.52	2.4
$\Delta \log(\text{ins\_acres})$	Change in log of total insured acres	0.48 (0.81)	-3.0	5.7
$\Delta \log(\text{ins\_acres65})$	Change in log of buy-up acres	0.84 (0.89)	-3.0	5.6
Mean_yield	Mean of yield	39 (11)	11	60
Var_yield	Variance of yield	34 (18)	9	116
$\Delta \text{cropins\_ratio}$	Change in ratio of yield to revenue insurance policy demand	-39 (26)	-100	19

Table A3. Major Variable Summary Statistics, Wheat

Variable Name	Description	Mean (Std Dev)	Min	Max
$\Delta \log(\text{croprate9601})$	Change in log of crop subsidy/acre between 1996 and 2001	0.54 (0.24)	-0.67	1.5
$\Delta \log(\text{croprate9702})$	Change in log of crop subsidy/acre between 1997 and 2002	0.44 (0.23)	-1.0	1.2
$\Delta \log(\text{totprem\_acre})$	Change in log of the total premium/acre	0.34 (0.81)	-4.4	4.6
$\Delta \log(\text{liab\_acre})$	Change in log of the total liability/acre	0.33 (0.26)	-1.4	1.7
$\Delta \log(\text{ins\_acres})$	Change in log of total insured acres	-0.11 (0.70)	-4.8	3.7
$\Delta \log(\text{ins\_acres65})$	Change in log of buy-up acres	0.36 (0.95)	-4.6	7.8
Mean_yield	Mean of yield	28 (10)	5.7	63
Var_yield	Variance of yield	42 (24)	5	193
$\Delta \text{cropins\_ratio}$	Change in ratio of yield to revenue insurance policy demand	-52 (25)	-100	0

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