How Do Premium Subsidies Affect Crop Insurance Demand at Different Coverage Levels: the Case of Corn

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Abstract

This paper uses regional county level data to explore the impacts of crop insurance premium subsidies on the demand for corn crop insurance at each coverage level. Although the demand for corn insurance is price-inelastic, the elasticities of demand with respect to per dollar net premium vary significantly among coverage levels, insurance plans, and regions. The elasticities of demand for corn yield insurance (APH) with respect to per dollar net premium are -0.230, -0.158, and -0.259 at the 80% coverage level in the Corn Belt, Lake States, and Northern Plains, respectively. The corresponding elasticity at the 75% coverage level in the Southern Plains is -0.654. The elasticities of demand for corn revenue insurance (CRC) with respect to per dollar net premium are -0.200, -0.208 at the 80% coverage level in the Corn Belt and Lake States, respectively, and it is -0.670 at the 75% coverage level in the Southern Plains. The results show that elasticities of demand for corn insurance tend to be larger in riskier regions at relatively higher coverage levels. This study also estimates the possible changes in producers' crop insurance purchases if federal crop insurance premium subsidies are reduced by 10 percentage points. The expected change in producers' purchases of corn revenue insurance at the 75% coverage level in the Southern Plains (-12.182%) would be three times greater than it is at the 80% coverage level in the Corn Belt (-4.167%) with a 10 percentage point decrease in premium subsidy rates.

Key words: crop insurance, premium subsidies, demand

JEL classification: A1, B2, C3

Introduction

The U.S. Federal Crop Insurance Program (FCIP) plays a critical part in providing farmers protection against agricultural risk. The federal crop insurance subsidies have been increased through several policies to encourage crop insurance participation. Figure 1 shows the corn insured acres and the federal premium subsidies in 1989 to 2013. Despite the higher participation with higher premium subsidies, this program has been criticized as inefficient because of the heavy government expenditure (see figure 1) and poor actuarial performance (Glauber 2004). Figure 2 presents the loss ratio (the ratio of indemnities to gross premium) and adjusted loss ratio (the ratio of indemnities to net premium) for the FCIP over all crops. On average, the adjusted loss ratio is 2.07 over 2000 - 2013, which means producers tend to collect $2.07 in indemnity payments for each dollar of their premium payment. Therefore, understanding the effects of subsidies on demand is essential for policy makers and private sectors.

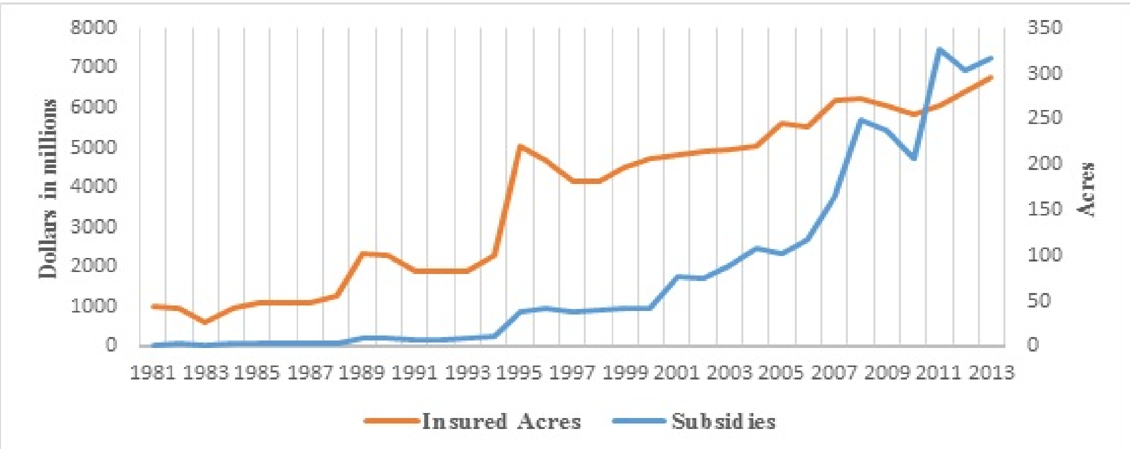

Figure 1. Federal Premium Subsidies and Insured Acres for the U.S. Corn Crop Insurance Program
Source: USDA, Risk Management Agency, Summary of Business files, 1989-2014.

Although the demand for crop insurance has been explored by many studies, the majority of the existing studies did not report the demand for crop insurance premium at each coverage level. Consequently, it is not clear whether there are differences among the price elasticities of crop insurance demand across coverage levels. The two known studies which account for the differences across coverage levels show that the demand for grape insurance in eleven

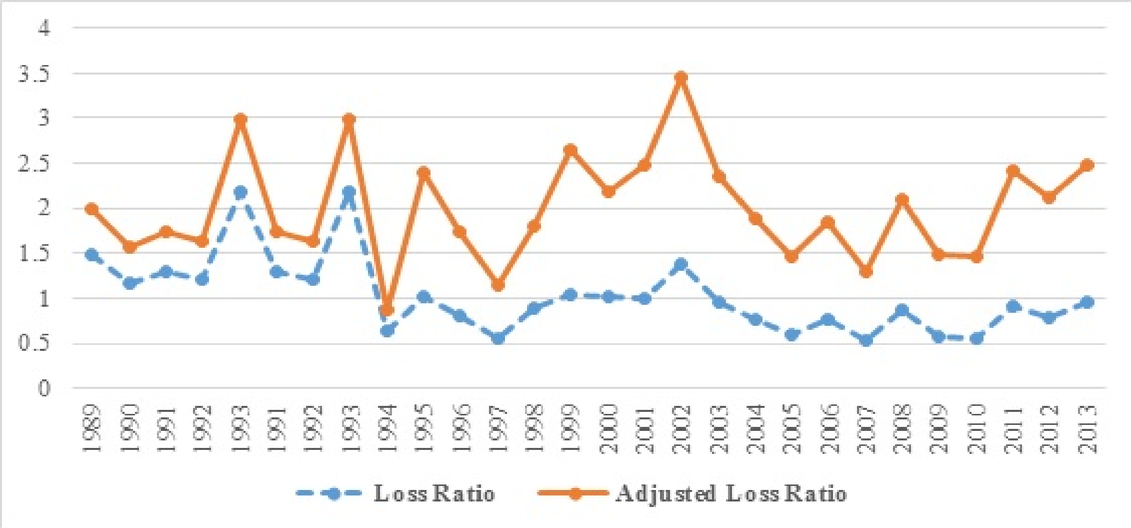

Figure 2. Loss Ratio and Adjusted Loss Ratio for the U.S. Crop Insurance Program
Source: Glauber and Collins 2002.

California counties is price-elastic at the catastrophic (CAT) level of insurance. However, the demand for grape insurance is price-inelastic among higher coverage levels (Knox and Richards 1999; Richards 2000). From the grape insurance evidence, we hypothesize that the demand for crop insurance at each coverage level could be significant different although previous studies show that the aggregated demand for the federal crop insurance is price-inelastic. Moreover, because the federal premium subsidy rates are specified at each coverage level, disaggregated demand analysis of crop insurance could provide more detailed information for policy makers and private sectors. This study is the first one that differentiates the demand for corn insurance policies across coverage levels, insurance policies (yield and revenue insurance policies), and regions.

Background

To encourage higher participation, crop insurance premium subsidies were increased by the Agricultural Risk Protection Act (ARPA) of 2000 (Babcock, Hart, and Hayes 2004; Coble and Barnett 2013). According to Babcock and Hart (2005), "One of the policy objectives of the ARPA was to induce producers to buy more insurance coverage in which one measure of more insurance is the proportion of acres insured at levels greater than 65%." Table 1 provides a comparison between the percentages of the premium paid by the FCIC at various coverage levels at 100% of price coverage pre- and post- ARPA. For corn insurance, coverage is available in 5% increments from 50% to 85%. Before the ARPA, the dollar amount of subsidies were the same among coverage levels higher than or equal to 65%. The constant dollar amount of subsidies was accomplished by setting different subsidy rates at each coverage level (Babcock and Hart 2005). Under the ARPA, the increase in the insurance premium at higher coverage levels was generally less than the associated increase in subsidy rates. Therefore, producers would benefit more from purchasing higher coverage levels (Babcock, Hart, and Hayes 2004). Another significant change is that the subsidy level, as a percentage of the full premium, is the same for both the yield insurance program (APH) and the revenue polices (CRC) under the ARPA. Besides, the administrative fee for CAT insurance was increased from $50 to $100 per crop per county (Kelley 2001).

Table 1. Basic Unit Subsidy Levels Pre- and Post-ARPA

Coverage Level	Pre-ARPA		Post-ARPA
	APH	CRC	
50/100	55%	42%	67%
65/100	42%	32%	59%
70/100	32%	25%	59%
75/100	24%	18%	55%
85/100	13%	10%	38%

Source: Kelly 2001; Jose 2001.

Although ARPA was implemented in 2000, it remains the most recent and broadest reform in crop insurance premium (O'Donoghue 2014). Furthermore, there are very few studies which explore the impacts of subsidy changes on crop insurance demand and none of them differentiated coverage levels and plans. Therefore, this study examines the demand for crop insurance at each coverage level and insurance plan.

Empirical Modeling Framework

Expected utility maximization is usually the theoretical framework in which the determinants of insurance purchases are examined. A representative producer is subject to constraints imposed by characteristics of marketing and production environment, such as commodity prices. Following Goodwin (1993), the maximization of the expected utility yields a linear equation, which is a function of the representative producers risk attitudes, and the production and marketing characteristics. The demand for corn insurance is given by

$$y_i = \alpha + X\beta_i + \varepsilon_i$$

where y_i is the insurance purchase decision made by the producer under the utility maximization problem. X_i is a vector of factors that influence the expected utility of insurance and ε_i is a random error term.

Following Gardner and Kramer (1986) and Goodwin (1993), each county is treated as a representative farm. Although the utilization of county-level data could reduce the variation, compared to farm-level data, given the data availability, the county-level dataset is the best one which can be used for estimating of crop insurance demand.

The term defined to quantify the crop insurance demand varies in previous studies, such as the percentage of insured acres used in Gardner and Kramer (1986), and premium less expected indemnities per dollar of liability in Cannon and Barnett (1995). In this study, the quantity variable is constructed as the per dollar liabilities (liabilities divided by projected prices) per enrolled acre. Liabilities are the amount of indemnities if all losses occur, and are determined by the production conditions of insured acres, the product of insured acres, the projected price of the product. As Goodwin (1993) mentioned, the liability should be the true measure of the level of insurance. In Goodwin (1993) , the dependent variable is the liability per planted acre of corn. However, insured acres should be preferred to the planted acres to adjust liabilities because liabilities are determined by the characteristics of the insured acres, not the total planted acres, and the total corn planted acres are also controlled in the model. Moreover, the liabilities per enrolled acres are divided by the corn projected price in each county to estimate the per dollar purchases.

The definitions of the price variable in the analysis of crop insurance demand are as diverse as the measure of the quantity. The premium rate per acre is a commonly used term to measure the cost of insurance, such as in Smith and Baquet (1996). In this study, the normalized net premium (gross premium less subsidies) per insured acre divided by the projected price is used to estimate the cost of insurance per insured dollar. The premium per acre is the acre unit price, while the net premium per acre per (insured) dollar is the dollar unit price. Therefore, the normalized net premium per insured acre per insured dollar should be the true dollar unit price faced by producers. The net premium is calculated by subtracting the subsidies from the premium. All monetary variables in this study are normalized using the Consumer Price Index (CPI).

Following Babcock and Hart (2005), insurance participation data in 1998 and 2002 are selected for the present analysis based on the following reasons. The ARPA was authorized in June of 2000, and the implementation would be even later. Corn producers already made their decisions on insurance selection in 2000 before the application of ARPA. Since the industry needs time to accommodate the changes, the participation data in 2001 is not as reflective of the changes in subsidies in crop demand as it is in later years. Therefore, 2002 crop year data would be more reasonable to be used in the analysis.

An ad hoc premium reduction program was introduced both in 1998 and 1999. In 1999, some producers might have not been aware of the premium reduction program. Thus, the insurance participation data in the 1999 crop year may not fully reflect producers decisions with respect to premiums. Although the program also existed in 1998, it was introduced after producers made their participation decisions (Babcock and Hart 2005). Therefore, we could assume that producers made their participation decisions based on full information in 1998.

In the literature, different estimation approaches were used. For example, a two-stage model was used in Richards (2000) and Serra, Goodwin, and Featherstone (2003) to adjust the non-participation problem. However, county-level data are used in this study and there is no server non-participation problem at the county level. The fixed effect model was used by Goodwin (1993) to estimate the demand for corn insurance by using panel data during 1985-1990. Because cross-sectional data (consisted of data for 1998 and 2002) are used to analyze the effects of subsidies in the ARPA in this study, fixed effects and random effects are not considered in the present study. Therefore, Original Least Squares (OLS) regression is used for the estimation of the demand for corn insurance in this study.

In this study, demand for APH and CRC insurance policies are the focus because they were the two most popular insurance policies in 1998 and 2002. Considering the APH insurance plan provides yield protection for corn producers, while the CRC insurance plan provides revenue protection, demand estimation is seperated for different insurance policies.

Table 2 provides a summary of the definition for each variable. The preceding three-years average yield is incorporated in the model to estimate producers expected yield (e.g., for 1998, the years 1997, 1996, and 1995 are used). One year lagged yield is a common term to estimate producers expectation of yield in the literature (e.g. Wang et al. 1998). However, the preceding three-years average yield should be preferable to the one year lagged term because agricultural production is quite variable and the preceding one years yield does not fully reflect the representative producer's expectation of the yield and the variability of yield. Meanwhile, as technology is changing, the preceding three-years average yield should be preferable to the mean of historical yield used in previous studies, such as the average yield in the preceding 10 years used by Goodwin, Vandeveer, and Deal (2004). Similarly, the preceding three-years revenue is used to estimate producers' revenue expectation in the CRC insurance demand equations.

Table 2. Definition of Variables in the Models

Variable	Definition
Dependent variable	normalized liabilities per acre/projected price
Unit price of crop insurance	normalized net premium per acre/projected price
Expected yield	average yield in the preceding three years
Expected revenue	average revenue in the preceding three years
Relative yield risk	coefficient of variation for corn yield (1989-2013)
Relative revenue risk	coefficient of variation for revenue (1989-2013)
Planted acres	planted acres
Enrolled acres in CRP	enrolled acres in CRP
Percentage of irrigated cropland	the ratio of acres of irrigated cropland to acres of total cropland in each county
Percentage of cropland operated by females	the ratio of acres operated by females to acres of total cropland in each county

O'Donoghue (2014) as well as Goodwin and Ker (1998) included the yield variance in the study of crop insurance. The coefficient of variation (CV) for yield is included in the current model to estimate the relative yield risk of the county. Using the CV for yield is better than the yield variance because the CV estimates the relative yield risk while the variance of yield reflects the absolute yield risk. Because of the significant difference in the mean yield in the four regions, relative yield risk is preferable to the absolute yield risk. In this study, historical corn yield data in 1989 through 2013 are used to compute the CV for each county.

The total corn planted acres are incorporated in the model since a potential correlation is expected between the planted acres and the insurance purchases. The enrolled acres of CRP are used as an independent variable because it is impossible to purchase insurance protection for acres enrolled in the CRP. The percentage of irrigated cropland in each county is controlled in the model as this item could reflect the production environment and affect the distribution of yield. Women tend to be more risk averse than men (Charness and Gneezy 2012), thus the percentage of cropland operated by females is also incorporated in the equations.

Data

The data utilized in this analysis were drawn from three major sources. The primary data source is USDA, Risk Management Agency (RMA) administrative data. The individual data are aggregated to the county-level by crop type and crop insurance policy at each coverage level. Information about insured acres, total premium, liabilities, and subsidies is available from RMA's Summary of Business Report (SBR) publications. The SBR publications report participation data from 1989 through 2014 and contain spatially identifying information. Thus the participation data can be combined with other datasets. There are about 2,000 observations for each year during the time period in the SBR publication. Among all the counties, the Corn Belt, Lake States, Northern Plains, and Southern Plains are the focus of this study. The states in each region are reported in table 3.

Table 3. Regional Division Definition

Regions	States Included
Corn Belt (CB)	Iowa, Illinois, Indiana, Missouri, and Ohio
Lake States (LS)	Michigan, Minnesota, and Wisconsin
Northern Plains (NP)	Kansas, and Nebraska, and South Dakoda
Southern Plains (SP)	New Mexico, Oklahoma and Texas

USDA, National Agricultural Statistics Service (NASS) surveys provide county-level data about crop yield and total planted acres in each crop. The Bureau of Labor Statistics (BLS) provides the annual Consumer Price Index (CPI). In this study, all monetary variables are normalized by deflating with the CPI. Data about irrigated cropland and acres operated by females and males are obtained from National Agricultural Statistics Services (NASS)s 1997 and 2002 Censuses of Agriculture. County-level data on participation in Conservation Reserve Program (CRP) is collected from USDA, Farm Service Agency (FSA) to estimate the effect of CRP acreage on insurance demand.

Demand Estimation

Breusch-Pagan (1979) and Cook-Weisberg (1983) test is applied to test for heteroskedasticity. The variances of error are all equal is assumed in the null hypothesis of the Breusch-Pagan and Cook-Weisberg test. If the regression is rejected by the null hypothesis at the 95% confidence interval, the robust standard errors are used in the regression. Variance inflation factors (VIF) are used to diagnose collinearity problems. Among all the estimations, the highest VIF is less than 10. Therefore, multicollinearity does not appear to be a considerable problem.

Link tests are applied to test for model specification. The basic idea of the link test is that any additional independent variable should be statistically insignificant if the model is correctly specified (Bruin 2006). According to Bruin (2006), the link test creates two variables: predicted dependent variable ($\hat{y}$) and the square of the predicted dependent variable ($\hat{y^2}$). The model is refit only using these two variables as predictors. In this study, the results of link tests suggest that models for APH insurance are well specified excepted at the 55% and 60% coverage levels in the Corn Belt, at the 65%, 70%, and 80% coverage levels in the Lake States, at the 50% coverage level in the Northern Plains, and at the 65% coverage level in the Southern Plains. To address the misspecification problem, linear-linear models are used at the 55% and 60% coverage levels in the Corn Belt, the linear-log models are used at the 65%, 70%, and 80% coverage levels in the Lake States, the linear-log model is used at the 50% coverage level in the Northern Plains, and the log-linear model is used at the 65% coverage level in the Southern Plains. The estimations for corn CRC insurance at the 75% and 80% coverage levels in the Corn Belt and at 65%, 70% and 75% coverage levels in the Northern Plains are rejected by the null hypothesis of link tests at the 95% confidence interval. To deal with the misspecification problem, linear-linear models are used at the two coverage levels (75% and 80%) in the Corn Belt, and log-log, linear-log, and linear-linear models are used at the 65%, 70%, and 75% coverage levels in the Northern Plains, respectively.

The Demand Estimation for Corn APH Insurance

In the Lake States, there are only nine observations at the 85% coverage level, which results in limited power for the F-test (0.30). Among all the other coverage levels and regions, the p-values of the F-tests are zero to four decimal places, which mean that the models are statistically significant. the coefficients of determination, or R^2, range from 0.399 (at the 80% coverage level in the Northern Plains) to 0.894 (at the 75% coverage level in the Southern Plains), which suggests that the model could explain from 39.9% to 89.4% of the total variation in the demand for liabilities by the variation in the independent variables. The results indicate that explanatory variables explain the demand for corn APH insurance fairly well.

The Demand Estimation for Corn CRC Insurance

Overall, the model explains the demand for corn CRC insurance fairly well. The coefficients of determination, or R^2, range from 0.227 (for 55% coverage level in the Northern Plains) to 0.946 (for 55% coverage level in the Southern Plains) which suggest that the model could explain from 22.7% to 94.6% of the total variation in the demand of per dollar liabilities by the variation in the independent variables. The F-tests are statistically significant (p-values are zero to four decimal places) except for the 85% coverage level in the Lake States and the 55% coverage level in the Northern Plains (the p-value of the F-test is 0.5352 and 0.0288, respectively).

Elasticities of Demand

The elasticities of corn APH and CRC insurance with respect to per dollar net premium are summarized in table 4 (the elasticities of demand for corn APH and CRC insurance with respect to each independent variable are reported in tables 6 through 13). The elasticities of demand for corn APH insurance with respect to per dollar net premium are -0.230, -0.158, and -0.259 at the 80% coverage level in the Corn Belt, Lake States, and Northern Plains, respectively. The corresponding elasticity at the 75% coverage level in the Southern Plains is -0.654. The elasticities of demand for corn CRC insurance with respect to per dollar net premium are -0.200, -0.208 at the 80% coverage level in the Corn Belt and Lake States, respectively, and it is -0.670 at the 75% coverage level in the Southern Plains. The results show that elasticities of demand for corn insurance tend to be larger in riskier regions at relatively higher coverage levels. The results show the importance of separating coverage levels, regions, and insurance plans in the study for crop insurance demand, which were not reported in previous studies.

Table 4. Estimated Elasticities of Demand for APH and CRC Insurance With Respect to Per Dollar of Net Premium

Region	Policy	50%	55%	60%	65%	70%	75%	80%	85%
Corn Belt	APH	-0.047**	-0.028	-0.106***	-0.114***	-0.137***	-0.149***	-0.230***	0.017
	CRC	-0.015	0.033	-0.040	-0.083**	-0.167***	-0.146***	-0.200***	-0.083
Lake States	APH	-0.180***	-0.138***	-0.138***	-0.147***	-0.094**	-0.157***	-0.158**	
	CRC	-0.213***	-0.323***	-0.190***	-0.239***	-0.285***	-0.229***	-0.208***	-0.177
Northern Plains	APH	-0.170***	-0.004	-0.305***	-0.038	-0.097	-0.188*	-0.259**	-0.284**
	CRC	-0.042	-0.205	-0.290***	0.017	-0.044	0.097	0.075	0.009
Southern Plains	APH	-0.221**	-0.131	-0.248*	-0.227**	-0.155	-0.654***		
	CRC	-0.331**	-0.094	-0.373***	-0.242*	-0.501***	-0.670***		

The negative correlation between the per dollar net premium and the amount of per dollar liability purchases (table 4) is consistent with theoretical expectations, and the magnitude of elasticities of demand for crop insurance with respect to price is basically consistent with results reported in other studies. The estimated average demand elasticities for liability per planted acre are -0.73 in Iowa in Goodwin (1993), -0.24 in the Heartland in Goodwin (2001), -0.13 in Illinois, Idaho, Iowa, and Ohio in O'Donoghue (2014). Because this study is the only one which separated coverage levels in the analysis of corn insurance demand, it is difficult to compare the estimated elasticities of corn insurance demand at each coverage level with existing studies at each coverage level. But overall, the elasticities derived in this analysis are generally consistent with results estimated in previous studies.

The elasticities of demand with respect to per dollar net premium vary across coverage levels. For example, in the Corn Belt (table 4), the elasticity of demand for corn yield insurance with respect to per dollar net premium at the 50% coverage level is small (-0.047), and the elasticity at the 55% is statistically insignificant (-0.028). The results in table 4 imply that corn producers in the Corn Belt are not likely to significantly change their demand for corn APH insurance at the 50% and 55% coverage levels due to the changes in subsidies. These producers may purchase the low coverage levels to meet the requirements for loan applications. As shown in table 4, the price elasticities are statistically significant but inelastic at the 60%, 65%, 70%, 75%, and 80% coverage levels (0.106, 0.114, 0.137, 0.149, 0.230, respectively). Although they are all price-inelastic, the elasticity at 80% coverage level (-0.230) is about five times of the elasticity at the 50% coverage level (-0.047). The results imply that producers are more sensitive to changes in premium at high coverage levels (e.g. 80% coverage level) than low coverage levels (e.g. 50% and 55%) in the Corn Belt. The results also prove the importance of differentiating coverage levels in the analysis of demand for corn insurance (table 4).

Results in table 4 also suggest that producers in riskier regions are more responsive to the change of per dollar net premium. For instance, with a 1% decrease in the per dollar net premium, producers in the Corn Belt would increase their purchase for corn APH insurance at the 50% coverage level by 0.047%, while producers in the Southern Plains would increase the purchase by 0.221%. So the change in the Southern Plains is quadrupled compared to the change in the Corn Belt. In O'Donoghue (2014), the elasticities of demand for corn insurance measured as liabilities per acre are -0.13, -0.24, and -0.25 in the Midwest, Lake, and Northern Plains, respectively, which also exhibit the patterns that producers in riskier regions tend to be more responsive to corn insurance, although the pattern was not mentioned in his study.

The elasticities of demand for insurance with respect to per dollar net premium not only change across coverage levels and regions, but the elasticities also change between insurance plans (table 4). In the Corn Belt and Northern Plains, the demand for corn APH insurance is more price responsive than the demand for corn CRC insurance, while the elasticities of demand for corn CRC insurance with respect to per dollar net premium are larger than the corresponding elasticities for corn APH insurance in the Lake States and Southern Plains. For example, in the Southern Plains, the elasticity of corn APH insurance with respect to per dollar net premium is 0.248, while the corresponding elasticity for corn CRC insurance is 0.373 at the 60% coverage (table 4).

Results presented in table 4 indicate the necessity for separating insurance plans, regions, and coverage levels in the analysis of corn insurance demand, which was overlooked in previous studies. The elasticity of demand for CRC insurance at the 75% coverage level in the Southern Plains is -0.670, which is more than 14 times of the elasticity of demand for APH insurance at the 50% in the Corn Belt (-0.047). Although the elasticities are price-inelastic, a 1% change in the net premium would induce 14 times larger effect at the 75% coverage level in the Southern Plains than the effect at the 50% coverage level in the Corn Belt (table 4).

Policy Implications

Federal crop insurance has undergone scrutiny regarding the significantly increased government costs. Critics of federal crop insurance have proposed bills to cut government subsidies on crop insurance premiums, such as Senate Bill 666 and Senate Bill 2244 in the 114th Congress. Reforms are proposed in the recently released Obama Administrations 2017 Budget, and the reforms call for an $18 billion cut to the FCIP over 10 years, according to the Administration. Under this situation, it is important to have a general view of the changes in demand if premium subsidies are reduced.

In CRS Report R43951 (Shields 2015), a 10 percentage point reduction in crop insurance premium subsidies is proposed. Table 5 shows how the purchases of corn crop insurance would likely change with a 10 percentage point decrease in federal premium subsidies.

Table 5. Estimated Changes of Corn Insurance Demand with a 10 Percentage Point Decrease in Premium Subsidies

Insurance	Region	50%	55%	60%	65%	70%	75%	80%	85%
APH	Corn Belt	-0.701%	-	-1.656%	-1.932%	-2.322%	-2.709%	-4.792%	-
	Lake States	-2.687%	-2.156%	-2.156%	2.492%	-1.593%	-2.855%	-	-
	Northern Plains	-2.537%	-	-4.766%	-	-	-3.418%	-5.396%	-7.474%
	Southern Plains	-3.299%	-	-3.875%	-3.847%	-	-11.891%	-	-
CRC	Corn Belt	-	-	-	-1.407%	-2.831%	-2.655%	-4.167%	-
	Lake States	-3.179%	-5.047%	-2.969%	-4.051%	-4.831%	-4.164%	-4.333%	-
	Northern Plains	-	-	-4.531%	-	-	-	-	-
	Southern Plains	-4.940%	-	-5.828%	-4.102%	-8.492%	-12.182%	-	-

A uniform percentage point reduction in the federal premium subsidy rate across coverage levels would result in significantly different responses in producers' participation in the FCIP by region and insurance type. For example, in the Corn Belt, the changes at relatively high coverage levels (75% and 80%) are greater than they are at the 50% coverage level, both for corn yield and revenue insurance policies. Thus, a small reduction in premium subsidy rates across coverage levels would result in a greater reduction in participation in high coverage policies in the Corn Belt, which contradicts a major purpose of the 2000 ARPA. (One of the major objectives of the 2000 ARPA was to encourage more participation at coverage levels higher than the 65% coverage level.)

A uniform percentage point reductions in the premium subsidy rates across coverage levels would also lead to significantly different purchase decisions across regions. For example, for yield insurance, the expected change at the 75% coverage level in the Southern Plains (-11.891%) would be 17 times greater than it is at the 50% coverage level in the Corn Belt (-0.701%). The significantly different effects could also be expected for the demand for revenue insurance. Therefore, the government may consider applying different changes to the subsidy rates across regions, coverage levels, and insurance types to insure significant use of crop insurance.

Conclusions

The highly subsidized crop insurance program has come under fire as a candidate for budget cutting. So it is useful to estimate the effects of reducing premium subsidies. Although several studies examined the elasticities of corn insurance demand, none of them differentiated coverage levels, and few of them separated insurance plans. Consequently, this undermines the effectiveness of projecting subsidy reductions. In this study the demand for corn insurance is estimated at each coverage level, region, and insurance plan.

This analysis finds empirical support for varying elasticities of corn insurance demand among coverage levels, insurance plans, and across regions, Therefore, decreasing premium subsidies could have significantly different effects across coverage levels, insurance plans, and regions. The demand for corn yield insurance at low coverage levels in less risky regions, such as the 50% coverage level in the Corn Belt, is expected to have modest response to the change of subsidies, while the demand for corn yield insurance at high coverage levels in riskier regions, such as the 75% coverage level in the Southern Plains, would be more price-sensitive. Therefore, changing subsidies at different coverage levels in different regions would trigger significantly different purchase responses.

GAO (2015) claims that the federal government costs in the crop insurance program are substantially higher in regions with higher crop production risks than in other regions by providing cheaper crop insurance. The cheaper insurance is realized by setting the county base premium rates much lower than the target premium rates. Although RMA disagrees with GAO's claim, it does not have more information to refute GAO's argument since RMA does not monitor and report government costs in riskier regions. This study shows that to keep high participation and high coverage levels, the government premium subsidies would need to be higher in riskier regions since the demand for corn insurance is more price sensitive in riskier regions and for higher coverage levels. But how large the differences would be to balance participation and actuarial fairness between different risk regions deserves more attention and future research.

To estimate the elasticities of demand for corn insurance, this study assumes there is no adverse selection in the corn insurance market. However, the existence of adverse selection is one of the longstanding problems in the analysis of crop insurance. The study would be improved if adverse selection is incorporated in the estimation of demand for corn insurance.

Table 6. Estimated Elasticities of Demand for Corn APH Insurance in the Corn Belt

Variable	50%	55%	60%	65%	70%	75%	80%	85%
Net premium	-0.047**	-0.028	-0.106***	-0.114***	-0.137***	-0.149***	-0.230***	0.017
Yield expectation	0.416***	0.377***	0.347***	0.276***	0.300***	0.534***	0.730***	0.237
Relative yield risk	-0.080*	-0.096	-0.128*	-0.130***	-0.097*	-0.112**	0.035	-0.204*
Planted acres	0.067***	0.088***	0.050***	0.063***	0.030**	0.021	0.029	0.100***
Enrolled acres	-0.012**	-0.024***	-0.022**	0.0004	0.004	0.01	-0.01	-0.022
Percentage of irrigated cropland	-0.100	-0.172	-0.016	0.065	0.06	0.112	-0.159	-0.174
Percentage of cropland operated by female	-0.148	0.105	0.095	0.064	-0.705	-0.843	0.075	-0.671

Table 7. Estimated Elasticities of Demand for Corn APH Insurance in the Lake States

Variable	50%	55%	60%	65%	70%	75%	80%
Net premium	-0.180***	-0.138***	-0.138***	-0.147***	-0.094**	-0.157***	-0.158**
Yield expectation	0.418***	0.336***	0.644***	0.540***	0.558***	0.756***	0.557
Relative yield risk	-0.098**	-0.188**	0.056	0.037	-0.031	0.019	-0.201
Planted acres	0.023*	0.055***	0.055**	0.042***	0.068***	0.033	0.204***
Enrolled acres in CRP	-0.014**	-0.018*	-0.020**	-0.008*	-0.016**	-0.002	-0.078**
Percentage of irrigated cropland	-0.273**	-0.121	-0.166	-0.022	-0.093	-0.031	0.156
Percentage of cropland operated by female	-0.172	0.418	0.606	0.301	0.752	-1.171	3.709**

Table 8. Estimated Elasticities of Demand for Corn APH Insurance in the Northern Plains

Variable	50%	55%	60%	65%	70%	75%	80%	85%
Net premium	-0.170***	-0.004	-0.305***	-0.038	-0.097	-0.188*	-0.259**	-0.284**
Yield expectation	0.538***	0.724***	0.599***	0.809***	0.720***	0.530***	0.890**	-0.257*
Relative yield risk	-0.289***	-0.257	-0.164	-0.137***	-0.057	-0.174	0.082	-0.618***
Planted acres	0.041***	0.047	0.051**	0.015***	0.067***	0.071***	0.002	-0.005
Enrolled acres in CRP	-0.018*	-0.092***	0.0005	-0.006	-0.007	-0.026	0.005	-0.041*
Percentage of irrigated cropland	-0.03	-0.238	-0.039	0.057	-0.007	-0.054	0.142	-0.237
Percentage of cropland operated by female	0.581	0.543	0.65	0.07	1.247	1.209	2.436	1.366

Table 9. Estimated Elasticities of Demand for Corn APH Insurance in the Southern Plains

Variable	50%	55%	60%	65%	70%	75%
Net premium	-0.221**	-0.131	-0.248*	-0.227**	-0.155	-0.654***
Yield expectation	0.469***	0.569**	0.455**	0.711	0.781***	0.850***
Relative yield risk	-0.474***	-0.026	-0.167	0.09	0.0898	0.00228
Planted acres	-0.00714	0.0333	-0.0209	0.007	0.0012	-0.0298
Enrolled acres in CRP	0.0286**	-0.0047	0.0402*	0.016	0.0456***	0.0287*
Percentage of irrigated cropland	0.312**	0.634**	0.615**	0.569***	0.525**	0.232
Percentage of cropland operated by female	0.426	-0.121	-1.175	0.01	1.553	-2.079*

Table 10. Estimated Elasticities of Demand for Corn CRC Insurance in the Corn Belt

Variable	50%	55%	60%	65%	70%	75%	80%	85%
Net premium	-0.015	0.033	-0.040	-0.083**	-0.167***	-0.146***	-0.200***	-0.083
Revenue expectation	-0.088	-0.082	-0.194***	-0.113***	-0.152***	-0.195***	0.432***	0.440***
Relative revenue risk	-0.009	0.226**	0.168*	-0.023	0.033	-0.020	0.051	-0.054
Planted acres	0.148***	0.127***	0.110***	0.108***	0.088***	0.086***	0.009	0.061**
Enrolled acres in CRP	-0.037***	-0.059***	-0.045***	-0.022***	-0.017***	-0.023***	-0.001	0.004
Percentage of irrigated cropland	-0.204	-0.177	-0.109	0.099	0.004	0.080	-0.054	0.099
Percentage of cropland operated by female	1.239*	-0.066	-0.305	-0.902*	-1.469***	-0.572	-1.551***	-1.635*

Table 11. Estimated Elasticities of Demand for Corn CRC Insurance in the Lake States

Variable	50%	55%	60%	65%	70%	75%	80%	85%
Net premium	-0.213***	-0.323***	-0.190***	-0.239***	-0.285***	-0.229***	-0.208***	-0.177
Revenue expectation	-0.129	0.014	-0.005	0.031	-0.113	0.052	1.104***	0.363
Relative revenue risk	0.018	-0.023	0.295**	0.221***	0.406***	0.334***	0.123	-0.066
Planted acres	0.120***	0.078**	0.077**	0.105***	0.075*	0.031	-0.075	0.043
Enrolled acres in CRP	-0.021*	-0.015	-0.037***	-0.019*	-0.011	0.029**	0.04	0.014
Percentage of irrigated cropland	-0.227	-2.096***	-0.307	-0.176	-0.258**	-0.193	-0.238	0.029
Percentage of cropland operated by female	1.283	3.198**	0.675	0.583	0.212	0.829	-0.308	-0.562

Table 12. Estimated Elasticities of Demand for Corn CRC Insurance in the Northern Plains

Variable	50%	55%	60%	65%	70%	75%	80%	85%
Net premium	-0.042	-0.205	-0.290***	0.017	-0.044	0.097	0.075	0.009
Revenue expectation	0.074	0.14	0.186**	0.236***	0.132***	0.058	0.839***	0.686***
Relative revenue risk	-0.014	-0.011	0.046	-0.129**	0.006	-0.025	0.061	-0.108
Planted acres	0.024	0.039	0.035	0.049***	0.01	0.061***	0.069***	-0.004
Enrolled acres in CRP	0.002	0.011	0.014	-0.020**	0.020**	0.001	0.002	0.020
Percentage of irrigated cropland	0.491***	0.241	0.348***	0.263***	0.480***	0.503***	-0.031	0.176
Percentage of cropland operated by female	0.314	0.043	2.140*	0.923*	0.588	2.406***	1.045	-3.308**

Table 13. Estimated Elasticities of Demand for Corn CRC Insurance in the Southern Plains

Variable	50%	55%	60%	65%	70%	75%
Net premium	-0.331**	-0.094	-0.373***	-0.242*	-0.501***	-0.670***
Revenue expectation	0.333***	0.564***	0.797***	0.519***	0.819***	0.613**
Relative revenue risk	0.229*	-0.067	-0.005	0.160**	-0.171*	0.023
Planted acres	0.074**	0.050	0.021	0.080***	-0.008	-0.021
Enrolled acres in CRP	0.072***	0.068	0.036**	0.041***	0.021	0.053**
Percentage of irrigated cropland	0.741***	0.738*	0.361*	0.471***	0.669***	0.364
Percentage of cropland operated by female	-0.031	-3.435	3.341**	3.776***	1.629	2.844*

References

Babcock, B.A., and C.E. Hart. 2005. "Influence of the premium subsidy on farmers' crop insurance coverage decisions.", pp. .

Babcock, B.A., C.E. Hart, and D.J. Hayes. 2004. "Actuarial fairness of crop insurance rates with constant rate relativities." *American Journal of Agricultural Economics* 86:563–575.

Bruin, J. 2006. "Newtest: command to compute new test. UCLA: Statistical Consulting Group."

Cannon, D., and B. Barnett. 1995. "Modeling changes in participation in the federal Multiple Peril Crop Insurance program between 1982 and 1987." *American Journal of Agricultural Economics* 77:1380–1380.

Charness, G., and U. Gneezy. 2012. "Strong evidence for gender differences in risk taking." *Journal of Economic Behavior & Organization* 83:50–58.

Coble, K.H., and B.J. Barnett. 2013. "Why do we subsidize crop insurance?" *American Journal of Agricultural Economics* 95:498–504.

Gardner, B.L., and R.A. Kramer. 1986. "Experience with crop insurance programs in the United States.", pp. .

Glauber, J.W. 2004. "Crop insurance reconsidered." *American Journal of Agricultural Economics* 86:1179–1195.

Goodwin, B.K. 1993. "An empirical analysis of the demand for multiple peril crop insurance." *American Journal of Agricultural Economics* 75:425–434.

—. 2001. "Problems with market insurance in agriculture." *American Journal of Agricultural Economics* 83:643–649.

Goodwin, B.K., and A.P. Ker. 1998. "Nonparametric estimation of crop yield distributions: implications for rating group-risk crop insurance contracts." *American Journal of Agricultural Economics* 80:139–153.

Goodwin, B.K., M.L. Vandeveer, and J.L. Deal. 2004. "An empirical analysis of acreage effects of participation in the federal crop insurance program." *American Journal of Agricultural Economics* 86:1058–1077.

Kelley, C.R. 2001. "Agricultural Risk Protection Act of 2000: Federal Crop Insurance, the Non-Insured Crop Disaster Assistance Program, and the Domestic Commodity and Other

Farm Programs, The." *Drake J. Agric. L.* 6:141.

Knox, L., and T.J. Richards. 1999. "A two-stage model of the demand for specialty crop insurance." In *American Agricultural Economics Association, Summer Meeting. Nashville, Tennessee*.

O'Donoghue, E. 2014. "The Effects of Premium Subsidies on Demand for Crop Insurance." *USDA-ERS Economic Research Report*, pp. .

Richards, T.J. 2000. "A two-stage model of the demand for specialty crop insurance." *Journal of agricultural and resource economics*, pp. 177–194.

Serra, T., B.K. Goodwin, and A.M. Featherstone. 2003. "Modeling Changes in the US Demand for Crop Insurance during the 1990s." *Agricultural Finance Review* 63:109–125.

Shields, D.A. 2015. "Federal Crop Insurance: Background." *Congressional Research Service*, pp. .

Smith, V.H., and A.E. Baquet. 1996. "The demand for multiple peril crop insurance: evidence from Montana wheat farms." *American journal of agricultural economics* 78:189–201.

Wang, H.H., S.D. Hanson, R.J. Myers, and J.R. Black. 1998. "The effects of crop yield insurance designs on farmer participation and welfare." *American Journal of Agricultural Economics* 80:806–820.