Policy Implications of Joint Estimation of Crop Insurance Demand

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Abstract

The federal crop insurance program is a major risk management program for U.S. farmers to manage production risks, but federal spending for the premium subsidy has been much debated. This study empirically estimates county-level demand for the two primary crop insurance policies – revenue and yield insurance – and allows substitution between the policies. Results show average own price elasticities of around -0.2 to -0.3 for insured acres and -0.3 to -0.4 for liability per planted acre, with significant cross-price effects indicating the importance of accounting for substitution between yield and revenue insurance. Based on our estimation results, we simulate policy scenarios to project the impact that premium subsidy reductions have on crop insurance participation and total insured liability. Policy simulations suggest a 30% reduction in premium subsidies would result in the share of planted acres insured to decrease 0.04% for yield insurance and 4.6% for revenue insurance, and the average liability per planted acre to decrease $0.23 for yield insurance and $23.41 for revenue insurance. State-specific results are also presented. These results can help policy makers better understand the tradeoffs for crop insurance and overall government support for agriculture.

Keywords: yield and revenue insurance, insurance policy substitution, system of equations
1. Introduction

The federal crop insurance program is one of the most widely used risk management tools by U.S. farmers, with more than $100 billion of insured liability in 2016 across a variety of policies and crops (RMA 2018). To encourage participation, the federal government subsidizes more than 60% of total premiums, with federal premium subsidies totaling almost $5.9 billion in 2016 (Goodwin and Smith 2013; RMA 2018). The premium subsidy is strongly supported by U.S. farmers, but the efficacy and utility of this government spending has been much discussed among policy makers (Glauber and Collins 2002). As the debate for the next Farm Bill continues, proposals to cut government spending by reducing premium subsidies have emerged, such as the Flake-Shaheen Crop Insurance Reform Bill proposed in November 2017. Important questions for these and other proposals are the impact that changes such as premium subsidy reductions, premium rate increases, and program structure have on farmers’ insurance participation and government spending. Research on these and related questions can inform this debate by helping policy makers better understand the tradeoffs for crop insurance spending and overall government support of agriculture.

To evaluate the profitability of insurance programs and the appropriateness of policy changes, several have studied the determinants of farmers’ crop insurance purchase behavior. For example, some have addressed the theoretical and empirical issues associated with the participation of crop insurance, choices of contract and coverage levels, and various factors connected to these choices (Goodwin 1993; Du et al., 2014; Du et al., 2017). A variety of factors have been found to affect crop insurance decisions, but without a doubt, the insurance price (or premium) is the most crucial explanatory variable, which suggests the own price elasticity of insurance demand. Across corps and regions, most studies have found that farmer demand for crop insurance is price inelastic (Goodwin and Smith 1995; Goodwin 1993; Coble et al. 1996; Goodwin 2001; Goodwin et al. 2004). Broadly speaking, the previous results for crop corn show the average demand elasticities for relative insured acres was varied in the range between -0.27 and -0.32 and the elasticity for liability is around -0.13 and -0.73 (O’Donoghue 2014).

Crop insurance premium subsidies, because they reduce the price the farmer pays for the insurance, are another crucial factor that significantly affects crop insurance
demand. The specific premium subsidy varies with the coverage level and policy, but in recent years, has averaged roughly 60% across policies and crops (Du et al. 2017). Given this level of subsidies, most farmers pay substantially less than an actuarially fair premium, so that these subsidies have significantly increased the participation rate and induced farmers to insure more acres. Subsidies affect crop acreage in two ways (Yu et al. 2017). First is a direct profit effect – for a given coverage level, a farmers’ expected profit increases as they received more subsidies, thus motivating farmers to insure more acres. Second is an indirect coverage effect – higher premium subsidies induce farmers to seek higher coverage levels, which reduces the farmer’s overall level of risk per acre, and so in an endogenous risk sense, induces farmers to plant more acres that are insured.

The effect and the magnitude of premium subsidies have also been widely discussed (Du et al. 2017; O’Donoghue 2014; Cai et al. 2016; Yu et al. 2017). For example, O’Donoghue (2014) shows that a 1% increase in subsidy per acre can induce a 0.13% increase in corn insurance demand as measured by the liability per acre in Midwestern states, with the responses almost twice as large in the Lake States and the Northern Plains. By taking the indirect coverage effect into account, Yu et al. (2017) find that a 10% increase in the premium subsidy per dollar of liability can induce a 0.43% increase in the crop planted acreage.

In this paper, to examine the effects on U.S. farmer demand of crop insurance program, we construct a model of responses to some recognized factors. We focus on yield-based insurance and revenue-based insurance programs for crop corn in 12 Midwest and Great Plains states from 1997-2016. These two insurance policies are the major types of crop insurance in recent years. In 2016, farmer insured more than 80 million acres of corn with Yield Protection or Revenue Protection, or 85.6% of corn planted acres, with corn accounting for almost 40% of total crop insurance liability. In the empirical analysis, the share of planted acres insured and the total liability per planted acre are the dependent variables representing insurance demand.

Our analysis focuses on four key determinants of county-level crop insurance demand among corn farmers. First, the farmer’s average out-of-pocket premium payment captures the own-price effect. The farmer’s average premium paid is calculated as the insurance premium minus the premium subsidy and is expected to have a negative effect on insurance participation, i.e., insurance demand is downward
sloping. Second, the crop insurance purchases of adjoining counties captures neighborhood effects, which have been identified as important drivers in various insurance contexts, but not U.S. crop insurance (Cai et al. 2016, Karlan et al. 2014, Gallagher 2014). We expect a positive neighborhood effect due to spatial/geographic correlation in soil, climate/weather, and cultural factors influencing crop insurance purchase decisions. Third, the county’s loss experience of the previous year captures historical loss effects, which we measure by the total indemnities paid in the previous year in the county. The recent experience of a bad crop year and associated high indemnity payment is expected to positively influence the insurance demand of the current season. The historical loss effect has been noted in Goodwin (1993) for Iowa corn farmers using a panel of annual county-level data. Fourth, allowing substitution between revenue and yield insurance policies captures cross-price or substitution effects. Farmers can choose to change insurance plans every year, so substitution between yield and revenue insurance is possible and proved to be significant in our study. To the best of our knowledge, no study has empirically investigated substitution between yield and revenue insurance, though corn farmers have been able to buy both since 1997. Hence, to better understand the impact of the substitution effect, we jointly estimate demand for yield and revenue insurance using the seemingly unrelated regression model. A key empirical question is how much joint estimation with cross-policy substitution affects the estimated own-price elasticities for yield and revenue insurance, as these elasticities drive the direct impact of changes in premium subsidies. The inclusion of cross-price effect is also one our key contributions.

Our empirical results confirm the negative own-price effect for crop insurance programs – that demand for crop insurance is downward sloping in the out-of-pocket cost of the policies to farmers, which depends on the premium subsidy. The larger the premium subsidy, the smaller the out-of-pocket farmer cost and the greater farmer demand, which is consistent with the findings in the literature that farmers are sensitive to their out-of-pocket payment (Goodwin 1993; Du et al. 2017). Our results also show that the demand elasticity for revenue insurance is greater than that for yield insurance before considering cross-price effects. The respective own-price elasticities for the share of insured acres for yield and revenue insurance are -0.19 and -0.28, while for liability they are -0.33 and -0.42. The elasticity for liability is larger in magnitude than that for the insured acreage share, since the elasticity for liability
captures the effects of both insured acreage and coverage level changes.

The empirical results find a significant substitution relation between the demand for yield and revenue insurance – positive cross-price elasticities. The magnitudes are similar for both the insured acreage share and liability equations, but the cross-price elasticity for revenue insurance is larger than that for yield insurance. In other words, when out-of-pocket prices for both policies increase by 10%, yield insurance demand in terms of the share of planted acre insured decreases by 1.94% due to its higher own price, but simultaneously increases by 0.75% as farmers are switching from revenue to yield insurance, which is driven by higher premium payment of revenue insurance. The net change is -1.19% for yield and -1.40% for revenue as a 10% increase in both insurances’ out-of-pocket prices. We also find a significant and positive neighborhood effect for both insurance programs. A 10% increases of neighboring counties’ insurance demand (in either acreage share or liability) in the previous year drives up a county’s current insurance purchase by 5%-6%. Historical loss experience is found to be significantly positive for revenue insurance only.

To contribute to the current policy debate for the next Farm Bill, we derive and simulate the total effects of changing premium subsidies on insurance demand. The results show that with a 30% reduction in premium subsidies for both yield and revenue insurance plans, the projected the share of planted acres insured with yield insurance decreases by 0.038%, while that insured with revenue insurance decreases by 4.60%. In terms of acres rather than percentages, the projected changes with a 30% reduction in premium subsidies is a decrease of 24,000 acres in yield insurance and 2.9 million acres in revenue insurance roughly. The projected average decreases in terms of insured liability per acre are $0.23 and $23.41 for yield and revenue insurance, respectively.

Projected changes due to the subsidy reduction are also aggregated to the state level. Nebraska and Missouri, which have the largest share of planted acre insured in yield insurance, have the largest reductions in the participation of yield insurance. South Dakota and North Dakota, which have the largest share of planted acre insured in revenue insurance in 2016, have the largest reductions in the participation of revenue insurance.

The remainder of the paper proceeds as follows. Section 2 provides a brief summary of the history and relevant features of the U.S. crop insurance program.
section 3, we present our analytical framework and derive the empirical demand function. The data, variable explanation, and empirical model and results are presented in Section 4. Section 5 shows the policy simulation results of several potential policy change scenarios followed by concluding remarks.

2. Federal Crop Insurance Program

The Crop Insurance Improvement Act of 1980 established the modern crop insurance program. The 1980 Act introduced the premium subsidies, considerably expanded insurable crops and regions, and allowed farmers to use individual expected yield instead of area expected yield to determine their insurance guarantee (Coble and Knight 2002). Even though the government covered up to 30% of the total premium, the participation rate grew slowly and the program had difficulty breaking even in terms of its loss ratio (O’Donoghue, 2014). The Crop Insurance Reform Act of 1994 significantly increased premium subsidies in order to bring more farmers into the program and to eliminate ad hoc disaster programs. The 1994 Act also introduced fully subsidized Catastrophic Risk Protection Endorsement (CAT). Crop insurance participation rates quickly grew, with enrolled acres increased from around 100 million in 1994 to more than 220 million in 1995 (Du et al. 2017; O’Donoghue 2014).

The most recent crop insurance reform is based on the Agricultural Risk Protection Act of 2000, which induced more enrollment by providing further subsidies for most buy-up levels. The insured acres increased noticeably to more than 265 million in 2011 (Glauber 2013).

The primary individual policies can be categorized into two main types: yield insurance and revenue insurance. Yield insurance, available since 1980, triggers an indemnity if actual harvested yield is less than farmer’s yield guarantee.1 Revenue insurance, added in 1997, triggers an indemnity payment if actual harvest revenue is less than farmer’s revenue guarantee.2 Revenue insurance integrates the yield protection with price protection built on Chicago Mercantile Exchange (previously the Chicago Board of Trade) futures contract prices, so that the lines become unclear between yield protection and future crop prices (Coble and Knight 2002).

1 Yield guarantee is based on the Actual Production History (APH), the average harvested yields over recent 4-10 years and the coverage level can be chosen from 50% to 75% (or 85% depending on availability) by 5% intervals.
2 Revenue guarantee is set with the yield history and Chicago Board of Trade (CBOT) prices established for an insurance plan in a given year.
Furthermore, the conditions that trigger indemnity payments are based on a farm’s yield performance, so that indemnities are better correlated with the farm’s actual need. As a result of this advantage of revenue insurance over yield insurance, it has become the most preferred policy, with more than an 80% share of the corn insurance market in recent years. Although the premium subsidy rate of these two insurance programs are the same across coverage levels, revenue insurance buyers have greater subsidies per acre given the higher premium of revenue insurance (Du et al. 2017; Du et al. 2014).

Constructed from the RMA/USDA and NASS/USDA datasets, Figure 1 shows the average share of planted acres insured in yield and revenue insurance for crop corn in 12 Midwest and Great Plains states from 1989-2016. Before the introduction of revenue insurance, the average share of yield insurance is about 35%, but experienced a rapid annual decrease after 1997. On the other hand, the share of revenue insurance started with only roughly 14% but has dramatically increased to 80% in recent years. In the first three years after the introduction of revenue insurance, the shares of yield insurance were still greater than the that of revenue insurance, but after 1999, the share the revenue insurance experienced rapid growth and the difference of share between yield and revenue insurance is growing from about 10% in 2000 to 77% in 2016.

3. Analytical Framework

Following the literature (e.g., Just and Calvin 1994; Du et al. 2017), farmers are assumed to maximize the expected utility of buying insurance for individual insurance units. When experiencing a negative yield or revenue shock on an insured unit, they receive indemnity $I(z) \equiv \max(\bar{z} - z, 0)$, where $\bar{z}$ is the insurance coverage that is determined by farmer’s specific insurance choices, including, e.g., yield or revenue insurance, coverage level, unit type, etc. For example, under revenue insurance with coverage level $\phi$ and revenue guarantee $\bar{z}$, $\bar{z} = \phi \bar{z}$. $z$ is the underlying stochastic item, which can be yield or revenue of the particular unit, and follows the distribution function of $F(z)$. The actuarially fair premium is by definition equal to the expected

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3 The insured acres data are from the Summary of Business Reports and Data maintained by the RMA/USDA, which can be found at https://www.rma.usda.gov/data/sob/scc/index.html, and the planted acreage of crop corn are from the USDA NASS Dataset which can be found at https://quickstats.nass.usda.gov/.
indemnity, i.e., \( p(\tilde{z}) = E(I(z; \tilde{z})) = \int_{0}^{\tilde{z}} (\tilde{z} - z)dF(z) \). The corresponding subsidy rate is \( s(\tilde{z}) \). A farmer’s expected utility with insurance can be written as:

\[
EU_i = F(\tilde{z})U \left( M + \tilde{z} - (1 - s(\tilde{z}))p(\tilde{z}) \right) + \left( 1 - F(\tilde{z}) \right)U(M + z - (1 - s(\tilde{z}))p(\tilde{z})), \tag{1}
\]

where \( M \) is the disposable income after covering production cost. Without crop insurance, farmer’s expected utility is: \( EU_0 = U(M + z) \). An expected-utility-maximizing farmer would purchase crop insurance is \( EU_i > EU_0 \), or \( F(\tilde{z})U(M + \tilde{z} - (1 - s(\tilde{z}))p(\tilde{z})) + \left( 1 - F(\tilde{z}) \right)U(M + z - (1 - s(\tilde{z}))p(\tilde{z})) > U(M + z) \). The optimal policy can be solved by differentiating (1) with respect to \( \tilde{z} \).\(^4\) Farm or county level results can be obtained by aggregating unit level choices to the appropriate level.

In this study, we treat counties as representative farms.

The discussion above guides us in multiple ways for the empirical setup we are turning to now. First, there are two ways to represent insurance demand at the county level, which is denoted by \( D_{it} \) for county \( i \) at year \( t \). An individual farmer’s discrete choice of buying crop insurance can be aggregated into share of insured acres in total planted acres for a given county. An alternative measure of county level insurance demand is the average per acre liability, which is \( \tilde{z} \) in eqn. (1) representing the payment to insured who experiences a complete crop loss (\( z = 0 \)). Second, a farmer’s insurance policy decision, yield/revenue insurance or coverage level, can be largely driven by out-of-pocket payment, i.e., premium payment after subsidy or \((1 - s(\tilde{z}))p(\tilde{z})\), production risk summarized in \( F(z) \) and farmer’s risk preference embedded in the utility function. While production risk is closely related to soil quality and risk preference is stable, both of which are unobservable and constant over time, it is reasonable to assume that they can be captured by farm or county level fixed effects. Third, in the empirical implementation, we incorporate several other factors not captured by the analytical framework including neighbor or network effects as farmers are influenced by connected others in making insurance decisions. Another is the dynamic learning effect. We assume that farmers update their insurance valuation based on the realization in the previous season. In other words, they are

\(^4\) Please find a detailed derivation of the optimal coverage level choice, which is an important dimension of \( \tilde{z} \) as discussed, on p. 736 of Du et al. (2017).
more likely to purchase if they received indemnity for the recent loss (see, e.g., Cai et al. 2016). This captures two other things simultaneously, negative weather shocks in the last period, which reflect production risk, and spatial correlation of soil condition and consequently insurance demand, the latter of which improves the efficiency of variance estimation.

Assume that insurance demand can be represented by a log-linear equation of determining factors, the demand $D_{it}$ for county $i$ in year $t$ becomes:

$$D_{it} = \alpha + X_{it} \beta + e_{it}$$

(2)

where $X_i$ are the vector of the explanatory variables, including, e.g., out-of-pocket premium payment, neighboring counties’ insurance purchase, $e_{it}$ represent unobservable factors with a mean of zero, and $\alpha$ and $\beta$ are the associated unknown parameters.

Farmers can choose from yield or revenue insurance plan. Therefore, it should be reasonable to model the demand for two plans simultaneously at the county level. Assume $P_{it}$ is a vector of paid insurance price (premium after subsidy) for farmer $i$ in year $t$, the insurance demand is a two-equation system and specified as:

$$D_{1it} = \alpha_1 + P_{it} \beta_1 + X_{1it} \gamma_1 + e_{1it}$$

$$D_{2it} = \alpha_2 + P_{it} \beta_2 + X_{2it} \gamma_2 + e_{2it}$$

(3)

where $D_{mit}$ is the demand of the insurance program $m$ ($m = 1, 2$), $X_{mit}$ is a vector of other explanatory variables other than the price. $\alpha_m$ represents the county level fixed effect, $\beta_m$, and $\gamma_m$ are the parameters to estimate, and $e_{mit}$ denotes the random error.

The error terms are expected to be correlated given the fact that farmers face the same information for making their insurance decisions and are free to switch between the plans. Therefore, we joint estimate the insurance demand functions in eqn. (3) using a seemingly unrelated regression model (SUR; Zellner 1962), which is a set of related regression equations that has contemporaneous cross-equation error correlation. The SUR model in (3) can be represented by the following equation (Greene 2012)

$$D_{mit} = \alpha_m + P_{it} \beta_m + X_{mit} \gamma_m + e_{mit}, \text{ for } m = 1, 2.$$  

(4)

where the disturbance formulation is $e_{it} = (e_{1it}', e_{2it}')'$. We assume that $X_{mit}$ is exogeneous and that the disturbances are uncorrelated across observations but
correlated across equations, i.e., \( E(e_{it}|X_{1it}, X_{2it}) = 0 \), \( E(e_{mit}e_{njt}^t|X_{1it}, X_{2it}) = \sigma_{mn} \) if \( i = j \) and 0 otherwise for \( m, n = 1,2 \). The SUR model produces more efficient estimates than ordinary least squares (OLS) model as it weights the estimates by the covariance of the disturbances from the individual regressions (Greene 2012).

4. Empirical Analysis

In the following empirical analysis, we treat each county as a representative farm and focus on crop insurance of corn. As discussed in the previous section, two measures of crop insurance demand are constructed as the dependent variables, the share of insured acres and liability per planted acre\(^5\). The share of insured acres is the proportion of insured acres in total planted acres of an individual county. The liability per acre is the maximum dollar amount of indemnities that the farmer can get in case of a complete crop loss. In some cases, the liability is preferable and regarded as the true level of insurance as it reflects a more complete picture of farmer’s insurance choices like price election, coverage level and the insurable yield estimated by the FCIC (the Federal Crop Insurance Corporation) (Goodwin 1993).

As for the right hand side variables, we specify several recognized mechanisms that may affect the purchase of county-level crop insurance among corn farmers. First, an own-price effect where a lower out-of-pocket premium enhances the demand of insurance plan. Second, a neighborhood effect where crop insurance practices of adjoining counties can influence a county’s insurance demand because that neighboring counties share similar weather risks and soil quality. Also a farmer in a county could observe his neighbors’ experience to update his own belief of risk. Third, a historical loss experience effect where a higher indemnity that has been received when a negative shock occurred in previous year can lead to higher insurance demand in the current period. Fourth, a cross-price or substitution effect where farmers are able to switch between revenue and yield insurance policies. The first three effects have been discussed and documented by previous analyses (e.g., Goodwin, 1993; Gallagher, 2014; Cai et al., 2016). We keep them in our analysis and

\(^5\) Even though some literatures use the liability per insured acre (e.g., O’Donoghue, 2014), we instead construct the liability per planted acre as the dependent variable as the measure adopted in Goodwin (1993). As the liability depends on the price election, yield guarantee, and most importantly, the insured acres, so more insured acres also raise the liability. For example, if a certain percent increase in insured acres causes the same percentage increase in liability, the liability per insured acre will not change, but in fact, the insurance demand grows.
incorporate the cross-price or substitution effect, which is crucial for modelling crop insurance demand but hasn’t been empirically investigated in the literature.

4.1 Data

We construct a county-level crop insurance panel for corn in 12 Midwestern and Great Plains states (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, and WI) for the period of 1997 to 2016 using the Summary of Business Reports and Data maintained by the Risk Management Agency of the US Department of Agriculture (RMA/USDA 2018). The dataset provides individual counties’ insurance information, including average premium, subsidy, indemnity and liability amount, loss ratios, and insured acreage under different crop insurance programs and coverage levels. For the analysis of insurance demand, we aggregate the insurance purchase information of the yield-based or revenue-based insurance plans across all coverage levels. We obtain from the USDA National Agricultural Statistics Service (NASS) database the county-level planted acres which are used for calculating counties’ shares of insured acres, and the index of price paid for production item which is used for deflating the monetary variables. The February average price of the December futures contract traded in the Chicago Board of Trade (CBOT)) is used as the expected corn price each year.

In order to define the neighboring counties, we use the latitude and longitude coordinates of the geographic center of counties in the twelve states that obtained from the 2017 Census U.S. Gazetteer Files to calculate the distances of any two counties. If the distance between two counties is less than 60 kilometers, we define these two counties as neighbors. Based on the rule of 60 kilometers, the average number of neighboring counties is 5.7. After defining each county’s neighboring counties, data can be downloaded from https://www.rma.usda.gov/data/sob/scc/index.html. The yield-based insurance plans include Yield Protection (YP), Actual Production History (APH) and Group Risk Plan (GRP), which trigger indemnity if the actual harvested yield is less than the yield guarantee; on the other hands, the revenue-based insurance plans, which trigger indemnity payment if the actual harvested revenue is below the revenue guarantee, include Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RPHPE), Group Risk Income Protection (GRIP) and Group Risk Income Protection with Harvest Revenue Option (GRIPH).

The USDA NASS Dataset can be found at https://quickstats.nass.usda.gov/. The 2017 Gazetteer Files can be found at https://www.census.gov/geo/maps-data/data/data/gazetteer2017.html. There are, however, 15 counties do not have neighboring counties based on our definition since some counties share a border with only one county and/or the counties’ areas are so large that there is no neighboring counties within 60 kilometers. We drop these counties since we cannot define their neighboring counties’ insurance purchasing information. The total number of remaining counties is 933.
counties, we then calculate the average values of neighboring counties’ insurance purchasing information, including liability and share of insured acres of yield or revenue insurance in the previous year to represent the neighbors’ previous experiences for each county.

The detailed definitions and summary statistics of all RHS variables are presented in Table 1.11 The average share of insured in 1997-2016 is about 13% for yield and 58% for revenue insurance. As for all of the monetary variables such as liability, out-of-pocket premium rate, and indemnity, we adjust them to 1991-equivalent dollars by deflating with the index of prices paid for production item. We consider the out-of-pocket premium, which is the total premium minus total subsidy, to account for the federal government subsidies and to reflect what farmers actually pay out of their own pockets. The price variable in the yield insurance equation is the out-of-pocket premium rate, i.e., the total out-of-pocket premium divided by hundred dollars of total liability. For the revenue insurance equation, two terms related to premium payment are included, out-of-pocket premium rate and premium rate times expected corn price, the latter of which is added in order to separate the effect of premium rate and crop price on insurance demand.

4.2 Analyses of Share of Insured Acres and Liability Per Acre

In this section, we jointly estimate the yield and revenue insurance demand using a SUR model with contemporaneously correlated error terms specified in eqn. (3). We first use the share of insured acres, then change to the liability per planted acre as the measure of crop insurance demand. Note that all the demand regressions are performed in a double logarithmic form, so the estimated coefficients represent the elasticities of the corresponding variables.

4.2.1 The share of insured acres

To evaluate the effects of the key determinants, i.e. the own-price effects, the neighbor effects, the historical loss effects, and the substitution effects, on the proportion of planted acres insured, the demand model for yield and revenue insurance policies of county \( i \) in year \( t \) can be specified as:

11 We keep the observations if the county has both yield and revenue insurance purchasing information in that year since we consider the substitute effects in our model, and only use the observations after 1998 since we do not have the lagged information in 1996 for year 1997.
$$\begin{align*}
\ln(\text{Share acres}^y_{it}) &= \alpha_{1y} + \ln(P^y_{it})\beta_{1yy} + \ln(P^r_{it})\beta_{1yr} + \ln(P^r_{it}) * \ln(CP_t)\rho_{1y} \\
&\quad + \ln(\text{Share Acres}^n_{it})\gamma_{1y} + \ln(LR_{it-1})\delta_{1y} + \theta_i + \upsilon_t + \epsilon^y_{it} \\
\ln(\text{Share acres}^r_{it}) &= \alpha_{1r} + \ln(P^r_{it})\beta_{1rr} + \ln(P^r_{it}) * \ln(CP_t)\rho_{1r} + \ln(P^y_{it})\beta_{1ry} \\
&\quad + \ln(\text{Share Acres}^n_{it-1})\gamma_{1r} + \ln(LR_{it-1})\delta_{1r} + \theta_i + \upsilon_t + \epsilon^r_{it}
\end{align*}$$

where $\text{Share Acres}_{it}$ is the share of insured acres. $P^y_{it}$ ($P^r_{it}$) is the out-of-pocket premium rate of yield (revenue) insurance. $CP_t$ is the expected corn price. $\text{Share Acres}^n_{it}$ is the share of insured acres in the previous year $(t - 1)$ of neighboring counties. $LR_{it-1}$ is county $i$’s own loss-ratio in the previous year $(t - 1)$. $\theta_i$ denotes the county fixed effect. $\upsilon_t$ are year dummies, $\alpha$, $\beta$, $\rho$, $\gamma$, and $\delta$ are parameters to estimate, and $\epsilon_j$ the error terms. The superscripts “$y$” and “$r$” indicate yield and revenue insurance. Note that the premium rates of the other insurance plans capture the substitution effect. For example, the out-of-pocket premium rate of revenue insurance, $P^r_{it}$, describes the cross-price effect in the yield insurance equation, $\text{Share acres}^y_{it}$. It captures the effect of revenue insurance premium on the demand of yield insurance. We expect the coefficient to be positive as higher revenue premium is expected to drive up the demand of yield insurance.

The estimation results are reported in Table 2. We find that the two regressions are related because that for the same counties, the correlation of the residuals in the two demand equations is -0.0394. Also from the Breusch-Pagan test of independence, we reject the null hypothesis of zero correlation.\(^{12}\) Thus, joint estimation of the insurance demand function is more realistic than estimating the equations separately.\(^{13}\) To make the comparison between two insurance programs easier, we report the elasticity of insurance demand at the means in Table 3. As expected, demand functions for both policies are downward sloping. The lower the out-of-pocket insurance price, the greater the insurance demand. This is consistent with the

\(^{12}\) The Breusch-Pagan test statistic, a Lagrange multiplier measure, is chi-squared distributed. If $m$ equations and $N$ observations are included in the system, the LM statistic is given by $\text{LM} = N \sum_{i=1}^{m} \sum_{j=1}^{N} r^2_{ij}$, where the $r^2_{ij}$ is the estimated correlation of residuals of $m$ equations, and this is distributed as $\chi^2(m(m - 1)/2)$ (Breusch and Pagan 1980).

\(^{13}\) Even though estimating the crop insurance demands separately is problematic, we also examined the influences of the key determinants, except cross-price effect, on the share of insured acres using the fixed effects panel data model as a robustness check. We find the signs of the regression coefficients are the same and the significance levels do not change much, but the magnitudes are different. Comparing to the joint estimation, the separate estimation has smaller own price elasticities, especially for revenue insurance. But the effects of the neighbor and historical loss ratio are almost the same. For example, a 10% increase in own price implies a 3.4% reduction in the liability of revenue insurance in the separately estimation, but a 4.2% reduction if estimated the two equations jointly.
findings in the literature (e.g., Goodwin 1993; Du et al. 2017). The elasticity is larger in magnitude for revenue insurance. If the out-of-pocket premium rate increases by 1%, the demand for revenue insurance decreases by 0.28% while the demand for yield insurance goes down by 0.19% only. Our results show a more inelastic demand for yield insurance than that in Goodwin (1993) which suggest the elasticity of -0.32, while our elasticity for revenue insurance is quite similar to the results in the literatures, ranging from -0.27 to -0.32 (O’Donoghue 2014).

Since farmers can purchase both yield and revenue insurance, the potential substitution effect between yield and revenue insurance is important. From the cross-price effects, we find the elasticities for both insurance programs are positive, indicating a substitution relation between demand for yield and revenue insurance. Further, the cross-price elasticity of revenue insurance is larger than that of yield insurance. In other words, if out-of-pocket revenue insurance price increases by 10%, the demand of yield insurance increases by 0.8%. But on the other hand, the demand of revenue insurance increases by 1.4% if out-of-pocket yield insurance price experiences a 10% increase. A key empirical question is how much joint estimation with cross-policy substitution affects the estimated own-price elasticities for yield and revenue insurance. These quantities drive the direct impact of changes in premium subsidies on crop insurance demand. We will simulate the total effects of subsidy changes on insurance demand and discuss the policy implication in next Section.

The neighborhood effects show that counties’ insurance demands for both policies are strongly and positively influenced by their neighboring counties’ levels of insured acres in the last year, which indicates positive spatial auto-correlation in the demand for both policies. A 10% greater in neighboring counties’ previous share of planted acres insured will increase the county’s share insured acres this year by 5%-6%. Finally, the lagged loss ratio, which depends on the premium and indemnity in last year, has a positive effect on demand for revenue insurance. The higher the indemnity and the lower the premium in last year, the greater the insurance demand in this year. On the other hand, a positive but not significant effect on demand is found for yield insurance demand.

4.2.2 Liability per acre

Using the county’s liability per planted acre as the dependent variable, the estimation equation is as follows:
\[
\begin{align*}
\ln(\text{Liability}_{it}^y) &= \alpha_{2y} + \ln(P^y_{it})\beta_{2yy} + \ln(P^r_{it})\beta_{2yr} + \ln(CP_{it})\gamma_{2y} \\
&+ \ln(\text{Liability}_{it-1}^y)\gamma_{2y} + \ln(LR_{it-1}^y)\delta_{2y} + \theta_i + v_t + \epsilon_{2it} \\
\ln(\text{Liability}_{it}^r) &= \alpha_{2r} + \ln(P^r_{it})\beta_{2rr} + \ln(P^y_{it})\gamma_{2r} + \ln(CP_{it})\gamma_{2r} \\
&+ \ln(\text{Liability}_{it-1}^r)\gamma_{2r} + \ln(LR_{it-1}^r)\delta_{2r} + \theta_i + v_t + \epsilon_{2itr}
\end{align*}
\]  

where \( \text{Liability}_{it} \) is per acre liability ($) in county \( i \) at year \( t \). \( \text{Liability}_{it-1}^r \) is the average liability in the previous year \( (t - 1) \) in neighboring counties. As above, “\( y \)” and “\( r \)” superscript indicate variables for yield and revenue insurance, respectively.

The estimated coefficients of the RHS variables are presented in Table 4. The last two rows indicate that the liability regression of two insurance plans are related since the residuals across equations are contemporaneously correlated and we reject the null hypothesis that their correlation is zero. In Table 5, the demand elasticities on the four key determinants at mean value for pre acre liability are reported. Comparing to the results of share of insured acres, the elasticities for liability are similar in magnitude for all effects except the own price effect – insured acres are less responsive than liability. A 1% increase in its own out-of-pocket insurance price will decrease the demand of yield and revenue insurance by 0.33% and 0.42% respectively, but the elasticities in the share equations are only 0.19% and 0.28% respectively. This makes sense because that if the own price of insurance increases, farmers can respond by insuring less acreage and by reducing their coverage level. The own price elasticity for insured acres only captures the first effect, while that for liability captures both effects and thus is larger in magnitude. Besides, our elasticity estimates for liability are more elastic than some other results in previous studies, like Goodwin (2001) and Goodwin et al. (2004), where elasticities are -0.24 and -0.28 for yield and revenue respectively.

We also find significant and positive cross-price effects between yield and revenue insurance, and the magnitudes are quite similar. A 1% increase in revenue insurance price increases the liability of yield insurance by 0.11%, while the liability in yield insurance enhances by 0.14%. The neighbor effects still play an important role in the per acre liability. When its neighboring counties purchase 1% more of liability per acre in the previous year, a county will increase its own liability by 0.5%~0.6% on average. Finally, the loss-ratio has a significant and positive effect on the revenue insurance demand, but no effect on yield insurance demand. Comparing to the literatures, our estimated results are more convincing and comprehensive as we
not only have a broader geographic coverage, but also consider the key determining factors and more importantly the cross-product substitution effect.

5. Simulation

Given the interest in the next Farm Bill and likely calls for reducing crop insurance premium subsidies, we anticipate interests in the policy implications. In this section, we use the estimated results and project impacts on crop insurance participation and liability to simulate policy scenarios.

To illustrate the overall effect of reducing subsidies for both insurance plans on the crop insurance demand, we first derive the predicted value of insurance demand, \( \hat{D}_{\text{original}} \), i.e. the share of planted acre insured and the liability per planted acre, using estimated results in Section 4.2\(^{14}\). Assume federal government now rescale both yield and revenue insurance premium subsidies by \( \tau \) percent, where \( 0 < \tau < 100 \). Then, our new predicted value of insurance demand after the changes in premium subsidies can be expressed as follows,

\[
\hat{D}_{\text{new}} = f(P_{\text{new}}^y, P_{\text{new}}^r, X) = g(premium^y - \tau S^y, premium^r - \tau S^r, X)
\]

where \( P_{\text{new}}^y \) and \( P_{\text{new}}^r \) are the new out-of-pocket payment rate of yield and revenue insurance plan, respectively, after government change the premium subsidies in both insurance plan; \( premium^y \) and \( premium^r \) are the total premium per hundred dollars of liability of yield and revenue insurance plan, respectively; \( S^y \) and \( S^r \) are the subsidies per hundred dollars of liability of yield and revenue insurance plan, respectively; and \( X \) are other dependent variables. After generating the \( P_{\text{new}}^y \) and \( P_{\text{new}}^r \), we use the estimated value of parameters from the previous section to create the new predicted values of insurance demand.

We then quantify the changes in crop insurance demand due to the policy changes, which are the difference between the original predicted insurance demand and the new one, i.e. \( \hat{D}_{\text{new}} - \hat{D}_{\text{original}} \). In the following, we assume federal government considers a 30\% reduction, i.e. \( \tau = 70\% \), in government premium subsidies of both yield and revenue insurance plans, and we will demonstrate how the insurance demands will change in the U.S. and each state. On the top right of Figures

\(^{14}\) We use the value of independent variables in 2016 instead of the mean value over the period to generate the predicted value of insurance demand, since in 2016, which can be called a normal crop year when there is no extreme weather event such as drought and flood and weather conditions are normal.
2 and 3, we show when a 30% reduction in government premium subsidies of both yield and revenue insurance plans, the share of planted acre insured in yield insurance plan will decrease 0.038%, while the share of planted acre insured in revenue insurance will reduce 4.60%. Note that the average shares of planted acre insured in yield and revenue insurance are roughly 3% and 82% respectively in the twelve states in 2016, and thus, a 4.6% reduction in the share of revenue insurance would not be a small change. We also report the change of total insured acres for both insurance plans in on the top right of Figures 4 and 5. If government reduces the premium subsidies in both insurance plans by 30%, the total acreage insured in yield insurance in twelve states will decrease 23,797 acres, while that in revenue insurance will be 2,854,586 acres. Finally, we find counties will spend less money on the liability per planted acre of yield insurance by $0.23, while the average dollar decrease in liability per planted acre of revenue insurance will be $23.41, if a 30% reduction in government premium subsidies in both insurance plans (as shown in the top right of Figures 6 and 7).

To analyze each state’s response to the reduced premium subsidies, we also compute the change in insurance demand for each studied state. Figures 2-7 present the average percent changes in share of planted acre insured, the changes of insured acreages, and the dollar changes in liability per planted acre for both insurances in each state when there is a 30% reduction in government premium subsidies of both yield and revenue insurance plans. We find the top three states with the highest reductions in the share of planted acre insured in yield insurance are Nebraska, Missouri and Wisconsin, while the top three highest reductions in the share of revenue insurance are shown in South Dakota, North Dakota, and Wisconsin. Interestingly, the states of Nebraska and Missouri have the highest share of planted acre insured in yield insurance, while South Dakota, North Dakota also have the highest share of planted acre insured in revenue insurance in 2016, comparing to other states. In other words, not only have those states the highest share of planted acre insured, but also their reductions in the shares are the largest when the reductions in both insurance premium subsidies occur. On the other hand, Illinois, Iowa, and Nebraska, which are the top three states with the highest corn production, have lower reductions in the share of planted acre insured in revenue insurance comparing to other states’ values (NASS/USDA 2017).

As for the average changes in the insured acreages due to a 30% reduction in
premium subsidies in both insurance plans, we find the states with the highest corn production have larger reductions in the insured acreage in both insurance plans. In Illinois, a 30% reduction in subsidies can cause 4,288 acreages decrease in yield insurance, while also make roughly 400,000 acres decrease in revenue insurance. Besides, we also look at the average dollar change in liability per planted acre since it captures the coverage level change and can be regarded as a more accurate measure of insurance demand. The simulation results present that Nebraska, Michigan and Wisconsin have higher decreases in the liability per planted acre of yield insurance when there are reductions in premium subsidies in both insurance plans, comparing to other states. In Nebraska, a 30% reduction in both insurances’ subsidies can cause the liability per planted acre decrease by $0.39. In the revenue insurance demand, South Dakota, Wisconsin, and Minnesota have larger reduction in the liability per planted acre, in contrast to other states, if there is a reduction in both insurance’s subsidies. The liability per planted acre will decrease by $33.68 in South Dakota. The average liability per planted acre in South Dakota in 2016 is about $188, and so a reduction of $33.68 in liability per planted acre is a noticeable value. These policy simulations provide a possible effect on the insurance demand, which should be considered in the design of a policy change.

6. Conclusions

In the United States, crop insurance program has grown to be the most important and well-known risk mitigation mechanism for inherent agricultural production uncertainty. Yet, since government highly subsidized the insurance premium, these subsidy interventions have been much disputed. A critical debate on the next Farm Bill is the reduction of government spending on premium subsidies. To develop a more effective and efficient insurance program for U.S. farmers, examining the effect of such a policy change on farmers’ crop insurance demand cannot be overstated. In this paper, we first identify a number of recognized determinants of crop insurance demand, and then examine the extent to which the factors may affect the participation rate. Further, we used the estimated insurance demand model to simulate the total effects of reducing both insurances’ premium subsidies on the insurance demand.

We specifically focus on four key determinants through which farmers’ current experience can influence their insurance demand: 1) out-of-pocket premium (own-
price effects), 2) crop insurance practices of adjoining counties (neighborhood effects), 3) previous county-level loss experience (historical loss effects), and 4) the ability to switch between revenue and yield insurance policies (cross-price or substitution effects). These substitution effects are also one of our main contributions to the prevailing literature, since the effects have not been investigated in the previous studies. In the empirical analysis, the county-level insurance data for crop corn in twelve Midwest and Great Plains states from 1997-2016 are used, focusing on the two major insurance programs, i.e. yield-based and revenue-based insurance policies. A seemingly unrelated regression model with contemporaneously correlated error terms are employed to jointly estimate the demands of two different insurance plans.

Our results suggest a negative own-price effect – i.e. demand for crop insurance is downward sloping in the farmers’ out-of-pocket insurance prices, which depends on the premium and the government subsidy. Positive spatial auto-correlation, i.e. a positive neighborhood effect, seems likely; neighboring counties tend to have similar levels of crop insurance demand. We also find historical loss experience to positively impact county-level demand, with losses in previous years tending to increase demand for insurance in the current year. More importantly, the estimation results present a significant substitution effect between yield and revenue insurance. With a 10% increase in the out-of-pocket revenue insurance prices, the demand of yield insurance will increase about 0.8%, while the demand of revenue insurance will increase 1.4%, if out-of-pocket yield insurance prices increase 10%. Our results demonstrate the importance of these factors on the crop insurance demands.

Our concerns also focus on policy implications since premium subsidies have a larger effect on the enrollment of crop insurance program. From the simulation results, we find a 30% reduction in government premium subsidies of both insurance plans can cause the share of planted acres insured in the yield insurance plan to decrease by 0.038%, while the share of planted acres insured in the revenue insurance will reduce by 4.60% in the studied states. In addition, the total insured acreage will decrease about 24 thousand acreages in yield insurance plans and roughly 2.9 million acreages in revenue insurance. As for the liability per planted acre, due to the 30% reduction, the average dollar decrease in liability per planted acre of yield and revenue insurance will be $0.23 and $23.41, respectively. These results ensure us that the premium subsidy plays a pivotal role in explaining the crop insurance demand and
why the government should better understand the implications of reducing subsidies.

References


Figure 1. Average proportion of planted acres insured in yield and revenue insurance for crop corn in 12 Midwest and Great Plains states from 1989-2016.
Table 1 Summary Statistics of the Selected Variables: 933 Counties in Twelve Midwestern and Great Plains States, 1997-2016.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Yield Insurance</th>
<th>Revenue Insurance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td><strong>Dependent Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share insured acres</td>
<td>Log of proportion of planted acres insured</td>
<td>-2.5400</td>
<td>1.0571</td>
</tr>
<tr>
<td>Liability</td>
<td>Log of real dollars of liability per planted acre</td>
<td>2.6712</td>
<td>1.0085</td>
</tr>
<tr>
<td><strong>Independent Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-of-pocket insurance price rate</td>
<td>Log of out-of-pocket insurance price rate (dollars per hundred dollars of liability)</td>
<td>0.9820</td>
<td>0.5200</td>
</tr>
<tr>
<td>Normalized out-of-pocket insurance price rate</td>
<td>Log of out-of-pocket insurance price rate divided by future corn price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normalized out-of-pocket insurance price rate* corn price</td>
<td>Normalized out-of-pocket insurance price rate times log of future corn price</td>
<td>0.5447</td>
<td>0.2953</td>
</tr>
<tr>
<td>Lag farmer’s loss-ratio</td>
<td>Log of real indemnities divided by real premium in preceding year</td>
<td>-1.7761</td>
<td>3.8524</td>
</tr>
<tr>
<td>Neighbors’ lag insured acres</td>
<td>Log of neighboring counties’ average proportion of planted acres insured</td>
<td>-2.3642</td>
<td>0.8950</td>
</tr>
<tr>
<td>Neighbors’ lag liability</td>
<td>Log of neighboring counties’ average liability</td>
<td>2.8492</td>
<td>0.8038</td>
</tr>
</tbody>
</table>

Note: The out-of-pocket insurance price is defined as the total premium amount minus the total subsidy amount.
### Table 2 Estimation of the Share of Planted Acres Insured Equation

#### Yield insurance

<table>
<thead>
<tr>
<th>Term</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-of-pocket payment rate of yield insurance</td>
<td>-0.194***</td>
<td>(0.018)</td>
</tr>
<tr>
<td>Normalized out-of-pocket payment rate of revenue insurance</td>
<td>0.304***</td>
<td>(0.065)</td>
</tr>
<tr>
<td>Normalized out-of-pocket payment rate of revenue</td>
<td>-0.284***</td>
<td>(0.075)</td>
</tr>
<tr>
<td>insurance*corn price</td>
<td>0.594***</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Neighbors' lag insured acres of yield insurance</td>
<td>0.001</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Lag loss ratio of yield insurance</td>
<td>-0.239**</td>
<td>(0.109)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.239**</td>
<td>(0.109)</td>
</tr>
</tbody>
</table>

#### Revenue insurance

<table>
<thead>
<tr>
<th>Term</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalized out-of-pocket payment rate of revenue insurance</td>
<td>-0.237***</td>
<td>(0.043)</td>
</tr>
<tr>
<td>Normalized out-of-pocket payment rate of revenue</td>
<td>-0.049</td>
<td>(0.050)</td>
</tr>
<tr>
<td>insurance*corn price</td>
<td>0.137***</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Neighbors' lag insured acres of revenue insurance</td>
<td>0.532***</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Lag loss ratio of revenue insurance</td>
<td>0.031***</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.815***</td>
<td>(0.074)</td>
</tr>
</tbody>
</table>

#### Year dummies

- Yes

#### County Fixed Effect

- Yes

#### Observations

- 14857

#### $R^2$ Yield Insurance

- 0.815

#### $R^2$ Revenue Insurance

- 0.848

#### Correlation of the residuals

- -0.0394

#### Breusch-Pagan test of independence

- Chi-square statistic = 23.107, P-value = 0.000

Note: Standard errors are displayed in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
### Table 3 Elasticities for the Share of Planted Acres Insured

<table>
<thead>
<tr>
<th>Elasticity</th>
<th>Yield Insurance</th>
<th>Revenue Insurance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Own price elasticity</strong></td>
<td>-0.194***</td>
<td>-0.277***</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.018)</td>
</tr>
<tr>
<td><strong>Cross price elasticity</strong></td>
<td>0.075***</td>
<td>0.137***</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.012)</td>
</tr>
<tr>
<td><strong>Neighbor effect</strong></td>
<td>0.594***</td>
<td>0.532***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.008)</td>
</tr>
<tr>
<td><strong>Loss Ratio</strong></td>
<td>0.001</td>
<td>0.031***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
</tbody>
</table>

Note: The own price and cross price elasticity for revenue insurance are calculated at the average deflated corn price, $2.24; Standard errors are displayed in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Table 4 Estimation of the Total Liability Per Planted Acre Equation

### Yield insurance

<table>
<thead>
<tr>
<th>Term</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-of-pocket payment rate of yield insurance</td>
<td>-0.334***</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Normalized out-of-pocket payment rate of revenue insurance</td>
<td>0.394**</td>
<td>(0.070)</td>
</tr>
<tr>
<td>Normalized out-of-pocket payment rate of revenue insurance*corn price</td>
<td>-0.347***</td>
<td>(0.081)</td>
</tr>
<tr>
<td>Neighbors' lag insured acres of yield insurance</td>
<td>0.575***</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Lag loss ratio of yield insurance</td>
<td>-0.001</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Constant</td>
<td>2.222***</td>
<td>(0.122)</td>
</tr>
</tbody>
</table>

### Revenue insurance

<table>
<thead>
<tr>
<th>Term</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalized out-of-pocket payment rate of revenue insurance</td>
<td>-0.372***</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Normalized out-of-pocket payment rate of revenue insurance*corn price</td>
<td>-0.061</td>
<td>(0.053)</td>
</tr>
<tr>
<td>Out-of-pocket payment rate of yield insurance</td>
<td>0.139**</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Neighbors' lag insured acres of revenue insurance</td>
<td>0.509***</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Lag loss ratio of revenue insurance</td>
<td>0.034***</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.993***</td>
<td>(0.080)</td>
</tr>
</tbody>
</table>

Year dummies: Yes  
County Fixed Effect: Yes  
Observations: 14857  
$R^2$ _Yield Insurance: 0.764  
$R^2$ _Revenue Insurance: 0.887  
Correlation of the residuals: -0.0537  
Breusch-Pagan test of independence: Chi-square statistic = 42.868, P-value = 0.000

Note: Standard errors are displayed in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Table 5 Elasticities for the Total Liability Per Planted Acre

<table>
<thead>
<tr>
<th>Elasticity</th>
<th>Yield Insurance</th>
<th>Revenue Insurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own price elasticity</td>
<td>-0.334***</td>
<td>-0.421***</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Cross price elasticity</td>
<td>0.114***</td>
<td>0.139***</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Neighbor effect</td>
<td>0.575***</td>
<td>0.509***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Loss Ratio</td>
<td>-0.001</td>
<td>0.034***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
</tbody>
</table>

Note: The own price and cross price elasticity for revenue insurance are calculated at the average deflated corn price, $2.24; Standard errors are displayed in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Figure 2 Average % change in insured acre share of yield insurance if a 30% reduction in both insurances’ subsidies.

Figure 3 Average % change in insured acre share of revenue insurance if a 30% reduction in both insurances’ subsidies.
Figure 4 Average insured acre change of yield insurance if a 30% reduction in both insurances’ subsidies.

Figure 5 Average insured acre change of revenue insurance if a 30% reduction in both insurances’ subsidies.
Figure 6 Average $ change in liability per planted acre of yield insurance if a 30% reduction in both insurances’ subsidies.

Figure 7 Average $ change in liability per planted acre of revenue insurance if a 30% reduction in both insurances’ subsidies.