Crop Insurance Decision under Expected Revenue

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Abstract

The Federal Crop Insurance Program is the safety net for U.S. farmers that protect them from natural disasters and market instability. To understand potential subjective determinants that affect producers' crop insurance decisions over time, this study explores a revenue-based theoretical framework on crop insurance decisions that incorporates behavioral concepts of reference-dependent and loss aversion. Empirical results using individual-level panel data provide supportive evidence that producers' experience in indemnity and revenue fluctuation affects their choices of crop insurance coverage. This study evaluates producer responses to crop insurance policies over time, which offers timely policy implications under the recent debates on a potential significant cut of crop insurance subsidy.

Background

The Federal Crop Insurance Program is the primary risk management program available to U.S. agricultural producers that protect against either the risks due to unexpected disasters, such as hail, drought, and floods, or the uncertainty of revenue due to volatilities in the market prices of crop commodity. As the centerpiece of federal support for farmers, the federal government provides increasing amounts of premium subsidies for the past three decades. While the high cost of crop insurance subsidies has generated much debate, it has improved total insurance acres for major crops increased from less than 30% prior to 1990 to well over 80% of planted crop acreage in recent years.

Crop insurance premiums are set by Risk Management Agency (RMA) of the U.S. Department of Agriculture with the intent of achieving actuarially fairness. However, in the recent history of federal crop insurance, there was only one year (1994) when producers paid more in premiums than they received in indemnities (Glauber, 2013), and the Trump administration has consecutively proposed significant cuts to crop insurance subsidies, which raises questions and concerns toward the future reform of the federal crop insurance program. Therefore, in order to accurately project the actuarial levels of crop insurance coverage during the enrollment period and explore the potential impact of changing the structure of premium subsidies on crop insurance enrollment, it is vital to have a better understanding on how farmers make crop insurance decisions and what are the important subjective and objective determinants that affect their decisions.

Similar to most of the production decisions, crop insurance decision involves significant risk and uncertainty due to unpredictable natural disasters and unknown end-of-season market price prior to the production cycle. To understand production decisions under risk and uncertainty, prior producer risk elicitations have been mainly studied using the expected utility theory (EU) (e.g., Lin et al., 1974; Moschini and Hennessy, 2001). However, numerous empirical studies have questioned EU's accuracy in explaining decisions under risks (e.g., Allais, 1953; Kahneman and Tversky, 1979), especially for the decision of crop insurance. Under the EU framework, Du et al. (2014) explained that if farmers are risk averse and premiums are actuarially fair, then all farmers should buy the maximum level of coverage available so long as per-acre subsidies are maximized, and no farmer will buy a lower coverage level if higher coverage has higher per-acre subsidies. However, no empirical support for EU framework was identified. To overcome the documented violations of EU, elements from prospect theory (PT) were adopted to capture the experimental evidence on risk-taking (Barberis, 2013; Tversky and Kahneman, 1992).

Reference-dependent and loss aversion are two basic elements from PT that are increasingly used in explaining producers' agriculture production decisions. First, producer decision making in the presence of risk and uncertainty heavily relies on a reference point. Based on the reference point, producers are often not willing to expend a certain small investment but rather bear the risk of a possible large loss. Such behavior can be explained by reference dependent, which assumes decision-makers are mostly risk averse for gains but risk seeking for losses. Crop insurance participation is a representative case, early voluntary crop insurance participation in the United States was low with only 25% of the eligible area under coverage before the 1990s, even after 30% subsidy was offered in the Federal Crop Insurance Act of 1980 (Walker et al., 1986; Glauber et al., 2002; Glauber, 2013). This contradicts the assumptions of EU where producers are expected to voluntarily purchase crop insurance without subsidy as long as the premium is smaller than the predicted value of possible large losses. The participation of crop insurance did not improve until Congress started to make insurance compulsory along with significantly increased subsidy level in 1994 (Glauber, 2013). In other production decisions, Tonsor (2018) suggested that U.S. cattle producers use the best outcome experienced as reference points that further impact market participation. Jacobs et al. (2018) developed a theoretical model of optimal hedging decision nested with reference-dependent theory and empirically showed that producers may use a rolling average of the current future price as a reference point when making hedging decisions. In addition, under the influence of loss aversion, producers often demand much more to give up an object (technology, policy, contract) than they would be willing to pay to gain it, which is also known as the endowment effect (Thaler, 1980; Kahneman et al., 1991). For example, Bocquého et al. (2014) found that producers are more sensitive to penalties than to rewards when dealing with production contracts or new insurance products. Zhao and Yue (2020) also showed empirical evidence of loss aversion and reference-dependent in the preferences of both major and specialty crop producers.

In this study, we first develop a revenue-based theoretical framework for producers' decision making for crop insurance coverage that incorporates reference-dependent and loss aversion. Then we use farm-level production and insurance premium data from the Kansas Farm Management Association (KFMA) to empirically evaluate the determinants for farmers' decision on crop insurance. Lastly, we investigate the potential reference point perceived by the majority of farmers when making crop insurance decisions as well as the underlying heterogeneity of the reference point.

Theoretical Framework

Crop insurance decisions are made in the pre-harvest period based on revenue per acre projected by the insurance policy as well as the revenue estimated by the producer. Due to information asymmetry, the producer may perceive the projected revenue in the crop insurance policy to be different from their own belief in future revenue. Unlike previous decision-making framework for crop insurance where producers narrowly compare insurance premium with the expected return, the revenue-based framework assumes producers are 1) board framing/forward-looking as farmers choose crop insurance decisions based on their expected achievable crop revenue rather than isolated consideration of insurance premium, and 2) perceiving crop insurance as default and consistent input for crop production, which means the crop insurance coverage is likely to be homogenous over the years within the individual farm.

Denote R^t as *projected revenue* per acre offered by the insurance agency, which is based on projected yield as well as the projected harvest price used to establish revenue guarantees in crop insurance, the producer's belief of *achievable revenue* per acre in the coming growing season is

$$R^T = \begin{cases} R^t + \varepsilon & with\ probability\ (1-\beta) \\ R^t - \varepsilon & with\ probability\ \ \beta \end{cases} \qquad (1)$$

Where probability $\beta \in [0,1]$, and the level the revenue variation $\varepsilon < (1-c)R^t$, which means producers' perception of unit achievable revenue is not dramatically different from the projected revenue in crop insurance to an extent that the producer-estimated revenue is lower than the protected revenue. Therefore, given the initial wealth w^t, the producer's objective function for crop insurance coverage decision is presented as

$$max_c E[U(w^t + cR^t + (1-c)R^T)] \quad (2)$$

In this case, we regard cR^t as protected revenue under crop insurance and $(1-c)R^T$ as additional revenue that is unprotected but achievable. Adding both terms together gives us an approximation of expected *terminal revenue* $T = cR^t + (1-c)R^T$ under crop insurance. Because T captures the relationship between crop insurance coverage c and achievable revenue R^T as increase in c secures the terminal revenue to be closer to insurance projected revenue, R^t, and decrease in c causes more volatility from farmer belief in R^T.

Under expected utility theory (EU), the producer will maximize the expected terminal wealth by choosing the optimal crop insurance coverage level, c^*. Therefore, given the power function form for risk preferences, the utility function is given by

$$U_{EU}(c; R^t, \varepsilon, \beta, R^T) = (w^t + cR^t + (1-c)R^T)^\alpha \quad (3)$$

where α is the risk parameter, $\alpha \in (0,1)$ indicating risk-averse preference and $\alpha > 1$ representing risk-seeking preference. While the EU maximizes the expected utility of terminal revenue from crop production, we propose another theory of reference-dependent (RD) to investigate the coverage-decision when the producer is maximizing utility relative to a *reference point*, R. Therefore, the producer maximizes reference-dependent utility by comparing the terminal revenue with a reference point, which gives us the RD utility

$$U_{RD}(c; R^t, \varepsilon, \beta, R^T) = \begin{cases} (T-R)^\alpha & \forall\, T \geq R \geq 0 \\ -\lambda(R-T)^\alpha & \forall\, R > T > 0 \end{cases} \quad (4)$$

Where $\lambda > 1$ measures the level of loss aversion, meaning the magnitude of utility decrease overweigh the magnitude of utility increase when comparing the same level of revenue loss and gain. Again, α is the risk parameter measuring producer risk preferences. The level of the reference point is ambiguous and heterogeneous as it can be different between producers. Generally, a few examples of feasible reference points can be projected revenue per acre, projected revenue please farmer-paid insurance premium per acre, or simply crop insurance premium per acre.

Producer with unbiased belief on achievable revenue

Now, under Expected Utility theory, considering the case when the producer's belief of future achievable revenue is unbiased comparing to the insurance-projected revenue (i.e., $\beta = 0.5$), the optimal coverage level is $c^* = 1$, indicating that an EU producer would always opt-in full coverage in crop insurance. In reality, the maximized coverage cannot be 100 percent, so this result points to the highest coverage possible.

For Reference-dependent theory, there are three cases when the producer is unbiased. First, the projected revenue given by crop insurance policy is higher than the producer's reference point ($R^t > R$). Then the revenue gain perceived by the producer is $T = R^t > R$. Based on the concavity of the RD utility for gain, an RD producer who believes the achievable revenue is unbiased will purchase the highest coverage insurance coverage possible. Second, for the case where the insurance-projected revenue is below the producer's reference point ($R^t < R$), the producer will always perceive a loss. Combining the convexity of the RD utility in the loss domain and the effect of loss aversion, an RD producer will not purchase crop insurance or choose minimal crop insurance coverage under mandatory regulation. Third, when the projected revenue equals to the producer's reference point. the producer will also choose the highest insurance coverage due to loss aversion. Therefore, we develop proposal 1 for an RD producer:

Proposition 1. *If the producer has unbiased belief towards achievable revenue comparing to the insurance-projected revenue, the optimal coverage decision for crop insurance is*

$$c^* = \begin{cases} 1 & \forall\, R^t \geq R \geq 0 \\ 0 & \forall\, R > R^t > 0 \end{cases}$$

Proposition 1 tells us that when an unbiased RD producer realizes the projected revenue per acre offered by the insurance policy, s/he would maximize coverage level when the insurance-projected revenue is greater or equal to the reference point and minimize coverage level when the insurance-projected revenue is below the reference point.

Producer with biased belief on achievable revenue

Under the case when the producer's belief in future achievable revenue is biased ($\beta \neq 0.5$), an EU producer who believes his or her achievable revenue is less than the insurance-projected revenue will tend to increase the coverage of crop insurance.

For an RD producer whose belief is biased, there are three cases. First, when the projected revenue is greater than the producer's reference point ($R^t > R > 0$), and the producer's belief in revenue variation does not exceed the magnitude of differences between insurance-projected revenue and reference point ($\varepsilon \leq R^t - R$), the optimal coverage is similar to the EU case where crop insurance coverage is monotonically increasing with the increase of β, so the RD producer whose belief on achievable revenue is biased downward will prefer for higher coverage of crop insurance. Next, when the reference point is higher than the insurance-projected revenue, and the discrepancy in between is higher than the producers' expected revenue variation, an RD producer would also prefer a higher coverage level if the belief for expected achievable revenue is biased downward.

In the last case, assuming again the projected revenue is greater than the producer's reference point, but the producer's belief in the magnitude of revenue variation exceeds the differences between the projected revenue and reference point ($\varepsilon > R^t - R$), which means RD producers may still feel a loss when the achievable revenue drops below the reference point. This is similar to the case of $R^t = R$, and $R^t < R/\varepsilon > R^t - R$. Following this condition, the marginal effect of belief on crop insurance coverage is negative when $\beta < 0.5$ without loss aversion λ, which means the producer will adopt lower coverages of crop insurance when s/he believes the terminal revenue will be more likely to be higher than the insurance-projected. However, the producer will start to increase the coverage along with the increase in subjective belief in lower-than-projected revenue when $\beta > 0.5$. Additionally, with the effect of loss aversion ($\lambda > 1$), the switching point between negative and positive marginal effect becomes $\dot{\beta} = 1/(1+\lambda) < 0.5$. Therefore, loss aversion triggers the increasing adoption of crop insurance even when the producer believes the future achievable revenue is biased downward. Combining all of the cases discussed above, we describe the second proposition as follows.

Proposition 2. *If the producer has biased belief towards achievable revenue comparing to the insurance-projected revenue, the marginal impact of change in belief on the optimal coverage decision for crop insurance is given by*

$$\frac{\partial c^*}{\partial \beta} = \begin{cases} -R^t g_1(\beta) & if \;\; R = 0 \\ -(R^t - R)g_1(\beta) & if \;\; R^t > R > 0 \; and \; \varepsilon \leq \; R^t - R \\ -(R^t - R)g_2(\beta) & if \;\; R^t \geq R > 0 \; and \; \varepsilon > \; R^t - R \; and \; g_3(\beta) < \varepsilon/(R - R^t) \; or \\ & \;\;\;\;\;\; 0 < R^t < R \; and \; \varepsilon > \; R^t - R \; and \; g_3(\beta) < \varepsilon/(R - R^t) \\ 0 & if \;\; R^t \geq R > 0 \; and \; \varepsilon > \; R^t - R \; and \; g_3(\beta) > \varepsilon/(R - R^t) \; or \\ & \;\;\;\;\;\; 0 < R^t < R \; and \; \varepsilon > \; R^t - R \; and \; g_3(\beta) > \varepsilon/(R - R^t) \\ -(R - R^t)g_1(\beta) & if \;\; 0 < R^t < R \; and \; \varepsilon \leq \; R^t - R \end{cases}$$

where $g_1(\beta)=\frac{2}{\varepsilon(\alpha-1)}\frac{\beta^{\frac{1}{\alpha-1}}(1-\beta)^{\frac{1}{\alpha-1}}\left(\beta^{-1}+(1-\beta)^{-1}\right)}{\left(\beta^{\frac{1}{\alpha-1}}+(1-\beta)^{\frac{1}{\alpha-1}}\right)^2}$, $g_2(\beta)=\frac{2}{\varepsilon(\alpha-1)}\frac{(\lambda\beta)^{\frac{1}{\alpha-1}}(\beta-1)^{\frac{1}{\alpha-1}}\left((\lambda\beta)^{-1}+(\beta-1)^{-1}\right)}{\left((\lambda\beta)^{\frac{1}{\alpha-1}}+(\beta-1)^{\frac{1}{\alpha-1}}\right)^2}$

and $g_3(\beta)=\frac{(\beta-1)^{\frac{1}{\alpha-1}}+(\lambda\beta)^{\frac{1}{\alpha-1}}}{(\beta-1)^{\frac{1}{\alpha-1}}-(\lambda\beta)^{\frac{1}{\alpha-1}}}$

Proposition 2 shows that the sign and magnitude of $\partial c^*/\partial\beta$ depends on the producer's belief about expected terminal revenue under crop insurance, which is illustrated in $g_1(\beta)$ and $g_2(\beta)$. Based on line one, an EU producer will increase the coverage of crop insurance if his belief for terminal revenue is biased downward comparing to the insurance-projected price. Simply put, if the producer thinks the revenue offered in the crop insurance policy is higher than the level he estimated to be, then the producer will purchase higher level crop insurance. Based on line two and line five, the producer will purchase higher crop insurance coverage if his belief for achievable revenue is close to the insurance-projected revenue. Lastly, based on line three and four, if the producer's belief about future revenue is considerably different from the revenue given in crop insurance, or if the producer simply uses insurance-projected revenue as his reference point, then the direction of the marginal impact of belief on crop insurance decision will depend on both the size of belief bias and the level of loss aversion. As the perceived probability to have lower achievable revenue goes from 0 to 1, the RD producer whose reference point is smaller than the projected-revenue will first increase the crop insurance coverage along with the increasing belief in lower revenue until it reaches a switching point ($\dot{\beta}=1/(1+\lambda)$)where the producer starts to decrease crop insurance coverage until the minimum level. For the RD producer whose reference is higher than the projected-revenue, he will first decrease crop insurance coverage until his belief reaches the switching point, then starts to increase the coverage along with the higher probability of lower revenue. The rational of decreasing crop insurance purchases with the increase in the possibility of lower revenue is that the producer is risk-seeking as he will not purchase crop insurance on top of an existing significant loss.

Methods

Following proposition 2, we investigate the effect of producers' subjective beliefs about future revenue on their crop insurance coverage decisions. Though producers' heterogeneous beliefs about future revenue cannot be observed, we assume that producers' belief for future revenue is based on their past experiences of revenue and indemnity. We aim to test the effects of revenue and indemnity history as proxies for future revenue belief.

Data

The empirical analysis was based on data collected from the Kansas Farm Management Association (KFMA) members. The dataset includes information on farmers' financial and socioeconomic characteristics. It is an unbalanced panel that contains 9,629 observations on 1,874 farms, covering the period 2009-2018. On average, farms stay in the sample for five years. The summary statistics of the variables used in this study are shown in Table 1.

Our dependent variable y_{it} is crop insurance premium. The crop insurance premium is the amount of money that farmers paid to receive crop insurance coverage in a particular year. Our selection of factors that may influence the level of crop insurance premium is based on our theoretical framework and data availability. These factors include crop insurance indemnity payment, crop revenue, the revenue share of each crop in total production value, operator's age, debt-to-asset ratio, subsidies, and off-farm income. Indemnity payment is the amount paid to the farmer for a covered loss. Crop revenue is the total value of crop products sold by the farm. Crop revenue share is calculated for each crop grown by the sample farmers (i.e. corn, wheat, sorghum, and soybeans), and is defined as the ratio of the revenue generated from selling a product to total crop revenue. Age is defined as the age in years of the principal farm decision-maker. The Debt-to-asset ratio is defined as a farmer's beginning-of-year value of total liabilities divided by his/her beginning-of-year value of total assets. Subsidies are defined as total payments received for participation in federal and state farm programs. Finally, off-farm income is the annual income of the operator from off-farm sources. Table 1 provides a descriptive summary of the variables examined in this study.

Empirical Strategy

To investigate the determinants of crop insurance premium, the Tobit model is appropriate because our dependent variable (i.e. crop insurance premium) is censored at zero when producers only covered minimum level of crop insurance with no out-of-pocket cost. The Tobit model assumes that the observed level of the dependent variable is related to a latent variable, which is in turn a linear function of a vector of explanatory variables. The Tobit model can be specified as follows:

$$y_{it} = \boldsymbol{\beta x_{it}} + \alpha_i + \varepsilon_{it} \tag{5}$$

$$y_{it} = \begin{cases} y_{it}^* = \boldsymbol{\beta x_{it}} + \alpha_i + \varepsilon_{it} & if\ y_{it}^* > 0 \\ 0 & if\ y_{it}^* \leq 0 \end{cases} \qquad i = 1, .., N \text{ and } t = 1, .., T \tag{6}$$

where the subscripts i and t denote a farm and year, respectively, y_{it} is the observed value of crop insurance premium, y_{it}^* is the latent variable for crop insurance premium, $\boldsymbol{x_{it}}$ is a vector of exogenous explanatory variables, $\boldsymbol{\beta}$ is a vector of parameters to be estimated, α_i are unobserved farm-specific heterogeneity effects (random effects), and ε_{it} is an error term.

Controlling for the impact of unobserved heterogeneity in non-linear models (such as our Tobit model) is not as straightforward as in linear models. In linear models, one can account for unobserved heterogeneity by including fixed-effects for each farm i. In non-linear models, fixed effects estimators suffer from the incidental parameters problem, resulting in biased and inconsistent estimates (Verbeek, 2008). The use of random effects, however, requires the standard independence assumption, i.e., the assumption that α_i are uncorrelated with the explanatory variables $\boldsymbol{x_{it}}$. Such an assumption is hard to maintain in the context of our study where omitted factors that contribute to fixed-effect unobserved heterogeneity (e.g. farmers' education and experience) are likely to be correlated with the observed explanatory factors.

To address the fixed-effects unobserved heterogeneity problem, we use a corrected random effects (CRE) framework, following the works of Mundlak (1978) and Chamberlain (1984). In the CRE framework, unobserved heterogeneity (α_i) is modeled as a function of the means of the time-varying explanatory variables ($\boldsymbol{\overline{x}_{it}}$) and an error term ($v_i$) which is distributed as $N(0, \sigma_v^2)$ and is uncorrelated with $\boldsymbol{x_{it}}$ and ε_{it}:

$$\alpha_i = c + \boldsymbol{\overline{x}_{it}\gamma} + v_i \tag{7}$$

where c is a constant, and $\boldsymbol{\gamma}$ is a vector of unknown parameters. Substituting equation (7) into (2) results in a model that can be estimated using standard random effects Tobit methods:

$$y_{it}^* = \boldsymbol{\beta x_{it}} + \boldsymbol{\overline{x}_{it}\gamma} + v_i + \varepsilon_{it} \tag{8}$$

where v_i is treated as a random effect. As a result, including the $\boldsymbol{\overline{x}_{it}}$ variables in equation (8) addresses the potential fixed-effects unobserved heterogeneity problem. Finally, we also include time dummies to account for unobserved aggregate shocks that affect all farms in a given year.

Results

The regression results using the Tobit model is presented in Table A1, and the marginal effects of the determinants of insurance premium are presented in Table 2. As shown in Table 2, six financial and socioeconomic variables were found to significantly affect the crop insurance premium. These are indemnity, crop revenue, corn revenue share, age, debt-to-asset ratio, and subsidies.

The expected value of crop insurance premium increases with the amount of indemnity payment received in the previous year. More specifically a $1,000 increase in indemnity increases the expected value of premium by $8. An increase in last year's crop revenues by $1,000 increases the expected value of crop insurance premium by $5. Farmers having a higher share of corn revenues in total crop revenues are found to spend more money to receive crop insurance coverage. Age has a negative effect on the expected value of crop insurance premiums. One possible explanation is that older farmers may be close to retirement and do not see the need to cover their crops under crop insurance schemes. The marginal effect of the debt-to-asset ratio on crop insurance premium is positive, which suggests that more indebted farmers may be more motivated to spend more money to receive crop insurance coverage so they can afford to pay off their debts in case of yield or crop revenue losses. The expected value of crop insurance premium increases with the amount of subsidies received. More specifically, an increase in last year's government payments received increases the expected value of insurance expenditures by $19.

Government payments increase farmers' financial resources and can make them spend more on crop insurance.

The marginal effects of time dummies are statistically significant implying that there has been an increase in crop insurance expenditures in the period 2011-2018. This demonstrates a favorable macro environment in that period for farmers to enroll more heavily in crop insurance programs. Finally, most of the marginal effects of the means of the time-varying covariates are statistically significant, implying that unobserved heterogeneity is substantially driving the expected value of crop insurance premiums.

[Work on methods and results is still underway]

Discussion and conclusion

This study develops a revenue-based framework that explains how crop insurance decisions are systematically affected by producers' own beliefs of future achievable revenue under reference-dependent and loss aversion preferences. Using the KFMA data, the empirical results present supportive evidence on the impact of subjective belief toward crop insurance decisions and explores potential reference points perceived by producers. The results of this study provide a novel perspective to understand the important determinants for crop insurance adoption, which shed light on future policy reform.

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Table 1. Descriptive statistics of the study variables

Variable	Unit	Mean	St.dev	Min	Max
Crop insurance premium	$1,000	20.35	25.12	0	682.31
Crop insurance indemnity	$1,000	37.35	93.3	0	2343.97
Crop revenue	$1,000	444.14	526.52	0	14818.20
Corn revenue share	ratio	0.28	0.25	0	1
Sorghum revenue share	ratio	0.09	0.16	0	1
Wheat revenue share	ratio	0.29	0.28	0	1
Soy revenue share	ratio	0.34	0.26	0	1
Age	years	57.68	13.06	18	94
Debt-to-asset ratio	ratio	0.27	0.35	-0.02	17.05
Subsidies	$1,000	29.26	37.38	0	630.56
Off-farm income	$1,000	37.48	72.26	0	1705.29

Table 2. Marginal effects of the determinants of crop insurance premium.

	dy/dx	Delta-method Std.Err.
Crop insurance indemnity $_{t-1}$	0.008***	(0.001)
Crop revenue $_{t-1}$	0.005***	(0.001)
Corn revenue share	1.604*	(0.962)
Sorghum revenue share	-1.261	(1.336)
Wheat revenue share	0.329	(1.000)
Age	-0.123***	(0.048)
Debt-to-asset ratio	1.834**	(0.744)
Subsidies $_{t-1}$	0.019***	(0.005)
Off-farm income $_{t-1}$	0.003	(0.002)
2011	4.253***	(0.401)
2012	3.972***	(0.432)
2013	4.362***	(0.459)
2014	1.115**	(0.436)
2015	2.337***	(0.459)
2016	2.333***	(0.479)
2017	2.203***	(0.511)
2018	1.989***	(0.536)
mean_indemnity$_{t-1}$	0.082***	(0.005)
mean_revenue $_{t-1}$	0.004***	(0.001)
mean_corn_share	7.929***	(1.793)
mean_sorg_share	8.275***	(2.421)
mean_wheat_share	5.632***	(1.575)
mean_age	0.062	(0.052)
mean_debt	0.821	(1.171)
mean_subsidies $_{t-1}$	0.137***	(0.013)
mean_off-farm income $_{t-1}$	0.000	(0.005)

Notes: *, ** and *** denotes a statistic is significant at the 1%, 5%, and 10% levels, respectively. Soy revenue share was dropped during estimation to avoid multicollinearity.

Appendix

Table A1. Coefficients of the Tobit model.

Variable	Coef.	Std. Err.	Variable	Coef.	Std. Err.
Crop insurance indemnity$_{t-1}$	0.013***	(0.002)	2016	3.882***	(0.794)
Crop revenue$_{t-1}$	0.009***	(0.001)	2017	3.676***	(0.847)
Corn_share	2.540*	(1.522)	2018	3.332***	(0.891)
Sorghum_share	-1.996	(2.116)	mean_indemnity$_{t-1}$	0.131***	(0.008)
Wheat_share	0.521	(1.584)	mean_revenue$_{t-1}$	0.006***	(0.001)
Age	-0.195***	(0.076)	mean_corn_share	12.554***	(2.839)
Debt-to-asset ratio	2.903**	(1.178)	mean_sorg_share	13.102***	(3.830)
Subsidies$_{t-1}$	0.030***	(0.008)	mean_wheat_share	8.918***	(2.495)
Off-farm income$_{t-1}$	0.004	(0.004)	mean_age	0.099	(0.082)
2011	6.841***	(0.643)	mean_debt	1.300	(1.854)
2012	6.420***	(0.697)	mean_subsidies	0.217***	(0.021)
2013	7.005***	(0.734)	mean_off-farm inc	0.000	(0.008)
2014	1.899**	(0.742)	_cons	-6.353***	(2.391)
2015	3.889***	(0.762)	Wald X^2	3442.8***	-

Notes: *, ** and *** denotes a statistic is significant at the 1%, 5%, and 10% levels, respectively. Soy revenue share was dropped during estimation to avoid multicollinearity.