Securing Break-Even: A Reference-dependent Framework for Crop Insurance Choices[1]

Xuche Gong[1], Hongli Feng[2], David A. Hennessy[2], Jennifer Ifft[3], Robert Shupp[4], Michel Regenwetter[5]

[1] *Department of Agricultural Economics, Mississippi State University*

[2] *Department of Economics, Iowa State University*

[3] *Department of Agricultural Economics, Kansas State University*

[4] *Department of Agriculture, Food, and Resource Economics, Michigan State University*

[5] *Department of Psychology, University of Illinois Urbana – Champaign*

Abstract: We develop a behavioral framework for analyzing farmers' crop insurance coverage level decisions under the explicit risk of not breaking even. We introduce two complementary innovations: a reference-dependent model where expected break-even revenue emerges as a salient reference point in farmers' insurance decisions, and the Break-Even Coverage Level (BECL) concept, which identifies the coverage level where revenue guarantee equals expected break-even revenue. Building on dual behavioral biases—loss aversion toward failing to achieve break-even status and premium aversion toward insurance costs—our model predicts bunching of coverage level choices at BECL with asymmetrically declining selection as distance increases. The model also enables us to investigate how premium subsidies and behavioral factors affect farmers' insurance decisions regarding securing *ex ante* break-even status. Data from a recent farmer survey strongly confirm these predictions. We observe pronounced bunching at BECL, with 20% of farmers choosing coverage exactly at their break-even threshold. Overall, 84% of farmers insure at or above their BECLs to secure *ex ante* break-even status through crop insurance. Analysis of self-reported attitudes toward break-even outcomes and premium expenses also aligns with our predictions regarding how these behavioral factors influence break-even coverage decisions.

Keywords: Behavioral model; Farmer survey; Loss aversion; Premium aversion; Reference point; Revenue insurance

JEL code: D9; D81; Q18

---

[1] This study is partially funded by the USDA's National Institute of Food and Agriculture (NIFA) grant, "Crop Insurance policy design and program participation: Conceptual and empirical analyses with economic and psychological decision paradigms," Award No. 2021-67023-34928.

"*I predominately make my crop insurance based on breakevens for the crop and my tolerance for risk*."

"*As always it is important to know cost of production to calculate necessary insurance needs.*"

— Two comments from participants in the survey conducted by the authors.

1. Introduction

The Federal Crop Insurance Program (FCIP) is regarded by many as the cornerstone of the federal farm safety net. In 2022, it covered about 87% of planted acres for major field crops, with total program liabilities amounting to 33% of the U.S. agricultural sector's production value (ERS, 2024). By letting producers purchase coverage at various levels against yield or revenue losses, FCIP offers farmers an *ex ante* hedge against income shortfalls. However, despite this massive scale and high participation, a fundamental puzzle remains: farmers' coverage level choices often deviate systematically from Expected Utility Theory (EUT) predictions (Du et al., 2017), suggesting that factors beyond conventional utility maximization drive these critical decisions. Recent work points to reference-dependent preferences as a key explanatory factor (Babcock, 2015; Feng et al., 2020; Lampe & Würtenberger, 2020), indicating that farmers evaluate coverage decisions relative to some specific reference points rather than through overall expected utility maximization.

A key yet underexplored reference point in farmers' coverage level decisions is the farm's break-even threshold, defined as the point where total revenues exactly match total costs. For most farms, failing to break even jeopardizes their ability to service debt, maintain operations, and withstand future shocks—risks that intensify when interest rates rise and loan obligations expand. While farmers may survive occasional non-break-even years, the economic and psychological consequences make break-even status a fundamental risk management objective that farmers actively pursue. This goal also aligns with the FCIP's policy objectives of aiding farmers in managing risk and sustaining solvency (GAO, 2017; Rosa, 2018). By offering

revenue guarantees, FCIP policies provide farmers with tools to plan for achieving break-even status through *ex ante* risk management.

However, securing *ex ante* break-even status through FCIP is neither straightforward nor guaranteed. Although higher coverage levels provide greater protection, they also carry higher premiums that often increase at an accelerating rate, particularly in high-risk regions. This creates a complex optimization problem where the premium costs required for break-even protection may themselves threaten farm financial stability. The challenge is compounded by FCIP's decreasing premium subsidy structure, which may provide higher subsidies at coverage levels below the *ex ante* break-even threshold, creating perverse incentives that discourage adequate protection. Additionally, farmers may exhibit "premium aversion"—reluctance to pay high upfront costs for protection that may prove unnecessary if revenues turn out to be strong (Du et al. 2017; Babcock, 2015). These structural and behavioral complexities underscore the need for a unified framework to understand how farmers' coverage level decisions reflect both policy constraints and individual preferences regarding *ex ante* break-even protection.

We address this gap by developing a behavioral framework that incorporates all these factors. Our approach centers on a reference-dependent model where expected break-even revenue serves as a salient reference point driving farmers' crop insurance decision. Since this expected cost includes both operating expenses and insurance premiums, our framework naturally captures the cost-benefit dynamics that emerge as farmers consider higher coverage levels. The model also incorporates farmers' dual behavioral biases: loss aversion toward failing to achieve break-even status and premium aversion toward paying insurance costs that may not translate into benefits. Premium subsidies are integrated into the framework through their effects on net premium costs and their interaction with farmers' premium aversion.

While the framework provides a comprehensive behavioral foundation, the endogenous nature of expected break-even revenue as the reference point—which changes with farmers' coverage level choices—makes solving the model analytically challenging. We address this complexity by introducing a novel concept: the break-even coverage level (BECL), which identifies the specific coverage level(s) where revenue guarantee equals expected break-even revenue. Since BECL emerges as the intersection point between the revenue guarantee and expected break-even revenue functions, it is exogenous to farmers coverage level choices. Once this intersection point is identified, one can simply compare any coverage level to this fixed benchmark to determine whether it provides *ex ante* break-even protection. This greatly simplifies our analysis by providing a concrete focal point that enables testable predictions while retaining the essential features of the reference-dependent framework.

Our model makes several important predictions regarding farmers' insurance decisions in securing *ex ante* break-even status, the effect of subsidies, and the interactions between subsidies and behavioral attitudes. Most importantly, our framework predicts a specific type of choice pattern—bunching at BECL—that standard expected utility models cannot explain. This provides a clear empirical test that distinguishes our approach from conventional theory. We also predict that farmers exhibit differential and asymmetric behaviors on either side of BECL, with loss aversion driving farmers to choose coverage levels below BECL less frequently than above. We show that due to the decreasing and concave subsidy rate structure, loss-averse farmers may forgo *ex ante* break-even coverage for higher subsidies. Finally, we predict that increased premium aversion unambiguously leads to less selection of BECL, with this effect being stronger when BECL is high.

Using data from a recent farmer survey, we find empirical evidence strongly consistent with our theory's predictions. In 2023, we conducted an online survey and obtained data from 653 non-irrigated corn producers in Iowa and Kansas. The survey collected detailed information on farmers' crop insurance experiences from 2020 to 2022. Crucially, the survey asked participants to indicate the percentage of their expected corn revenue required to break even in a typical year, thereby eliciting each farmer's BECL. We also collected information on farmers' aversion to lacking an insurance guarantee for breaking even *ex ante* and to paying premiums.

Survey responses show that approximately 89% of farmers have a BECL at or below the 85% coverage level, the highest coverage level offered by individual-loss based FCIP policies[1]. This indicates that FCIP makes *ex ante* break-even protection feasible for the vast majority of farmers. Among those 89%, about 84% chose to insure at or above their BECL during the 2020–2022 period. Most notably, we observe pronounced "bunching" of coverage level choices around farmers' BECL. About 20% of farmers insuring exactly at their BECLs, with asymmetrically declining selection rates as distance from this threshold increases. These choice patterns provide compelling revealed preference evidence of both the reference point role of expected break-even revenue and loss aversion effects. The behavioral mechanisms are further confirmed by individual-level variation: farmers who are strongly loss averse are more likely to insure at or above their BECLs, whereas those who are highly premium averse are less likely to do so.

Our paper makes several contributions to the literature and has important policy implications. First, our paper extends the application of reference-dependent models to the

[1] FCIP offers both individual-loss and area-loss based policies, with the latter providing coverage level up to 90%. In addition, area-loss based endorsements are available to cover deductibles on individual policies. However, these policies are not popular among U.S. farmers and cannot guarantee break-even status even from an *ex ante* perspective due to basis risk—the potential mismatch between individual and area losses (Gong et al., 2023) .

agricultural insurance field. Prior behavioral theories have formalized the notion that decision-makers respond not only to final outcomes but also to deviations from certain reference points, incurring psychological costs when outcomes fall below these benchmarks (Gul, 1991; Kahneman & Tversky, 1979; Koszegi & Rabin, 2006, 2007; Loomes & Sugden 1982, 1986; Tversky & Kahneman, 1992). Empirical evidence of reference-dependent preferences has emerged across diverse settings such as labor supply (Crawford & Meng, 2011; Farber, 2008; Richards, 2020; Thakral & Tô, 2021), health insurance (Sydnor, 2010), tax liabilities (Rees-Jones, 2018), housing markets (Andersen et al., 2022), and retirement behavior (Seibold, 2021).

Early studies applying reference-dependent models to explain U.S. farmers' crop insurance behaviors include Babcock (2015) and Feng et al. (2020). Using a Cumulative Prospect Theory framework, Babcock (2015) examines three potential reference points: expected crop revenue, out-of-pocket premium, and a combination of these two. Feng et al. (2020) apply Third Generation Prospect Theory by treating state-dependent reference points where farmers compare insured outcomes against the counterfactual uninsured outcome in each state of nature, rather than against a fixed expected value. Both studies identify important reference points that drive farmers' decision making. We identify expected break-even revenue as another economically salient reference point, one that integrates farmers' essential risk management needs with observable program features. Our approach goes beyond explaining EUT-deviation behaviors to provide a metric for evaluating whether crop insurance delivers the protection farmers actually need, bridging behavioral theory with practical policy design. The expected break-even revenue can also be interpreted as a farmer-specific "safety-first" threshold (Bigman, 1996; Moscardi & de Janvry, 1977; Roy, 1952; Telser, 1955), blending safety-first principles with modern behavioral insights.

Our paper also contributes to the ongoing policy debate over FCIP budget reduction and subsidy reform (CBO, 2017; GAO, 2017, 2023; Goodwin & Smith, 2013). A central issue is how farmers respond to premium subsidy changes, where the elasticity of crop insurance demand with respect to subsidies plays a critical role. Prior studies have produced mixed evidence on this elasticity across regions, time periods, and methods (Bulut & Hennessy, 2021; Goodwin, 1993; O'Donoghue & Tulman, 2016; Shaik et al., 2008; Woodard & Yi, 2020; Yi et al., 2020). Our behavioral framework provides new insights by identifying the expected break-even threshold as a critical reference point in farmers' coverage decisions. We find that farmers strongly prefer insuring at or above their BECLs to secure *ex ante* break-even status, suggesting a "kinked" demand pattern: coverage demand is relatively inelastic up to the BECL due to strong loss aversion around the break-even threshold, but becomes more elastic above it under standard risk considerations. Consequently, farmers may remain committed to insuring up to the BECL with moderate subsidy rate cuts. However, since subsidy rate cuts inevitably increase out-of-pocket premium expenses and may push BECL above the subsidy maximization point, farmers may switch to insure below their BECLs due to premium aversion and subsidy-seeking behavior. Ultimately, effective reform of the subsidy schedule must account for both economic incentives and behavioral responses to achieve the desired level of risk protection.

The remainder of this paper proceeds by first presenting our reference-dependent framework and BECL concept. Next, we describe our survey and data. We then test our theory using the survey data, presenting evidence on reference-dependent behaviors. Following this, we analyze the determinants of BECL, loss aversion, and premium aversion. This paper concludes with a discussion of policy implications and prospective future research directions.

2. Conceptual Model

In this section we establish our reference-dependent framework. We first introduce the crop production process and crop insurance policy under consideration. We then present our model and introduce the BECL concept, exploring their key properties and formulating predictions.

2.1 Crop production and crop insurance policy

We present a simple crop production and market process. A representative farmer commits to positive operating costs c at the beginning of the growing season—including expenses such as land rent, seed, and fertilizer—and receives uncertain revenue at harvest. We denote this nonnegative revenue as a random variable, *r*, bounded by some $\hat{r} < \infty$. Denoting $f(r)$ and $F(r) \equiv \int_0^{\hat{r}} f(r)dr$ as the respective probability density and cumulative density functions, and $\mathrm{E}(\cdot)$ as the expectation operator, we write the expected crop revenue as $\bar{r} \equiv \mathrm{E}(r) = \int_0^{\hat{r}} rdF(r)$.

We further assume:

Assumption 1. $f(r) > 0$ *for all* $r \in [0, \hat{r}]$.

The farmer can purchase a revenue insurance policy to protect against low revenues. The farmer selects a coverage level $\phi \in [0, \hat{\phi}]$[2], at which the policy provides a revenue guarantee $G(\phi)$ defined as $G(\phi) \equiv \phi\bar{r}$. Whenever *r* falls below $G(\phi)$ then the policy pays indemnity to make up the difference. This leads to the indemnity function: $n(\phi) \equiv \max(G(\phi) - r, 0)$.

The farmer pays a premium for this protection. Denoting $H(\phi)$ as the premium without government subsidies, we assume this premium is actuarially fair:

Assumption 2. $H(\phi) = \mathrm{E}(n(\phi))$.

[2] Policymakers typically set $\hat{\phi} < 1$ to mitigate moral hazard issues.

In practice, governments often subsidize a portion of this premium at rate $s(\phi) \in (0,1)$. Farmers only pay the unsubsidized portion, denoted as $P(\phi, s(\phi)) = [1 - s(\phi)]H(\phi)$. Writing a single subscript for the first-order partial derivative and a double subscript for the second-order partial derivative, we make the following assumption to reflect FCIP's weakly decreasing and weakly concave subsidy rate structure[3]:

Assumption 3. $s_{\phi}(\phi) \leq 0$ *and* $s_{\phi\phi}(\phi) \leq 0$ *for all* $\phi \in [0, \hat{\phi}]$.

With the operating cost and crop insurance premium established, the farmer's expected total cost is

(1) $$C(\phi, s(\phi)) \equiv P(\phi, s(\phi)) + c,$$

which also represents the expected break-even revenue at coverage level ϕ [4]. To ensure tractability we further assume:

Assumption 4. c *is a constant with respect to* ϕ.

Assumptions 1 – 4 yield: $C_{\phi}(\phi, s(\phi)) = P_{\phi}(\phi, s(\phi)) > 0$ and $C_{\phi\phi}(\phi, s(\phi)) = P_{\phi\phi}(\phi, s(\phi)) > 0$ (mathematic proofs provided in Section I of Supplementary Materials). Thus, both the expected break-even revenue and the subsidized premium are strictly increasing and strictly convex functions of coverage level. This reflects the rising marginal cost of risk protection—higher coverage levels provide additional protection against shallow revenue losses that occur more frequently, making incremental coverage increasingly expensive.

---

[3] As shown in Table 1, this assumption holds for Enterprise Unit policies and Whole Farm Unit policies. Enterprise Unit policies represented approximately 63% of total FCIP liability in 2022, with this share showing an upward trend (Zulauf et al., 2023).

[4] We call it expected break-even revenue because, in the United States, row crop farmers typically make crop insurance decisions before planting dates, when many operating costs have not yet been realized. Farmers therefore base insurance decisions on expected operating costs.

2.2 A reference-dependent crop insurance decision model

The expected break-even revenue represents a critical revenue threshold for farm planning. It provides a benchmark for farmers to make their farm management decisions where they can expect at least zero profit rather than a loss. While farmers may survive occasional non-break-even years and can reasonably expect some such years over time, the economic and psychological consequences of not breaking even make break-even status a fundamental risk management objective that farmers actively pursue[5]. This makes the expected break-even revenue an important reference point in farmers' crop insurance decision making.

Let $W(r;c,\phi,s) = r + n(\phi) - C(\phi, s(\phi))$ be the net revenue that the farmer receives at harvest. We specify the following model to capture this reference-dependent decision-making process:

$$U(W(r;c,\phi,s),\lambda,\eta) = u(W(r;c,\phi,s)) + \lambda u(W(r;c,\phi,s))I(W(r;c,\phi,s) < 0) - \eta P(\phi, s(\phi)). \quad (2)$$

This model follows established specifications in reference-dependent literature and has three components (O'Donoghue & Sprenger, 2018). The first component is a standard von Neumann-Morgenstern utility function $u(\cdot)$ which satisfies $u(0) = 0$ [6] and $u'(\cdot) > 0 > u''(\cdot)$. This component captures the consumption utility from purchasing crop insurance.

The second component captures gain-loss utility around a reference point (expected break-even revenue), where outcomes below the reference point receive additional psychological

[5] In addition to the direct impact of negative returns, not breaking even can lead to other unwanted outcomes, including: the stress and uncertainty of financial distress, costs of securing external financing to cover shortfalls, the need to liquidate assets or draw down savings, and potential impacts on future creditworthiness and operational flexibility.

[6] Condition $u(0) = 0$ is convenient and is without loss of generality because a constant may be added to the right-hand side in Equation (2) so as to allow for $u(0) = 0$.

weight. This is accomplished through the parameter $\lambda \geq 0$, which captures the farmer's aversion level to not breaking even *ex ante*, and the indicator function, $I(\cdot)$, specified as:

$$(3) \qquad I(W(r;c,\phi,s)<0) = \begin{cases} 1 & \text{whenever } W(r;c,\phi,s)<0; \\ 0 & \text{whenever } W(r;c,\phi,s)\geq 0. \end{cases}$$

Substituting Equation (3) into Equation (2) yields:

$$(4) \qquad U(W(r;c,\phi,s),\lambda,\eta) = \begin{cases} (1+\lambda)u(W(r;c,\phi,s)) - \eta P(\cdot) & \text{whenever } W(r;c,\phi,s)<0; \\ u(W(r;c,\phi,s)) - \eta P(\cdot) & \text{whenever } W(r;c,\phi,s)\geq 0. \end{cases}$$

Thus, the specification of the first two components leads to the result that the farmer values losses (relative to the expected break-even revenue) more than same-size gains by factor $1+\lambda$. Consequently, farmers are incentivized to secure break-even status *ex ante* through crop insurance coverage.

The third component, $-\eta P(\phi, s(\phi))$, incorporate what we term "premium aversion" into the model. The parameter $\eta \geq 0$ measures premium aversion level, and the whole term enters the utility function as a counterforce to the farmer's desire to secure *ex ante* break-even status through crop insurance coverage. This parallels "effort costs" commonly found in other reference dependent applications, such as search effort in job markets (Della Vigna et al., 2017) or tax planning costs (Rees-Jones, 2018). While premium impacts are already incorporated as negative values in $W(r;c,\phi,s)$, empirical evidence shows decision makers assign additional weight to insurance premiums beyond traditional cost-benefit analysis[7]. Our survey results, to be

[7] For example, Du et al. (2017) document that higher out-of-pocket premiums at higher crop insurance coverage levels reduce the probability of selecting these coverage levels, even though the increased expenditures should reflect increased farmer welfare under expected utility theory. Similarly, Abaluck and Gruber (2011) report that participants weigh plan premiums significantly more heavily than expected out-of-pocket costs in their study of Medicare Part D choices.

introduced later, also show that premiums play a role beyond pure expense in affecting farmers' crop insurance coverage level decisions[8].

With these model specifications, we establish a behavioral analysis framework that integrates farmers' *ex ante* break-even objectives with their behavioral biases toward losses and premium payments. The farmer's task is to choose a coverage level to maximize the expected utility over $r \in [0, \hat{r}]$, expressed as $\max_{\phi \in [0, \hat{\phi}]} \mathrm{E}(U(W(r; c, \phi, s), \lambda, \eta))$.

2.3 Break-even coverage level (BECL): Aligning insurance protection with farmers' *ex ante* break-even objectives

A key feature of our model is that the reference point is endogenous to the decision maker's choice. Specifically, as the farmer's coverage level choice changes, the expected break-even revenue will also change due to varying premium costs. This in turn affects the farmer's coverage level decision. While this feature captures the dynamics of the break-even threshold, it also makes solving this optimization problem analytically complex. However, we can identify a critical coverage level threshold that can greatly simplify our analysis and provide powerful predictions for empirical assessments.

[8] Premium aversion may arise from several behavioral and economic factors: mental accounting effects where farmers treat salient premium commitments differently from economically equivalent costs (i.e., the operating cost c, which is also in $W(r; c, \phi, s)$) (Thaler, 1985); loss aversion applied specifically to visible insurance expenditures (Babcock, 2015); "payment depreciation" where the disutility of premium commitments persists longer than protection benefits (Prelec & Loewenstein, 1998); and uncertainty about policy benefits leading farmers to focus disproportionately on certain costs relative to uncertain benefits. Importantly, these psychological effects persist even under FCIP's deferred payment structure, where farmers commit to premiums at planting but pay net premiums (premium minus any indemnity) after harvest. The upfront commitment creates mental accounting effects and binding financial obligations that constrain flexibility throughout the growing season, while uncertainty about final payment amounts may amplify loss aversion responses (Gneezy & Potters, 1997).

Notice that $r + n(\phi) = \max(G(\phi), r)$. Consequently, if there exists any ϕ^{be} at which the revenue guarantee equals the expected break-even revenue, i.e.,

(5) $G(\phi^{be}) = C(\phi^{be}, s(\phi^{be}))$,

then $r + n(\phi^{be}) - C(\phi^{be}, s(\phi^{be})) = \max(G(\phi^{be}), r) - C(\phi^{be}, s(\phi^{be})) \geq G(\phi^{be}) - C(\phi^{be}, s(\phi^{be})) = 0$ for all $r \in [0, \hat{r}]$. That is, by insuring at this ϕ^{be} the farmer can expect at least a break-even status *ex ante* (i.e., $W(r; c, \phi^{be}, s) \geq 0$ for all $r \in [0, \hat{r}]$). We call ϕ^{be} a break-even coverage level (BECL), emphasizing its role in helping farmers achieve *ex ante* break-even status through crop insurance protection.

The introduction of BECL transforms the reference point from the endogenous, multiple-dimensional expected break-even revenue to an exogenous and concrete coverage level threshold. This transformation is analytically powerful because BECL emerges as the natural intersection point of two fundamental curves—the revenue guarantee and expected total cost—whose shapes are determined entirely by the farmer's risk profile and program features, not by the farmer's coverage choice. Once this intersection point is identified, farmers can simply compare any potential coverage level to this fixed benchmark to determine whether it provides *ex ante* break-even protection. This greatly simplifies our analysis by providing a concrete focal point that enables testable predictions while retaining the essential features of the reference-dependent framework.

Since both revenue guarantee and expected break-even revenue increase with coverage level, a critical question is whether BECL always exists for farmers under different risk and cost conditions. The result below addresses this issue, which follows directly from the results that $G_{\phi}(\phi) = \bar{r}$, $C_{\phi}(\phi, s(\phi)) > 0$ and $C_{\phi\phi}(\phi, s(\phi)) > 0$.

Remark 1. Under assumptions 1 – 4, there exists either no BECL, a unique BECL, or two distinct BECLs.

Figure 1 illustrates when BECL exists and is unique. The two upper panels present scenarios where no BECL exists. In Panel A, $c \geq G(\hat{\phi})$ and thus the expected break-even revenue always exceeds revenue guarntee for any ϕ. This scenario may apply to farmers operating on slim expected profit margins (i.e., high values of $c/\bar{r}$). Panel B instead shows a scenario where $c < G(\hat{\phi})$, but where still no BECL exists because $C(\phi, s(\phi))$ increases rapidly with ϕ. Since $C_{\phi}(\phi, s(\phi)) = P_{\phi}(\phi, s(\phi)) = (1 - s(\phi))\bar{r}F(\phi\bar{r}) - s_{\phi}(\phi)\int_0^{\phi\bar{r}} F(r)dr$ and $\int_0^{\phi\bar{r}} F(r)dr$ is completely ordered under a mean-preserving spread (p. 110 in Shaked & Shanthikumar, 2007), this scenario may well apply to farmers facing high risks. In these two scenarios, the farmer cannot solely rely on crop insurance to secure *ex ante* break-even status, necessitating alternative risk management strategies.

BECL is more feasible for farmers facing higher expect operating profit margins and lower risks. Panel C plots a scenario with a unique BECL, where $c < G(\hat{\phi})$ and $C(\phi, s(\phi))$ increases modestly with ϕ. However, when $C(\phi, s(\phi))$ initially rises slowly relative to $G(\phi)$ but then accelerates at higher coverage levels, two BECLs may arise. Panel D illustrates such a scenario. It may apply to farmers facing rapidly escalating risks at higher coverage levels—for example, in regions where frequent moderate losses make higher coverage levels particularly expensive due to the high probability of payouts.

Moreover, when BECL exists, there may exist some coverage levels at which $C(\phi, s(\phi)) < G(\phi)$, which also provide *ex ante* break-even protection. The following two

remarks characterize these coverage levels and will inform our subsequent analysis (see Panels C and D for visual illustrations).

Remark 2. With a unique BECL ϕ^{be}, insuring at or above ϕ^{be} ensures *ex ante* break-even status while insuring below ϕ^{be} does not provide such protection.

Remark 3. With two distinct BECLs ϕ^{bel} and ϕ^{beh} where $\phi^{bel} < \phi^{beh}$, insuring within the range $[\phi^{bel}, \phi^{beh}]$ ensures *ex ante* break-even status while insuring outside this range does not provide such protection.

While there are three possibilities regarding BECL existence and uniqueness, our subsequent analysis focuses on the unique-BECL scenario for two reasons. First, as Remark 1 suggests, the decision-making context under the no-BECL scenario is similar to choosing below the BECL in the unique-BECL scenario, where no coverage level provides *ex ante* break-even protection. Second, in subsection II of Supplementary Materials we show that for any farmer with a strictly increasing utility function and two distinct BECLs, the farmer always prefers insuring below the higher BECL rather than insuring at or above it. This means the BECL-pair scenario can be transformed into a single-BECL problem by treating the lower BECL as the unique BECL and the higher BECL as a strict upper bound[9].

[9] Moreover, although BECL pairs are theoretically possible, Supplementary Materials Section III demonstrates that they are empirically rare when examined using county-level crop insurance participation data.

2.4 Bunching of coverage level choices at BECL

One specific choice pattern that the reference-dependent model predicts, while EUT cannot, is that decision makers' choices bunce at exogenous reference points (O'Donoghue & Sprenger, 2018). This choice pattern also applies to our setting. With a unique BECL ϕ^{be}, differentiating the objective function $\mathrm{E}(U(W(r;c,\phi,s),\lambda,\eta))$ with respect to ϕ yields:

$$(6) \qquad \frac{\partial \mathrm{E}(U(\cdot))}{\partial \phi} = \begin{cases} \mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right] + \lambda \dfrac{\partial \mathrm{E}\ u(W(\cdot))I(W(\cdot)<0)}{\partial \phi} - \eta P_\phi(\cdot) & \text{for any } \phi \in [0,\phi^{be}); \\ \mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right] - \eta P_\phi(\cdot) & \text{for any } \phi \in [\phi^{be},\hat{\phi}]. \end{cases}$$

Thus, there is a discontinuous drop in the marginal expected utility at ϕ^{be}. This drop arises as the gain-loss utility component disappears once coverage level reaches ϕ^{be}.

To illustrate the bunching mechanism, we decompose the marginal expected utility function into two components. The first component—marginal protection benefit (MPB)—captures the marginal benefit of achieving higher revenue protection through increased coverage. The second component, $\eta P_\phi(\cdot)$, represents marginal premium aversion (MPA), capturing the premium aversion or "effort cost" effect, of increased coverage.

Figure 2 plots these components. For visual clarity we assume that $u'(\cdot)=1$, $f'(\cdot)=0$, and subsidy amount increases linearly with coverage level[10]. The x-axis represents ϕ values and the y-axis represents values of the marginal functions. The values of the unique BECL and the maximum possible coverage level are marked as ϕ^{be} and $\hat{\phi}$ on the x-axis, respectively. The two

[10] These simplifying assumptions facilitate graphical illustration but do not affect our main theoretical predictions. The bunching mechanism depends primarily on the discontinuous drop in marginal utility at BECL due to loss aversion elimination, which persists under more general utility functions, revenue distributions, and subsidy schemes.

black solid lines represent the MPB component. The discontinuous drop at ϕ^{be} reflects the elimination of the gain-loss utility by insuring at ϕ^{be}. The six blue dashed lines represent the MPA component at six different premium aversion levels, from η_1 to η_6, with higher subscripts representing lower premium aversion levels. The intersection points of MPB and MPA determine the optimal coverage levels.

Figure 2 represents six farmers with the same crop revenue distribution and loss aversion level and thus the same BECL but different premium aversion level. The one with the highest premium aversion level (η_1), choose to insure below ϕ^{be}, reflecting that her premium aversion is so high that she gives up *ex ante* break-even protection to avoid premium costs at ϕ^{be}. The farmer with η_2 also insures below ϕ^{be} but is closer to this level as $\eta_2 < \eta_1$. Farmers with η_3 and η_4 insure exactly at ϕ^{be}, securing *ex ante* break-even status without incurring additional premium costs. The farmer with η_5 insures above ϕ^{be}, as her premium aversion level is so low that she is willing to pay extra premiums for protection level above ϕ^{be}. The farmer with the lowest premium aversion, η_6, insure at $\hat{\phi}$, which provides the highest risk protection level.

The cluster of choices at ϕ^{be} by farmers with η_3 and η_4 creates bunching at BECL for a specification combination of loss aversion level and risk profile (crop revenue distribution). When sufficient premium aversion variation exists within some of such combinations, aggregating farmers' choices across all combinations leads to population-level bunching at the BECL. We thus predict:

Prediction 1. There is bunching of farmers' coverage level choices at their BECLs.

In addition to bunching at BECL, we expect differential behavior on either side of BECL. This is due to the standard convexity structure aside from the nondifferentiable point at BECL. While farmers may not insure exactly at their BECL, they should prefer coverage level close to their BECL to balance loss aversion and premium aversion effects. Moreover, since reaching ϕ^{be} eliminates the loss aversion effect, farmers below ϕ^{be} face stronger incentives to move toward the threshold than farmers above it. Together, we predict:

Prediction 2. There is differential behavior on either side of BECL, with lower frequency of choices below BECL than above it.

2.5 Role of premium subsidies

The crop insurance literature has extensively documented the effects of premium subsidies on farmers' insurance demand (e.g., Du et al., 2017; Glauber, 2013; Woodard et al., 2018). We now examine how subsidies specifically influence farmers' decisions about securing *ex ante* break-even status when a BECL exists[11].

We first assume that the farmer is premium neutral, i.e., $\eta = 0$. The marginal expected utility function becomes:

$$\frac{\partial \mathrm{E}(U(\cdot))}{\partial \phi} = \begin{cases} \mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right] + \lambda \dfrac{\partial \mathrm{E}\ u(W(\cdot))I(W(\cdot)<0)}{\partial \phi} & \text{for any } \phi \in [0, \phi^{be}); \\ \mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right] & \text{for any } \phi \in [\phi^{be}, \hat{\phi}]. \end{cases} \tag{7}$$

Let $S(\phi) = s(\phi)H(\phi)$ be the premium subsidy amount the farmer receives. As demonstrated in Supplementary Materials Section IV, both pieces of the marginal expected utility

[11] The most direct effect of premium subsidies is to increase the likelihood that farmers can achieve feasible BECLs. By reducing farmer-paid premiums, subsidies cause some farmers who face situations like Panel B of Figure 1 to transition to situations like Panel C.

function are strictly positive whenever $S_\phi(\phi) \geq 0$. In this scenario, premium-neutral farmers will always insure at $\hat{\phi}$, the highest possible coverage level. The intuition is straightforward: an increase in coverage level always leads to higher expected utility through the mean-preserving contraction mechanism when paying actuarially fair premiums, while non-decreasing subsidy amounts make choosing higher coverage levels even more attractive. The role of BECL is thus muted as higher coverage levels bring strictly higher expected utility.

However, if there exists some $\phi^{sm} \in (0, \hat{\phi})$ such that $S_\phi(\phi) > 0$ for any $\phi \in [0, \phi^{sm})$ and $S_\phi(\phi) < 0$ for any $\phi \in [\phi^{sm}, \hat{\phi}]$[12], premium-neutral farmers may insure below ϕ^{be} if $\phi^{sm} < \phi^{be}$. While this incurs break-even risk, the utility gain from higher subsidies may outweigh the loss from increased break-even risk. Conversely, if $\phi^{sm} \geq \phi^{be}$ then incentives for higher subsidies and *ex ante* break-even protection are aligned, ensuring premium-neutral farmers never sacrifice *ex ante* break-even status. In summary:

Remark 4. Without premium aversion, farmers always insure at or above their BECLs unless their premium subsidies are maximized at coverage levels below their BECLs.

Premium aversion creates an additional channel through which subsidies affect break-even protection decisions. Since subsidies reduce out-of-pocket premiums, premium-averse farmers choose higher coverage when subsidies are provided. Moreover, because premium

[12] This is theoretically possible since actuarially fair premiums increase convexly with coverage level while FCIP subsidy rates decrease concavely. Du et al. (2017) document this empirically: among U.S. growers, subsidy amounts increase at lower coverage levels until 80% but may decrease between 80% and 85%.

aversion enters linearly in the utility function, subsidies have stronger effects on more premium-averse farmers, making subsidies most effective for those most reluctant to purchase insurance.

Some FCIP subsidy features enable us to make another prediction regarding farmers choices in relation to their BECLs. As shown in Table 1, the subsidy rate of the Enterprise Unit policy, the most popular crop insurance policy, remains constant for coverage levels from 50% to 70% and then starts to decrease. Thus, among farmers with $\phi^{be} \leq 70\%$, the incentives for securing *ex ante* break-even status and pursuing higher subsidies are well aligned by insuring at 70% coverage level or higher. Moreover, while premium aversion can induce farmers with $\phi^{be} \leq 70\%$ to insure below their BECLs, this effect is likely limited. The out-of-pocket premiums at coverage levels of 70% or below are quite affordable due to high subsidy rates and relatively low protection levels provided by these coverage options[13]. We thus predict:

Prediction 3. Farmers with $\phi^{be} \leq 70\%$ rarely insure below their BECLs.

2.6 Comparative statics with respect to loss aversion and premium aversion

Our final theoretical analysis focuses on the comparative statics of loss aversion and premium aversion. Figure 2 suggests that, for the same farmer, an increase in premium aversion level (from η_6 to η_1) decreases the probability of insuring at or above ϕ^{be}. This effect will be greater when BECL is high (considering a rightward shift of BECL in the graph). In summary:

Prediction 4. The probability of insuring at or above the BECL decreases with an increase in premium aversion, and this effect is greater among farmers with higher BECLs.

[13] According to the Risk Management Agency's Summary of Business data, the average county aggregated out-of-pocket premium per acre for the 70% coverage level corn revenue policy was $4.9 in Iowa and $9.5 in Kansas from 2011 to 2023.

For loss aversion, the effects are more nuanced and depend on subsidy schedule. If $\phi^{sm} < \phi^{be}$, then an increase in loss aversion may make farmers more likely to insure below ϕ^{be} to obtain higher subsidies. However, if $\phi^{sm} \geq \phi^{be}$ then an increase in loss aversion would give farmers strong incentives to insure at or above ϕ^{be}.

Prediction 5. An increase in loss aversion increases the probability of insuring at or above the BECL unless premium subsidies are maximized at coverage levels below BECL.

3. Survey and Data

In 2023, we conducted an online survey, funded by the USDA's National Institute of Food and Agriculture, to examine farmers' crop insurance decisions. To capture variation in production conditions while focusing on commercial operations, we restricted participation to farmers from Iowa and Kansas who planted at least 100 corn acres in either 2021 or 2022. The survey was administered in two waves through the Qualtrics online survey platform. The first wave (January-April 2023) recruited participants through multiple channels: in-person recruitment at farmer meetings, university extension website advertisements, as well as emails or mailed postcards with survey links and QR codes directly to farmers.[14] For the second wave (August-October 2023) we partnered with Kynetec, a farmer survey company. In both waves, the farmers could participate using a laptop, tablet, or cell phone.

[14] We obtained email or postal contact information from a purchased agricultural vendor list and from various professional networks.

In total, 653 farmers participated: 330 in the first wave and 323 in the second, with 476 from Iowa and 177 from Kansas.[15] Table 2 provides state-wise summary statistics of our survey participants. Overall, our sample matches nationwide farmer demographic features where male, older, and those possessing at least some college-level education dominate. However, due to the corn acreage requirement, our sample is more representative of medium to large-scale farmers, as reflected in farm size and farming sales.

Our survey also collected information about farmers' crop insurance experiences and their break-even information. In the first regard, we asked whether the responding farmer had purchased any corn insurance policy during the years 2020 to 2022. If the response was "Yes", we then inquired about the coverage level applied to the largest portion of corn acres in each insured year.

Regarding farmers' BECLs, our survey asked[16]:

"*What is the percentage of your expected corn revenue that would allow you to break even in a typical year? Please give your best estimate.*"

This question is designed to mirror our definition of BECL—that is, the coverage level at which the crop insurance revenue guarantee equals the expected break-even revenue. Respondents provided a number between 0% and 100%, yielding a unique BECL value for each farmer. In contrast to directly asking for cost and income information, this approach likely improves

[15] The lower number of Kansas farmers is because the survey company that assisted in the second wave had a limited Kansas farmer pool. In addition, as shown in Figure A1 in Section V of Supplementary Materials, our survey covers most counties in Iowa as well as primarily eastern and northern counties in Kansas.

[16] Screenshots of survey questions used in this paper are provided at the end (Section XI) of Supplementary Materials.

response rates. Moreover, it allows farmers to define break-even according to their own operational criteria, thereby better reflecting their practical needs[17].

Following the BECL estimation question, we asked farmers:

"*In any given year, how important is it to you that your corn insurance revenue guarantee allows you to break even?*"

Farmers were requested to choose one among five response options: "not important at all," "slightly important," "quite important," "very important," and "extremely important." Unlike our theoretical framework, which uses a continuous parameter λ to reflect the general aversion level to not break-even *ex ante*, this survey-elicited measure provides a descriptive, rank-order assessment of farmers' aversion specific to achieving break-even status through insurance revenue guarantees. We use this ordinal measure as a proxy for λ in our empirical analysis[18].

[17] A concern with self-reported BECL is that farmers might have simply reported their actual coverage level as their BECL, even though their true BECL differs. This would create a spurious correlation between coverage choices and reported BECLs, potentially invalidating our empirical tests. In Section VI of Supplementary Materials we address this issue by showing that state-wise average self-reported BECL values closely match BECL values calculated from state budgets published by land grant universities. Additionally, Table A2 in Section VII of Supplementary Materials shows that farmers who included more opportunity costs in their break-even calculations reported higher average BECLs. This suggests that self-reported BECLs consistently reflect farmers' cost considerations. Our empirical analysis shows that both how farmers' BECL varies with farm and farmer characteristics follows economic intuition and how farmers' coverage level choices relate to their self-reported BECLs closely matches our theory's predictions. Collectively, these results suggest that it is unlikely for farmers to have simply based their reported BECLs on their actual coverage level choices.

[18] Both self-reported descriptive measures and controlled experiments have been widely used for eliciting behavioral preferences (Dohmen et al., 2011; Falk et al., 2018). However, a recent meta-analysis has highlighted challenges in measuring loss aversion—substantial variation occurs in estimates across domains and contexts (Brown et al., 2024), while experimental evidence suggests that nonstandard risk preferences such as loss aversion may reflect task complexity rather than true preferences (Oprea, 2024). By directly capturing farmers' attitudes in their actual decision-making environment, our descriptive measure avoids experimental complexity while maintaining real-world relevance for analyzing how loss aversion affects crop insurance choices. However, we acknowledge that our measure captures stated rather than revealed preferences, provides only ordinal rankings, and may reflect factors beyond pure loss aversion such as risk

Inquiring about premium aversion, our survey asked:

For the years 2018-2022, how much impact did your out-of-pocket premium for each coverage level have on the coverage level choices of your corn crop insurance policies?

Farmers were required to choose one category among "no impact," "little impact," "some impact," "significant impact," and "great impact." We interpret these responses as measures of premium aversion, with higher reported impacts reflecting stronger aversion. By examining historical decision-making over a five-year period, we aim to establish farmers' premium aversion levels across years rather than a single year.

4. Empirical Results

We begin our empirical analysis by examining survey responses to the loss aversion, premium aversion, and BECL questions. We then analyze farmers' actual coverage level choices relative to their BECLs to evaluate the first three predictions. Finally, we investigate how behavioral factors influence coverage level choices as predicted by the last two predictions.

4.1 Suggestive evidence on loss aversion and premium aversion

Table 3 summarizes data from the loss aversion and premium aversion questions. About 15% of farmers considered covering their expected break-even revenue with crop insurance revenue guarantee to be "extremely important," 33% deemed it "very important," and 31% reported it as "quite important." These responses demonstrate a clear preference for securing *ex ante* break-even status through crop insurance coverage, providing strong empirical support for our theoretical modeling.

preferences or financial constraints. We interpret our results as suggestive evidence of loss aversion effects while acknowledging these measurement limitations.

The data also demonstrate widespread premium sensitivity. When asked about how premium expenses influence their coverage level decisions, 15% reported "great impact," 37% "significant impact," and 31% "some impact." This pervasive sensitivity to premium expenses justifies our incorporation of premium aversion into the theoretical framework.

4.2 Farmers' actual coverage level choices and BECLs

Figure 3 presents farmers' actual coverage level choices between 2020 and 2022. In each year, Iowa farmers predominantly insured at coverage levels of either 80% or 85%, while Kansas farmers most frequently chose the 75% coverage level, followed by 70%. These patterns align with state-level observations as reported in Schnitkey et al. (2021), indicating our sample represents state-level corn grower populations well.

Figure 4 shows the distribution of farmers' self-reported BECLs, with values below 50% and above 85% grouped as "<50%" and ">85%," respectively. Intermediate values are rounded up to the nearest 5%. Iowa farmers most commonly reported BECLs of "75%" or "80%," while Kansas farmers showed roughly equal preference for "70%," "75%," and "80%." The mean and median BECLs are 74% and 75% for Iowa farmers and 69% and 70% for Kansas farmers, respectively. Given that Iowa farms typically enjoy higher expected corn revenues and face lower out-of-pocket premiums than Kansas farms, these differences suggest that Iowa farmers have tighter expected profit margins excluding crop insurance premiums. A possible explanation is that Iowa farmers, given the greater corn revenue potential, are incentivized to invest more in operational expenses to achieve higher absolute returns.

Notably, about 11% of farmers in both states reported BECLs that exceed FCIP's maximum buyup coverage level of 85%, indicating that 89% of our sample farmers can typically secure break-even revenue through crop insurance *ex ante*. However, this finding warrants

qualification given our sample's underrepresentation of small-scale operations. According to Whitt et al. (2022), small-scale farms generally have lower profit margins than do medium and large-scale farms. This suggests a lower proportion of small-scale farms that are able to secure *ex ante* break-even status through FCIP policies.

4.3 Bunching of uptake at BECL and declining frequency with distance from BECL

Figure 5 presents comparisons between farmers' coverage level choices in 2022 and their BECLs. Panel A reports the distribution of the difference between the actual choice and the BECL for the full sample, while Panel B presents the same distribution but restricts the sample to farmers whose BECLs fall within the current FCIP coverage level range (50% to 85%). Panel C further decomposes the distribution by the combination of BECLs and coverage level choices. The size of a marker is proportional to the number of farmers falling into that combination. The red dotted line indicates where BECL equals actual coverage level. Markers left (right) of the line show coverage above (below) BECL. The green rectangle contains the 50% to 85% coverage levels.

Panels A and B present choice patterns consistent with the first two predictions. First, there is a notable bunching of farmers insuring exactly at their BECLs. The share of farmers insuring exactly at their BECL is about 20%, and this share increases to 24% when we restrict the sample to farmers with $50\% \leq \phi^{be} \leq 85\%$. Second, farmers exhibit differential behavior on either side of their BECLs, with bunching at BECL being particularly pronounced when examining coverage level choices below BECL compared to above. This asymmetry results in approximately 83.7% of farmers with a BECL of 85% or lower choosing coverage levels at or above their BECLs in 2022.[19] These findings provide strong revealed preference evidence for the

[19] This share was 83.8% in 2021 and 84% in 2020.

existence of aversion to falling below the expected break-even revenue and demonstrate that it serves as a salient reference point in farmers' coverage level decisions.

Panel C presents evidence consistent with Prediction 3: Farmers with $\phi^{be} \leq 70\%$ rarely insured below their BECL (only 2% at 60% and 5% at 70%). A notable share of farmers with $70\% < \phi^{be} \leq 85\%$ insured below their BECLs with this share increases markedly with an increase in the BECL value (9% for $\phi^{be} = 75\%$, 33% for $\phi^{be} = 80\%$, and 53% for $\phi^{be} = 85\%$). These patterns align with both subsidy rate structure and premium aversion: as one gradually increases the coverage level above 70%, the premium subsidy may decrease significantly, and the out-of-pocket premium may increase sharply.

4.4 Effects of increases in loss aversion and premium aversion

Figure 6 presents how the share of farmers insuring at or above the BECL changes with loss aversion and premium aversion. We first divide farmers into two groups: $50\% \leq \phi^{be} \leq 70\%$ and $70\% < \phi^{be} \leq 85\%$ as farmers with $50\% \leq \phi^{be} \leq 70\%$ rarely insured below their BECLs. We then classify farmers by their behavioral preferences using four-point scales. For loss aversion, responses regarding the importance of having a break-even revenue guarantee were coded as follows: "not important" or "slightly important" as least loss averse, "quite important" as moderately loss averse, "very important" as strongly loss averse, and "extremely important" as extremely loss averse. Similarly, for premium aversion, we code responses on the impact of premiums as: "no impact" or "little impact" for least premium averse, "some impact" for moderately premium averse, "significant impact" for strongly premium averse, and "extreme impact" for extremely premium averse.

Figure 6 shows that the share of farmers insuring at or above their BECL increases with declared loss aversion and decreases with premium aversion. These results are consistent with

the first part of Prediction 4 and provide evidence for the primary mechanism in Prediction 5, though we cannot rule out the offsetting subsidy effects for all farmers. The effects are most pronounced between least averse and other groups for loss aversion, and between extremely averse and other groups for premium aversion. These patterns indicate that even moderate levels of loss aversion strongly encourage securing *ex ante* break-even status, while only extreme premium aversion substantially discourages it. While not directly comparable, this difference suggests that loss aversion's positive effect on securing *ex ante* break-even status dominates premium aversion's negative impacts. This helps explain why the majority of farmers insured at or above their BECLs, despite the prevalence of both loss aversion and premium aversion.

To address the effects of potential confounding factors on the relationship between behavioral factors and the probability of securing *ex ante* break-even status, we develop the following linear regression model:

$$(8) \qquad Insure^{\geq}_i = \alpha_0 + \alpha_1 BECL_i + \alpha_2 LA_i + \alpha_3 PA_i + \mathrm{A}X_i + \varepsilon_i,$$

where $Insure^{\geq}_i$ is a binary variable that equals one whenever farmer i's 2022 coverage level was no less than their BECL and equals zero otherwise, and $BECL_i$ is farmer i's self-reported BECL. In addition, LA_i is a vector of four dummy variables for loss aversion levels and PA_i is a vector of four dummy premium aversion variables, both ranging from least to extremely averse, with the least averse farmers as the base group. Finally, X_i is a vector of farm and farmer characteristic control variables while ε_i is the error term. Since almost all farmers with $50\% < \phi^{be} \leq 70\%$ insured at or above their BECLs, we estimate Equation (8) only for farmers with $70\% < \phi^{be} \leq 85\%$.

Column (1) in Table 4 shows that higher BECL values significantly reduce the probability of insuring at or above BECL. Increased loss aversion raises the probability of insuring at or above BECL. This effect is statistically significant for "strongly loss averse" and for "extremely loss averse" relative to "least loss-averse." Increased premium aversion reduces the probability of insuring at or above BECL, an effect that is statistically significant for "extremely premium averse" relative to "least premium averse." These results provide further support for Predictions 4 and 5.

Column (2) introduces an interaction term between BECL and a binary premium aversion indicator (more versus less averse) into Equation (8). Farmers are classified as "more premium averse" if they are "strongly premium averse" or "extremely premium averse" and "less premium averse" if they are "least premium averse" or "moderately premium averse." We apply the same classification to loss aversion, creating "more loss averse" and "less loss averse" groups. The estimation reveals that the interaction between premium aversion and BECL is negative and statistically significant (albeit at the 10% level). This finding is consistent with the second part of Prediction 4: premium aversion's negative effect on securing break-even coverage intensifies at higher BECLs, where premiums are higher.

In Column (3) we introduce the interaction term between BECL and the binary loss aversion indicator. We find that loss aversion's positive effect on securing *ex ante* break-even coverage strengthens with higher BECL. However, this interaction effect lacks statistical significance.

An issue with the above regression analysis is the inclusion of potentially endogenous variables such as leverage rates and risk management tool usage. These variables, being part of farmers' financial and risk management decisions, may correlate with ε_i and bias our estimates.

As a robustness check, the last three columns present estimation results that exclude these variables. This modification produces minimal changes, slightly enhancing the effects of both loss aversion and premium aversion on the probability of insuring at or above the BECL.[20] These findings suggest that our findings are robust across different regression model specifications.

4.5 Direct evidence on premium aversion's effects on forgoing *ex ante* break-even coverage

Our target income models emphasize premium subsidy structure and premium aversion as key factors influencing farmers' decisions to forgo *ex ante* break-even coverage. However, other influences may also contribute. For example, Table A3 in Supplementary Materials shows that farmers with named peril insurance are significantly less likely to insure at or above their BECL than those without. This suggests potential substitution effects across risk management tools. To better understand the rationale behind forgoing *ex ante* break-even coverage, our second survey wave included an additional question for farmers who rated break-even coverage at least "quite important" but who nevertheless insured below their BECLs in 2022. Farmers encountering this question were asked to choose one of the four options listed in Table 5 as their rationale.

Notably, despite "used other risk management tool" being an available option, over 70% of farmers cited excessive premium costs relative to perceived protection benefits as the primary reason for forgoing *ex ante* break-even coverage. This finding provides direct evidence that premium aversion deters farmers from purchasing *ex ante* break-even coverage through crop insurance. It further justifies the inclusion of premium aversion into our conceptual framework.[21]

[20] Likelihood-ratio tests report no statistically significant difference in the goodness of fit between specifications with and without the potentially endogenous variables.

[21] In the second survey wave, we posed a similar question to farmers who insured at or above the BECL but insured below the 85% coverage level. As shown in Table A4 in Supplementary Materials, these farmers predominantly selected the premium-related option. This finding highlights the broader influence of premium aversion: even when farmers secure *ex ante* break-even coverage, the reluctance to incur high premiums lead them to forgo additional coverage.

5. Determinants of BECL, loss aversion and premium aversion

In this section we investigate the determinants of our models' key components: BECL values, aversion to not breaking even, and premium aversion. Understanding what drives these factors is crucial for at least two reasons. First, by analyzing how farmer and farm characteristics influence self-reported BECLs, we can better understand what shapes farmers' expected break-even thresholds. Second, exploring the sources of farmers' loss aversion and premium aversion can help clarify whether these behavioral responses are fundamental, or whether they are contingent on specific operational conditions. Such insights can inform the design of crop insurance programs, ensuring they are better tailored to meet diverse break-even needs.

Column (1) in Table 6 reports estimation results for linear models with $BECL_i$ as dependent variable, and LA_i, PA_i, and other farmer and farm characteristics as explanatory variables. Here, both LA_i and PA_i are specified as binary variables indicating more or less aversion. We find that neither LA_i nor PA_i has a statistically significant impact on BECL, suggesting that farmers' expected break-even thresholds do not depend on these behavioral measures. This result is consistent with our theoretical framework where BECL is exogenous to farmers' loss aversion and premium aversion levels.

Among other explanatory variables, total farm sales above $250,000 in 2022 are associated with a lower BECL compared to sales below this threshold. The share of rented land in total land operated significantly increases BECL, consistent with survey evidence that many farmers exclude opportunity costs of owned land from break-even calculations (see Supplementary Materials Section VII). Farmers who purchase named peril insurance exhibit significantly higher BECLs, which may reflect reverse causality—farmers with higher break-

even thresholds may opt for more insurance products. Finally, consistent with Figure 4, Iowa farmers report significantly higher BECLs than do their Kansas counterparts.

Columns (2) and (3) respectively present estimation results for linear models with LA_i and PA_i as the dependent variables. In both columns, we find a positive and statistically significant correlation between loss aversion and premium aversion. One way to interpret this finding is that premium aversion may be another facet of loss aversion. Specifically, premium aversion reflects farmers' discomfort with the certain, upfront loss involved in paying premiums. Indeed, the same underlying behavioral factor (loss aversion) can manifest differently in multiple aspects of a single decision. For example, Crawford and Meng (2011) report that taxi drivers are simultaneously averse to missing both daily income and working-hour targets, with each goal eliciting distinct behavioral responses. Their findings suggest that treating reference points as multidimensional—spanning different forms of loss—provides a more accurate explanation of observed patterns of quitting working. Likewise, recognizing premium aversion as a separate manifestation of loss aversion illuminates how farmers' reluctance to pay certain costs can interact with their broader effort to avert uncertain losses, ultimately shaping insurance decisions.

Few other control variables have statistically significant impact on either loss aversion or premium aversion. Among the exceptions, an increase in the share of land operated that is in corn significantly increases loss aversion. This potentially reflects that corn's higher drought sensitivity increases revenue risk relative to other major crops (Daryanto et al., 2016; Zipper et al., 2016). Farm sales exceeding $1 million significantly reduce loss aversion, suggesting that larger operations experience less pressure to secure break-even coverage. Additionally, a higher share of rented land significantly increases loss aversion, potentially reflecting added break-even pressures from rental obligations. With respect to premium aversion, larger farm acreage is

significantly related to lower premium aversion, whereas higher farm sales significantly increase premium aversion. Overall, the low pseudo R-squared values indicate that the explanatory variables contribute little to explaining why some farmers are more loss averse and/or premium averse than other farmers. These results suggest that differences in these behavioral attitudes may primarily reflect fundamental preferences rather than variations in operational contexts. However, due to data limitations, our findings remain suggestive rather than definitive.

6. Conclusion and Discussion

This paper analyzes farmers' crop insurance coverage level decisions for securing *ex ante* break-even status. We introduce two complementary conceptual innovations: a reference-dependent model where the expected break-even revenue emerges as a salient reference point in farmers' crop insurance decisions, and the concept of break-even coverage level (BECL), which identifies the coverage level at which the revenue guarantee equals the expected break-even revenue. The reference-dependent model provides a behavioral foundation for understanding farmers' insurance decision-making under dual aversions—toward failing to achieve break-even status and toward paying premiums that may not translate into benefits. BECL converts the endogenous, multidimensional break-even reference point into an exogenous, observable coverage threshold that can be directly compared with farmers' coverage level choices. Together, these innovations create a behavioral optimization framework that enables unique predictions, particularly bunching behavior at BECL—a phenomenon that standard expected utility theory cannot explain.

Our empirical analysis, drawing on a recent online survey that elicits farmers' BECLs and behavioral attitudes, strongly supports these theoretical predictions. We observe pronounced

"bunching" of coverage choices at the BECL, with about 20% of farmers insuring exactly at their BECLs and asymmetrically declining selection rates as distance from this threshold increases. Overall, approximately 84% of farmers insured at or above their BECLs during 2020-2022, providing revealed preference evidence of both the reference point role of expected break-even revenue and loss aversion effects. These patterns are reinforced by individual-level heterogeneity: farmers with stronger loss aversion tendencies are significantly more likely to insure at or above their BECLs, while those exhibiting higher premium aversion show the opposite pattern.

Our theoretical framework can be extended in several directions. First, farm operational costs could be modeled as a function of coverage level choices, capturing how higher insurance coverage might alter farm management practices. This approach would illuminate how crop insurance indirectly affects break-even outcomes through shifts in farmers' operating decisions. Second, one could define state-contingent BECLs tailored to each possible cost realization. Doing so would more tightly link the BECL to actual break-even outcomes, especially in environments where volatility in input markets or extreme weather events routinely disrupt farm-level cost structures. Third, one might replace the concave utility function in the loss domain with a convex specification, in line with Prospect Theory (Kahneman & Tversky, 1979). Under such a setup, farmers who anticipate remaining below their break-even threshold might display risk-seeking behavior. This risk-seeking tendency, in tandem with premium aversion, could further prevent farmers from break-even coverage.

References

Abaluck, J., and J. Gruber. 2011. "Choice Inconsistencies among the Elderly: Evidence from Plan Choice in the Medicare Part D program." *American Economic Review* 101(4):1180–1210.

Andersen, S., C. Badarinza, L. Liu, J. Marx, and T. Ramadorai. 2022. "Reference Dependence in the Housing Market." *American Economic Review* 112(10):3398–3440.

Babcock, B.A. 2015. "Using Cumulative Prospect Theory to Explain Anomalous Crop Insurance Coverage Choice." *American Journal of Agricultural Economics* 97(5):1371–1384.

Babcock, B.A., and D.A. Hennessy. 1996. "Input Demand under Yield and Revenue Insurance." *American Journal of Agricultural Economics* 78(2):416–427.

Baldwin, K., D. Turner, and F. Tsiboe. 2024. "Recent Developments in Ad Hoc Assistance Programs for Agricultural Producers." EIB-278. U.S. Department of Agriculture, Economic Research Service. September.

Bigman, D. 1996. "Safety-First Criteria and Their Measures of Risk." *American Journal of Agricultural Economics* 78(1):225–235.

Brown, A.L., T. Imai, F.M. Vieider, and C.F. Camerer. 2024. "Meta-analysis of Empirical Estimates of Loss Aversion." *Journal of Economic Literature* 62(2):485–516.

Bulut, H. 2017. "Managing Catastrophic Risk in Agriculture through ex Ante Subsidized Insurance or ex Post Disaster Aid." *Journal of Agricultural and Resource Economics* 42(3): 406–26.

- 2020. "The Impact of Enterprise Unit Policy Change on the Quantity Demanded for Crop Insurance." *Agricultural Finance Review* 80(4):507–527.

Bulut, H., and D.A. Hennessy. 2021. "Estimating Elasticities via Market Share Impacts for Crop Insurance Coverage Options." Paper Presented at the 2021 Annual Meeting of the Applied in Agricultural Economic Association, Austin, TX, 1 – 3 August.

Congressional Budget Office (CBO). 2017. "Options to Reduce the Budgetary Costs of the Federal Crop Insurance Program." CBO Publication 53375. Congress of the United States, December.

Che, Y., H. Feng, and D.A. Hennessy. 2020. "Recency Effects and Participation at the Extensive and Intensive Margins in the U.S. Federal Crop Insurance Program." *The Geneva Papers on Risk and Insurance - Issues and Practice* 45:52–85.

Coble, K.H., T.O. Knight, R.D. Pope, and J.R. Williams. 1996. "Modeling Farm-Level Crop Insurance Demand with Panel Data." *American Journal of Agricultural Economics* 78(2):439–447.

Crawford, V.P., and J. Meng. 2011. "New York City Cab Drivers' Labor Supply Revisited: Reference-Dependent Preferences with Rational-Expectations Targets for Hours and Income." *American Economic Review* 101(5):1912–1932.

Daryanto, S., L. Wang, and P.-A. Jacinthe. 2016. "Global Synthesis of Drought Effects on Maize and Wheat Production." *PLOS ONE* 11(5):e0156362.

DeLay, N.D., B. Brewer, A. Featherstone, and D. Boussios. 2023. "The Impact of Crop Insurance on Farm Financial Outcomes." *Applied Economic Perspectives and Policy* 45(1):579–601.

Dohmen, T., A. Falk, D. Huffman, U. Sunde, J. Schupp, and G.G. Wagner. 2011. "Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences." *Journal of the European Economic Association* 9(3):522–550.

Du, X., H. Feng, and D.A. Hennessy. 2017. "Rationality of Choices in Subsidized Crop Insurance Markets." *American Journal of Agricultural Economics* 99(3):732–756.

Economic Research Service (ERS). 2024. "Crop Insurance at a Glance." Topics, Farm Practice & Management, Risk Management. U.S. Department of Agriculture, Economic Research Service. May.

Falk, A., A. Becker, T. Dohmen, B. Enke, D. Huffman, and U. Sunde. 2018. "Global Evidence on Economic Preferences." *The Quarterly Journal of Economics* 133(4):1645–1692.

Farber, H.S. 2008. "Reference-Dependent Preferences and Labor Supply: The Case of New York City Taxi Drivers." *American Economic Review* 98(3): 1069–1082.

Feng, H., X. Du, and D.A. Hennessy. 2020. "Depressed Demand for Crop Insurance Contracts, and a Rationale Based on Third Generation Prospect Theory." *Agricultural Economics* 51(1):59–73.

Froot, K.A., D.S. Scharfstein, and J.C. Stein. 1993. "Risk Management: Coordinating Corporate Investment and Financing Policies." *The Journal of Finance* 48(5):1629–1658.

Gächter, S., E.J. Johnson, and A. Herrmann. 2022. "Individual-Level Loss Aversion in Riskless and Risky Choices." *Theory and Decision* 92(3–4):599–624.

Gneezy, U., and J. Potters. 1997. "An Experiment on Risk Taking and Evaluation Periods." *The Quarterly Journal of Economics* 112(2): 631-645.

Government Accountability Office (GAO). 2017. "Crop Insurance: Opportunities Exist to Improve Program Delivery and Reduce Costs." GAO-17-501. U.S. Government Accountability Office. Washington, D.C. July.

- 2023. "Farm Bill: Reducing Crop Insurance Costs Could Fund Other Priorities". GAO-23-106228, U.S. Government Accountability Office. Washington, D.C. February.

Gong, X., D.A. Hennessy, and H. Feng. 2023. "Systemic Risk, Relative Subsidy Rates, and Area Yield Insurance Choice." *American Journal of Agricultural Economics* 105(3):888–913.

Goodwin, B.K. 1993. “An Empirical Analysis of the Demand for Multiple Peril Crop Insurance.” *American Journal of Agricultural Economics* 75(2):425–434.

Goodwin, B.K., and V.H. Smith. 2013. “What Harm Is Done by Subsidizing Crop Insurance?” *American Journal of Agricultural Economics* 95(2):489–497.

Gul, F. 1991. “A Theory of Disappointment Aversion.” *Econometrica* 59(3):667–686.

Ifft, J., T. Kuethe, and M. Morehart. 2015. “Does Federal Crop Insurance Lead to Higher Farm Debt Use? Evidence from the Agricultural Resource Management Survey (ARMS).” *Agricultural Finance Review* 75(3):349–367.

Ifft, J., T. Kuethe, G. Lyons, A. Schultz, and J.Y. Zhu. 2024. “Crop Insurance’s Impact on Commercial Bank Loan Volumes: Theory and Evidence.” *Applied Economic Perspectives and Policy*, 46(1), 318-337.

Innes, R. 2003. “Crop Insurance in a Political Economy: An Alternative Perspective on Agricultural Policy.” *American Journal of Agricultural Economics* 85(2): 318–35.

Kahneman, D., and A. Tversky. 1979. “Prospect Theory: An Analysis of Decision under Risk.” *Econometrica* 47(2):263–292.

Kim, Y., J. Yu, and D.L. Pendell. 2019. “Effects of Crop Insurance on Farm Disinvestment and Exit Decisions.” *European Review of Agricultural Economics* 47(1):324–347.

Koszegi, B., and M. Rabin. 2006. “A Model of Reference-Dependent Preferences.” *The Quarterly Journal of Economics* 121(4):1133–1165.

- 2007. “Reference-Dependent Risk Attitudes.” *American Economic Review* 97(4):1047–1073.

Loomes, G., and R. Sugden. 1982. “Regret Theory: An Alternative Theory of Rational Choice Under Uncertainty.” *The Economic Journal* 92(368):805–824.

- 1986. “Disappointment and Dynamic Consistency in Choice under Uncertainty.” *The Review of Economic Studies* 53(2):271–282.

Mas-Colell, A., M. Whinston, and J. Green. 1995. *Microeconomic Theory*. 1st. ed., Oxford: Oxford University Press.

Mieno, T., C.G. Walters, and L.E. Fulginiti. 2018. “Input Use under Crop Insurance: The Role of Actual Production History.” *American Journal of Agricultural Economics* 100(5):1469–1485.

Moscardi, E., and A. de Janvry. 1977. “Attitudes Toward Risk Among Peasants: An Econometric Approach.” *American Journal of Agricultural Economics* 59(4):710–716.

O’Donoghue, E. 2014. “The Effects of Premium Subsidies on Demand for Crop Insurance.” ERR–169. U.S. Department of Agriculture, Economic Research Service, July.

O'Donoghue, E., and S. Tulman. 2016. "The Demand for Crop Insurance: Elasticity and the Effect of Yield Shocks." Paper Presented at the 2016 Annual Meeting of the Applied in Agricultural Economic Association, Boston, MA, 31 July – 2 August.

O'Donoghue, T., and C. Sprenger. 2018. "Reference-Dependent Preferences." In *Handbook of Behavioral Economics: Applications and Foundations 1.* Vol 1, edited by B.D. Bernheim, S. Dellavigna, and D. Laibson, 1–724.Amsterdam: Elsevier.

Oprea, R. 2024. "Decisions under Risk Are Decisions under Complexity." *American Economic Review* 114(12):3789–3811.

Paulson, N., G. Schnitkey, C. Zulauf and J. Coppess. 2025. "Impacts of Economic Assistance Payments." *Farmdoc Daily* (15):4, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January.

Prelec, D., and G. Loewenstein. 1998. "The Red and the Black: Mental Accounting of Savings and Debt." *Marketing Science* 17(1): 4-28.

Quiggin, J.C., G. Karagiannis, and J. Stanton. 1993. "Crop Insurance and Crop Production: An Empirical Study of Moral Hazard and Adverse Selection." *Australian Journal of Agricultural Economics* 37(2):95–113.

Rees-Jones, A. 2018. "Quantifying Loss-Averse Tax Manipulation." *The Review of Economic Studies* 85(2):1251–1278.

Richards, T.J. 2020. "Income Targeting and Farm Labor Supply." *American Journal of Agricultural Economics* 102(2):419–438.

Rosa, I. 2018. "Federal Crop Insurance: Program Overview for the 115th Congress." CRS Report for Congress, Congressional Research Service. R45193. Washington, D.C. May.

Rosch, S. 2021. "Federal Crop Insurance: A Primer." CRS Report for Congress, Congressional Research Service, R46686. Washington, DC. February.

Roy, A.D. 1952. "Safety First and the Holding of Assets." *Econometrica* 20(3):431–449.

Schnitkey, G., N. Paulson, C. Zulauf and K. Swanson. 2021. "Crop Insurance Coverage Levels and ECO Use on Corn." *Farmdoc Daily* (11):71, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, May.

Seibold, A. 2021. "Reference Points for Retirement Behavior: Evidence from German Pension Discontinuities." *American Economic Review* 11(4):1126–1165.

Shaik, S., K.H. Coble, T.O. Knight, A.E. Baquet, and G.F. Patrick. 2008. "Crop Revenue and Yield Insurance Demand: A Subjective Probability Approach." *Journal of Agricultural and Applied Economics* 40(3): 757-66.

Shaked, M., and J.G. Shanthikumar. 2007. *Stochastic Orders,* 3rd. ed. New York: Springer.

Sherrick, B.J., P.J. Barry, P.N. Ellinger, and G.D. Schnitkey. 2004. "Factors Influencing Farmers' Crop Insurance Decisions." *American Journal of Agricultural Economics* 86(1):103–114.

Smith, V.H., Glauber, J.W., and Goodwin, B.K., 2017. "Time to Reform the US Federal Agricultural Insurance Program." Agricultural Policy in Disarray. Washington, D.C. American Enterprise Institute (AEI). October.

Sydnor, J. 2010. "(Over)insuring Modest Risks." *American Economic Journal: Applied Economics* 2(4):177–199.

Thaler, R. 1985. "Mental Accounting and Consumer Choice." *Marketing Science* 4(3): 199-214.

Telser, L.G. 1955. "Safety First and Hedging." *The Review of Economic Studies* 23(1):1–16.

Thakral, N., and L.T. Tô. 2021. "Daily Labor Supply and Adaptive Reference Points." *American Economic Review* 111(8):2417–2443.

Tsiboe, F., and D. Turner. 2023. "The Crop Insurance Demand Response to Premium Subsidies: Evidence from U.S. Agriculture." *Food Policy* 119:102505.

Tversky, A., and D. Kahneman. 1992. "Advances in Prospect Theory: Cumulative Representation of Uncertainty." *Journal of Risk and Uncertainty* 5(4):297–323.

Velandia, M., R.M. Rejesus, T.O. Knight, and B.J. Sherrick. 2009. "Factors Affecting Farmers' Utilization of Agricultural Risk Management Tools: The Case of Crop Insurance, Forward Contracting, and Spreading Sales." *Journal of Agricultural and Applied Economics* 41(1):107–123.

Vercammen, J., and G.C. van Kooten. 1994. "Moral Hazard Cycles in Individual-Coverage Crop Insurance." *American Journal of Agricultural Economics* 76(2):250–261.

Whitt, C. N. Miller, and R. Olver. 2022. "Large Family Farms Faced Less Risk in 2021 Based on the Operating Profit Margin Ratio." EIB–247. U.S. Department of Agriculture, Economic Research Service. December.

Woodard, J.D., and J. Yi. 2020. "Estimation of Insurance Deductible Demand under Endogenous Premium Rates." *Journal of Risk and Insurance* 87(2): 477–500.

Yi, J., H.L. Bryant and J.W. Richardson. 2020. "How Do Premium Subsidies Affect Crop Insurance Demand at Different Coverage Levels: The Case of Corn." *The Geneva Papers on Risk and Insurance - Issues and Practice* 45: 5–28.

Yu, J., A. Smith, and D.A. Sumner. 2018. "Effects of Crop Insurance Premium Subsidies on Crop Acreage." *American Journal of Agricultural Economics* 100(1):91–114.

Zipper, S.C., J. Qiu, and C.J. Kucharik. 2016. "Drought Effects on US Maize and Soybean Production: Spatiotemporal Patterns and Historical Changes." *Environmental Research Letters* 11(9): 094021.

Zulauf, C., G. Schnitkey, J. Coppess and N. Paulson. 2023. “The Importance of Insurance Unit in Crop Insurance Policy Debates.” *Farmdoc Daily* (13):107, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June.

Figures and Tables

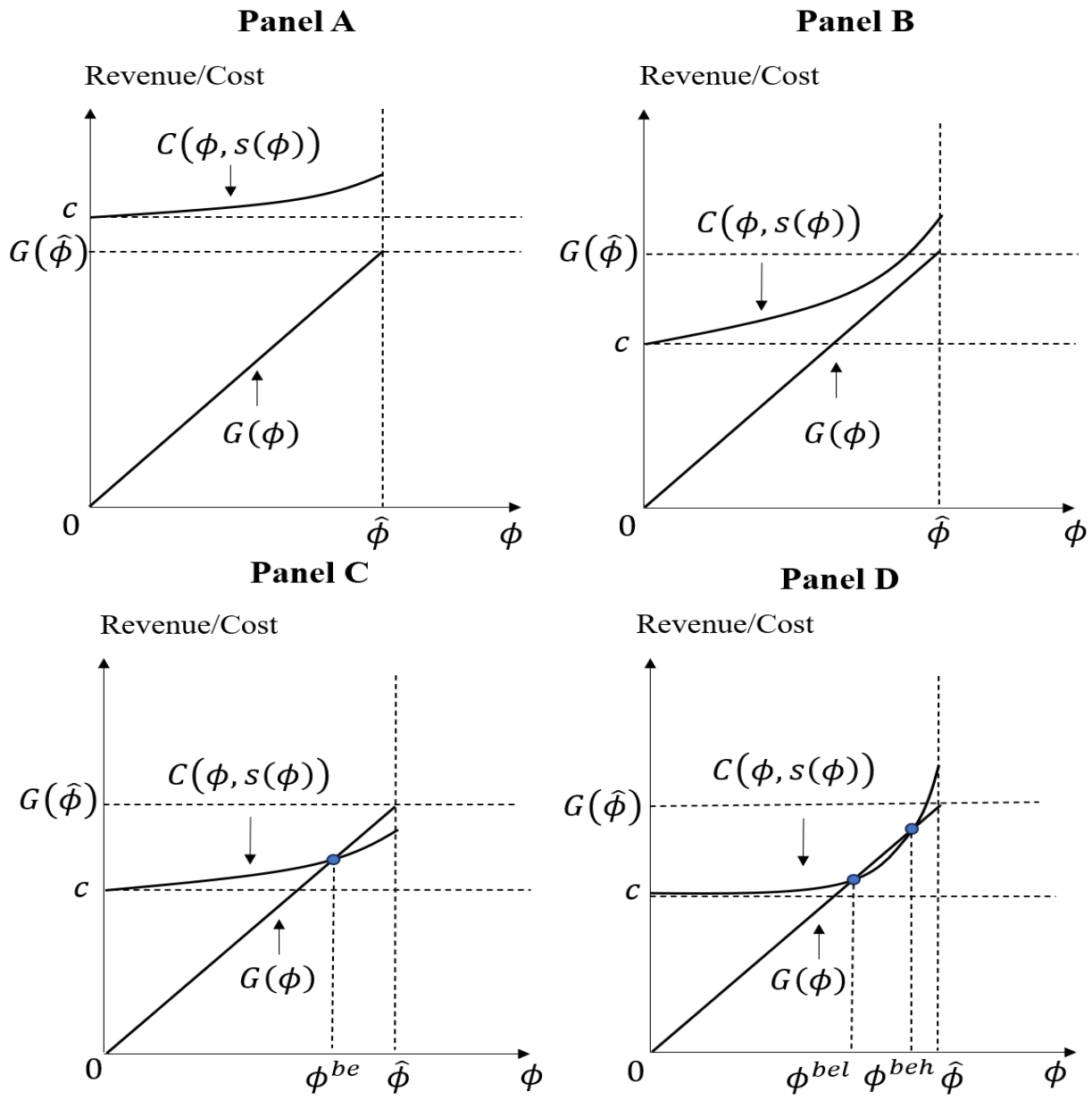


Figure 1. Illustrations of the existence and uniqueness of (feasible) BECL

Note: This figure presents four scenarios illustrating the existence and uniqueness of (feasible) BECL. Each panel's x-axis shows the value of coverage level, while the y-axis shows revenue guarantee and expected break-eve revenue. The increasing and convex curve denotes the expected break-even revenue function, $C(\phi, s(\phi)) = P(\phi, s(\phi)) + c$, while the increasing line denotes the revenue guarantee function, $G(\phi) = \phi \bar{r}$. Panel A shows a scenario with no BECL as the expected operational cost exceeds the maximum possible revenue guarantee. Panel B shows a scenario with no BECL as the expected break-even revenue increases sharply with coverage level. Panel C shows a scenario where there exists a unique BECL in $[0, \hat{\phi}]$. Panel D shows a scenario where there exist two distinct BECLs in $[0, \hat{\phi}]$.

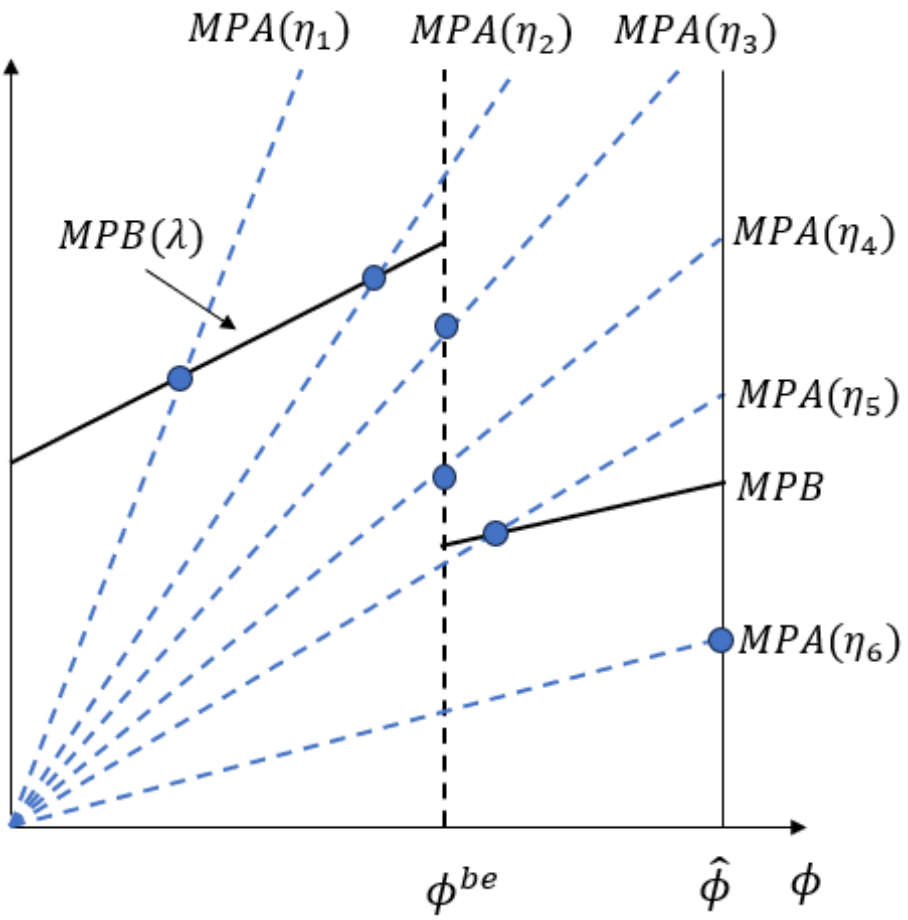


Figure 2. A graphic illustration of the bunching mechanism

Note: This figure illustrates bunching at BECL under a unique-BECL scenario. For simplicity we assume that we assume that $u'(\cdot)=1$, $f'(\cdot)=0$, and subsidy amount increases linearly with coverage level. The x-axis represents ϕ values and the y-axis represents values of the marginal functions. The values of the unique BECL and the maximum possible coverage level are marked as ϕ^{be} and $\hat{\phi}$ on the x-axis, respectively. The two black solid lines represent the MPB component. The discontinuous drop at ϕ^{be} reflects the elimination of the gain-loss utility by insuring at ϕ^{be}. The six blue dashed lines represent the MPA component at six different premium aversion levels, from η_1 to η_6, with higher subscripts representing lower premium aversion levels. The intersection points of MPB and MPA determine the optimal coverage levels.

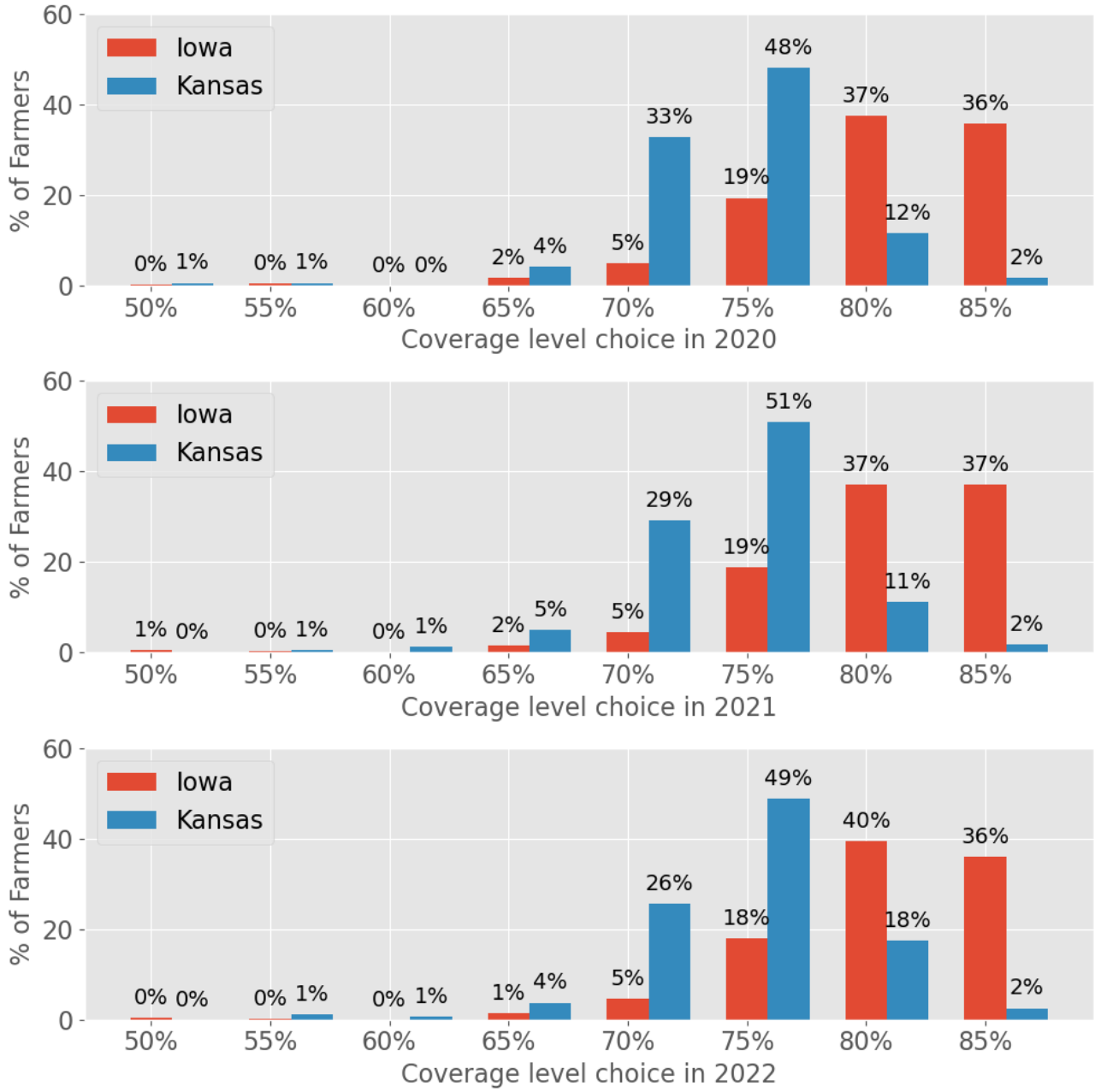


Figure 3. Farmers' coverage level choices during 2020-2022, by state
Data source: Survey conducted by the authors.

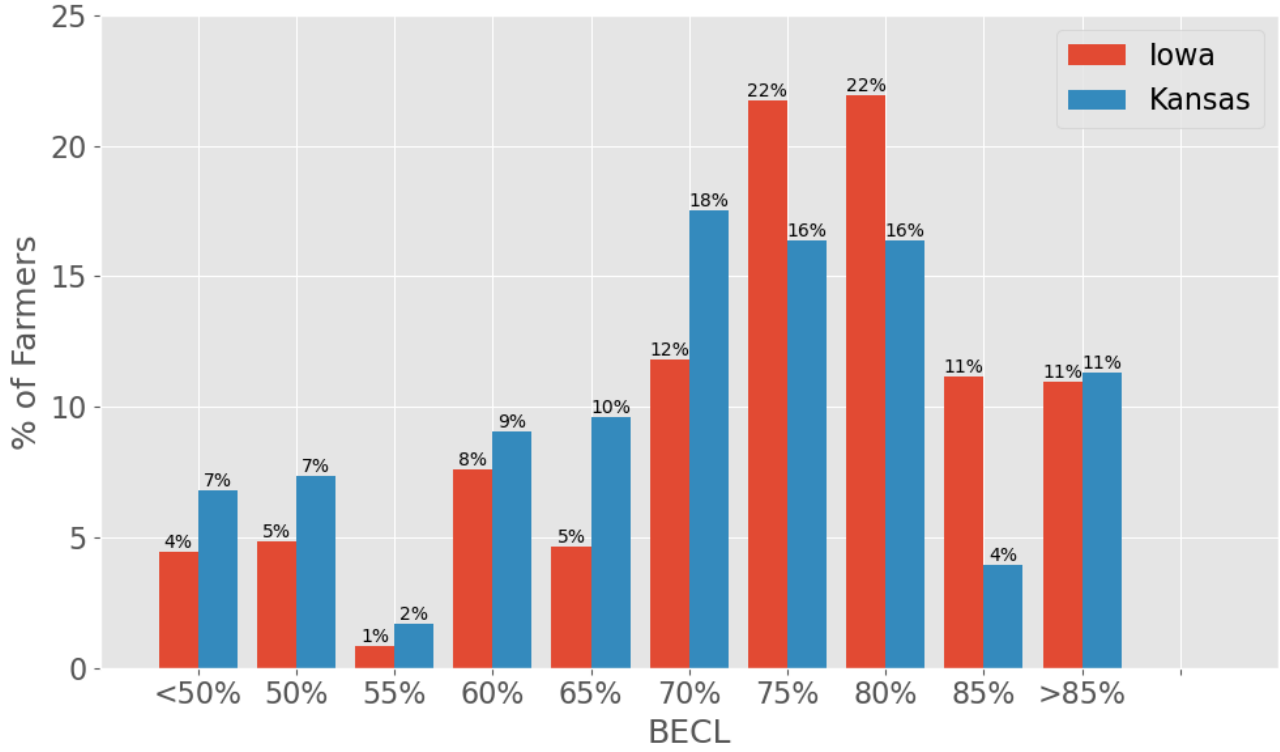


Figure 4. Farmers' BECLs, by state
Data source: Survey conducted by the authors.

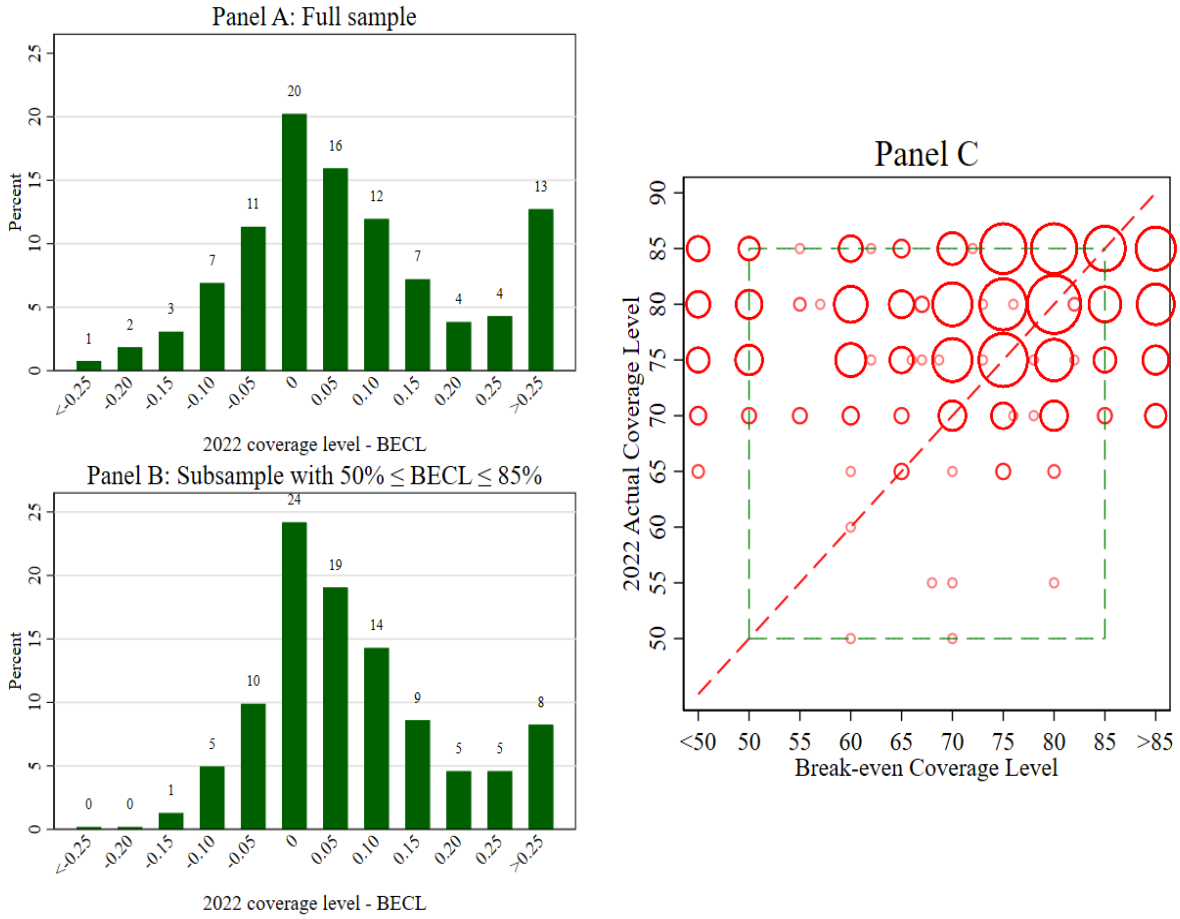


Figure 5. Comparing farmers' BECLs and their 2022 coverage level choices
Data source: Survey conducted by the authors.
Notes: 1. Panel A reports the distribution of the difference between farmers' 2022 coverage level choices and their BECLs for the full sample. Panel B reports the same distribution for the subsample where farmers BECLs are within the current FCIP coverage level domain, i.e., between 50% and 85%.
2. Panel C combines farmers' 2022 actual coverage levels with their BECLs. Each mark represents a combination of BECL and actual coverage levels, with size proportional to the number of farmers making that choice. The dotted red line indicates where BECL equals actual coverage level. Markers left (right) of the line show coverage above (below) BECL.

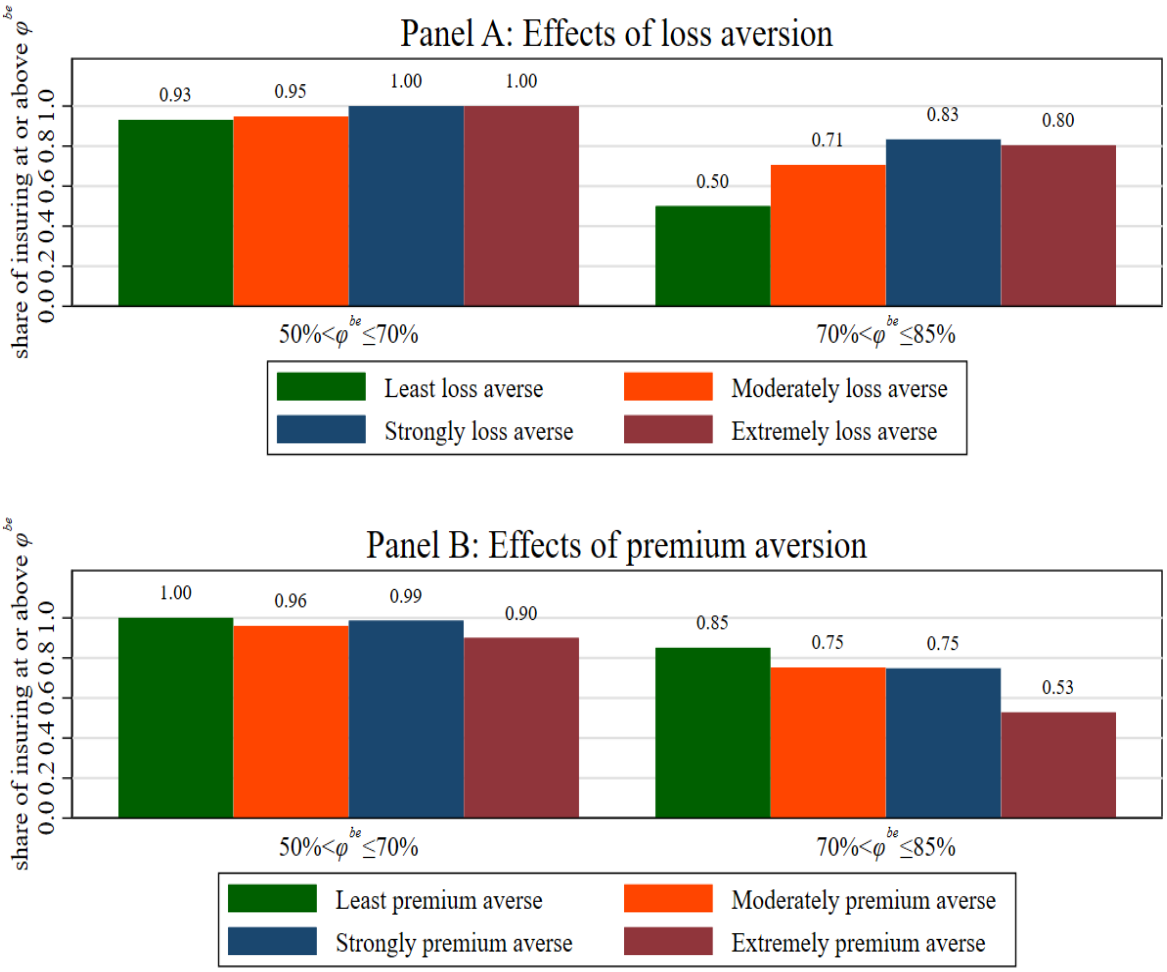


Figure 6. Share of farmers who insured at or above their BECLs in 2022, by behavioral responses and BECL.
Data source: Survey conducted by the authors.
Notes: 1. Least, moderately, strongly, and extremely loss averse farmers are farmers who reported that it is, respectively, either not important at all or slightly important, quite important, very important, and extremely important to have an insurance guarantee to allow them to break even in a typical year.
2. Least, moderately, strongly, and extremely premium averse farmers are farmers who reported that out-of-pocket premiums had, respectively, either no impact or slight impact, some impact, significant impact, and great impact on their coverage level choices during 2018 to 2022.

Table 1. Current FCIP premium subsidy rates and how the premium subsidy rate changes with coverage level for different FCIP policies

Insurance policy by unit type		Coverage level (ϕ)								
		CAT	50%	55%	60%	65%	70%	75%	80%	85%
Basic and Optional Units:	$s(\phi)$	100	67	64	64	59	59	55	48	38
	$s_\phi(\phi)$	n/a	n/a	-0.6	0	-1	0	-0.8	-1.4	-2
Enterprise Unit (EU):	$s(\phi)$	n/a	80	80	80	80	80	77	68	53
	$s_\phi(\phi)$	n/a	n/a	0	0	0	0	-0.6	-1.8	-3
Whole Farm Unit:	$s(\phi)$	n/a	80	80	80	80	80	80	71	56
	$s_\phi(\phi)$	n/a	n/a	0	0	0	0	0	-1.8	-3

Data source: Rosch, S. 2021. "Federal Crop Insurance: A Primer." CRS Report for Congress, Congressional Research Service, R46686. Washington, DC.

Note: For each insurance policy type, the $s(\phi)$ row reports the subsidy rates at different coverage levels; the $s_\phi(\phi)$ row reports the ratio of the difference between subsidy rates over the difference between the coverage levels, calculated as $s_\phi(\phi) = [s(\phi_+) - s(\phi_-)]/(\phi_+ - \phi_-)$, where ϕ_+ and ϕ_- are two consecutive coverage levels with $\phi_+ - \phi_- = 0.05$ and ϕ_+ the column value.

Table 2. Summary statistics for farmer and farm characteristics among survey participants

	N	Mean	SD	Min	Max	*N*	Mean	SD	Min	Max
Variables	Iowa sample					Kansas sample				
Male = 1	471	0.95	0.22	0	1	177	0.88	0.33	0	1
Age <= 50	475	0.25	0.43	0	1	177	0.33	0.47	0	1
Education: at least some college = 1	474	0.81	0.40	0	1	177	0.86	0.35	0	1
Main occupation: farming = 1	476	0.88	0.32	0	1	177	0.77	0.42	0	1
Total farm acreage operated in 2022 (unit: 100 acres)	476	11.8 (10)	9.27	0.09	60	177	22.2 (17.5)	19.5	1	100
Share of farm acreage in corn (unit: %)	476	52.3	14.4	0	100	177	32.5	20.6	0	100
Corn yield in 2022 in bushels	469	209	27.7	90	285	164	94.4	54	5	227
Total farm sales: < $250,000	439	0.11	0.32	0	1	174	0.24	0.43	0	1
Total farm sales: $250,000-$499,999	439	0.2	0.40	0	1	174	0.24	0.43	0	1
Total farm sales: $500,000-$999,999	439	0.3	0.46	0	1	174	0.18	0.38	0	1
Total farm sales: > $1,000,000	439	0.39	0.49	0	1	174	0.34	0.47	0	1
Share of land rented from others (unit: %)	476	48.1	33.5	0	100	177	45.3	31.3	0	100
Leverage rate: < 26%	445	0.67	0.47	0	1	173	0.64	0.48	0	1
Leverage rate: 26% - 50%	445	0.22	0.41	0	1	173	0.24	0.43	0	1
Leverage rate: > 51%	445	0.11	0.31	0	1	173	0.12	0.33	0	1
Purchased crop insurance = 1	476	0.97	0.16	0	1	177	0.98	0.13	0	1
Purchased named peril insurance = 1	476	0.61	0.49	0	1	177	0.46	0.50	0	1
Used forward/future/option contracts = 1	476	0.73	0.44	0	1	177	0.66	0.47	0	1
Participated in other government risk management programs = 1	476	0.78	0.41	0	1	177	0.84	0.37	0	1
Invested in risk management technologies or practices = 1	476	0.55	0.50	0	1	177	0.36	0.48	0	1
First wave = 1	476	0.42	0.49	0	1	177	0.75	0.44	0	1

Data source: Survey conducted by the authors.

Note: Numbers in the parentheses are median values of total farm acreage operated in 2022.

Table 3. Summary statistics of farmers' responses to the loss aversion and premium aversion questions

	N	Percentage	Cum. Percentage
Panel A: How important is it to have insurance revenue guarantee to allow for break-even?			
Extremely important	101	15%	15%
Very important	217	33%	49%
Quite important	205	31%	80%
Slightly important	110	17%	97%
Not important at all	19	3%	100%
Panel B: how much impact did out-of-pocket premium have on coverage level choices?			
Great impact	99	15%	15%
Significant impact	237	37%	52%
Some impact	196	31%	83%
Slight impact	63	10%	93%
No impact	43	7%	100%

Data source: Survey conducted by the authors.

Notes: 1. Panel A reports summary data on farmers' responses to the question: "In any given year, how important is it to you that your corn insurance revenue guarantee allows you to break even?"

2. Panel B reports summary data on farmers' responses to the question: "For the years 2018-2022, how much impact did your out-of-pocket premium for each coverage level have on the coverage level choices of your corn crop insurance policies?"

Table 4. Effects of being more loss averse and premium averse on the probability of insuring at or above the BECL, conditional on $70\% < \phi^{be} \leq 85\%$

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Insured at or above the BECL					
VARIABLES	Probit	Probit	Probit	Probit	Probit	Probit
BECL	-0.040***	-0.032***	-0.050***	-0.038***	-0.028***	-0.045***
	(0.005)	(0.008)	(0.006)	(0.005)	(0.008)	(0.007)
Moderately LA	0.116			0.153**		
	(0.077)			(0.072)		
Strongly LA	0.236***			0.247***		
	(0.073)			(0.066)		
Extremely LA	0.264***			0.272***		
	(0.079)			(0.074)		
Moderately PA	-0.043			-0.054		
	(0.062)			(0.057)		
Strongly PA	-0.083			-0.092		
	(0.072)			(0.063)		
Extremely PA	-0.185**			-0.253***		
	(0.078)			(0.074)		
More LA		0.141***	-1.161		0.138***	-0.606
		(0.041)	(0.830)		(0.038)	(0.854)
More PA		1.632*	-0.083*		1.827**	-0.114**
		(0.932)	(0.047)		(0.932)	(0.048)
More PA * BECL		-0.022*			-0.024**	
		(0.012)			(0.012)	
More LA * BECL			0.017			0.009
			(0.010)			(0.011)
Non-choice control variables included	Yes	Yes	Yes	Yes	Yes	Yes
Choice-related control variables included	Yes	Yes	Yes	No	No	No
Observations	277	277	277	305	305	305
Pseudo R2	0.377	0.370	0.367	0.329	0.308	0.297

Data source: Survey conducted by the authors.

Notes: 1. *** p<0.01, ** p<0.05, * p<0.1.

2. Numbers in parentheses are robust standard errors clustered at the county level.

3. The base group of the LA comparisons is farmers with the least LA level.

4. The base group of the PA comparisons is farmers with the least PA level.

5. "More LA" is a binary variable that equals one if the farmer is categorized as strongly or extremely LA, and zero otherwise.

6. "More PA" is a binary variable that equals one if the farmer is categorized as strongly or extremely PA, and zero otherwise.

7. See Table A3 in Supplementary Materials for regression results of other control variables.

Table 5. Summary statics on reasons for insuring below BECL in 2022

	Farmers who insured below their BELCs	
Choice options	*N*	%
The additional out-of-pocket premium required is too high relative to the value that I derived for the additional protection from a coverage level higher than the one that I chose.	29	71%
I used other risk management tools in 2022.	3	7%
I believed that I could handle the situation in which my actual corn revenue fell below the break-even revenue in 2022.	9	22%
Other	0	0%

Data source: Survey conducted by the authors.

Notes: 1. This table presents summary data for responses to why farmers insured below their BECLs in 2022. Each farmer was asked to select one among the four options listed in the first column.

2. This question was only posed to second-wave survey participants who reported that securing break-even status through crop insurance was at least "quite important" but insured below their BECLs in 2022.

Table 6. Determinants of BECL, loss aversion, and premium aversion

	(1)	(2)	(3)
	Dependent variables:		
	BECL	More LA	More PA
VARIABLES	OLS	Probit	Probit
BECL		-0.001	-0.000
		(0.001)	(0.001)
More LA	-1.099		0.090**
	(1.130)		(0.037)
More PA	-0.334	0.087**	
	(1.176)	(0.036)	
Male	2.548	-0.106	0.023
	(3.190)	(0.098)	(0.094)
Age < 50	0.991	-0.004	0.028
	(1.318)	(0.054)	(0.052)
At least some college education	-2.429	-0.092	-0.061
	(1.706)	(0.061)	(0.059)
Farming as main occupation:	-1.003	0.006	0.086
	(1.668)	(0.067)	(0.072)
Farm acreage (100 acres)	0.020	-0.001	-0.004**
	(0.070)	(0.002)	(0.002)
Share of farm acreage in corn: %	-0.047	0.003*	-0.000
	(0.034)	(0.002)	(0.002)
Corn yield (10 bu/acre)	-0.019	-0.000	-0.000
	(0.018)	(0.001)	(0.001)
Total farm sales: $250,000-$499,999	-4.216*	-0.104	0.006
	(2.141)	(0.082)	(0.089)
Total farm sales: $500,000-$999,999	-0.191	-0.104	0.088
	(2.200)	(0.077)	(0.086)
Total farm sales: > $1,000,000	-2.093	-0.165*	0.177**
	(2.528)	(0.084)	(0.085)
Share of land rented from others	0.042**	0.002***	-0.001
	(0.020)	(0.001)	(0.001)
Leverage rate: 26% - 50%	1.030	0.030	0.039
	(1.315)	(0.052)	(0.053)
Leverage rate: > 50%	0.127	0.082	-0.062
	(2.341)	(0.074)	(0.081)
Purchased named peril insurance	2.163*	0.075*	0.031
	(1.255)	(0.041)	(0.040)
Used forward/future/option contracts	2.469	0.005	0.023
	(1.900)	(0.048)	(0.053)
Participated in other government risk management programs	-0.652	0.041	0.039
	(1.586)	(0.053)	(0.057)
Invested in risk management technologies or	1.922	0.014	0.063

practices			
	(1.531)	(0.048)	(0.050)
Iowa	5.195**	-0.006	-0.103
	(2.281)	(0.081)	(0.073)
First wave	-1.091	0.044	0.070
	(1.315)	(0.045)	(0.045)
Constant	71.769***		
	(5.052)		
Observations	550	550	550
R-squared	0.059	0.054	0.037

Data source: Survey conducted by the authors.

Notes: 1. *** p<0.01, ** p<0.05, * p<0.1.

2. Numbers in parentheses are robust standard errors clustered at the county level.

3. “More LA” is a binary variable that equals one if a farmer is categorized as strongly or extremely LA, and zero otherwise.

4. “More PA” is a binary variable that equals one if a farmer is categorized as strongly or extremely PA, and zero otherwise.

5. The base group for total farm sales comparisons is farmers with sales < $250,000.

6. The base group for total leverage rate comparisons is farmers with leverage rate < 26%.

Supplementary Materials

I. Demonstration of Expression (11)

Since $C(\phi, s(\phi)) = c + P(\phi, s(\phi))$ then $C_{\phi}(\phi, s(\phi)) = P_{\phi}(\phi, s(\phi)) = (1 - s(\phi))H_{\phi}(\phi) - s_{\phi}(\phi)H(\phi)$.

Since $H(\phi) = \mathrm{E}(n(\phi)) = \mathrm{E}(\max(G(\phi) - r, 0)) = \int_0^{\phi\bar{r}} \phi\bar{r} - r dF(r)$, by Leibniz Integral Rule then

$H_{\phi}(\phi) = \bar{r}F(\phi\bar{r}) > 0$. Since $s(\phi) \in (0,1)$ and $s_{\phi}(\phi) \leq 0$, then $C_{\phi}(\phi, s(\phi)) = P_{\phi}(\phi, s(\phi)) > 0$.

Further, $C_{\phi\phi}(\phi, s(\phi)) = P_{\phi\phi}(\phi, s(\phi)) = (1 - s(\phi))H_{\phi\phi}(\phi) - 2s_{\phi}(\phi)H_{\phi}(\phi) - s_{\phi\phi}(\phi)H_{\phi}(\phi)$.

Since $H_{\phi\phi}(\phi) = \bar{r}^2 f(\phi\bar{r}) > 0$ and $s_{\phi\phi}(\phi) \leq 0$, then we also have $C_{\phi\phi}(\phi, s(\phi)) = P_{\phi\phi}(\phi, s(\phi)) > 0$.

II. Farmers' coverage level choices under the BECL-pair scenario

The following result holds in the BECL-pair scenario, which directly implies that any farmer with a strictly increasing utility function should prefer insuring at any $\phi \in [\phi^{bel}, \phi^{beh})$ over insuring at or above ϕ^{beh}.

Proposition A1. In the presence of two distinct BECLs, ϕ^{bel} and ϕ^{beh} with $\phi^{bel} < \phi^{beh}$, then for any $\phi^{beh^-} \in [\phi^{bel}, \phi^{beh})$ and $\phi^{beh^+} \in [\phi^{beh}, \hat{\phi}]$, we have $W(r; c, \phi^{beh^-}, s) \geq W(r; c, \phi^{beh^+}, s)$ whenever $0 \leq r \leq G(\phi^{beh^-})$ and $W(r; c, \phi^{beh^-}, s) > W(r; c, \phi^{beh^+}, s)$ whenever $G(\phi^{beh^-}) < r \leq \hat{r}$.

Proof:

Letting $\phi^{beh^-} \in [\phi^{bel}, \phi^{beh})$ and $\phi^{beh^+} \in [\phi^{beh}, \hat{\phi}]$, then

$$W(r; c, \phi^{beh^-}, s) = \begin{cases} G(\phi^{beh^-}) - C(\phi^{beh^-}, s(\phi^{beh^-})) & \text{whenever } 0 \leq r \leq G(\phi^{beh^-}); \\ r - C(\phi^{beh^-}, s(\phi^{beh^-})) & \text{whenever } G(\phi^{beh^-}) < r \leq G(\phi^{beh^+}); \\ r - C(\phi^{beh^-}, s(\phi^{beh^-})) & \text{whenever } G(\phi^{beh^+}) < r \leq \hat{r}; \end{cases}$$

and

$$W(r;c,\phi^{beh^+},s)=\begin{cases}G(\phi^{beh^+})-C(\phi^{beh^+},s(\phi^{beh^+})) & \text{whenever } 0\le r\le G(\phi^{beh^-});\\ G(\phi^{beh^+})-C(\phi^{beh^+},s(\phi^{beh^+})) & \text{whenever } G(\phi^{beh^-})<r\le G(\phi^{beh^+});\\ r-C(\phi^{beh^+},s(\phi^{beh^+})) & \text{whenever } G(\phi^{beh^+})<r\le \hat{r}.\end{cases}$$

By Remark 3 we obtain that $G(\phi^{beh-})-C(\phi^{beh^-},s(\phi^{beh^-}))\ge 0$ and $G(\phi^{beh^+})-C(\phi^{beh^+},s(\phi^{beh^+}))\le 0$. Then $W(r;c,\phi^{beh^-},s)\ge W(r;c,\phi^{beh^+},s)$ whenever $0\le r\le G(\phi^{beh^-})$.

In addition, since $r-C(\phi^{beh^-},s(\phi^{beh^-}))>0$ whenever $G(\phi^{beh^-})<r\le G(\phi^{beh^+})$, then $W(r;c,\phi^{beh^-},s)>W(r;c,\phi^{beh^+},s)$ whenever $G(\phi^{beh^-})<r\le G(\phi^{beh^+})$.

Finally, since $C(\phi^{beh+},s(\phi^{beh+})>C(\phi^{beh-},s(\phi^{beh-}))$ then $r-C(\phi^{beh-},s(\phi^{beh-}))>r-C(\phi^{beh+},s(\phi^{beh+}))$. Consequently, $W(r;c,\phi^{beh^-},s)>W(r;c,\phi^{beh^+},s)$ whenever $G(\phi^{beh^+})<r<\hat{r}$. *Q.E.D.*

III. Prevalence of BECL-pair scenario

We investigate the prevalence of two distinct BECLs. By Equation (1) and the definitions of ϕ^{beh} and ϕ^{bel} we obtain

$$\begin{aligned}C(\phi^{beh},s(\phi^{beh}))-C(\phi^{bel},s(\phi^{bel}))&=P(\phi^{beh},s(\phi^{beh}))+c-[P(\phi^{bel},s(\phi^{bel}))+c]\\&=P(\phi^{beh},s(\phi^{beh}))-P(\phi^{bel},s(\phi^{bel}))\\&=G(\phi^{beh})-G(\phi^{bel}).\end{aligned}\tag{A1}$$

The following is immediate:

Remark A1. A necessary condition for the existence of two distinct BECLs is that there exist two coverage levels $\phi^1, \phi^2 \in (0, \hat{\phi}]$ with $\phi^1 \neq \phi^2$ such that $P(\phi^2, s(\phi^2)) - P(\phi^1, s(\phi^1)) = G(\phi^2) - G(\phi^1)$.

We employ Risk Management Agency's (RMA) Summary of Business (SOB) data from 2011-2023 to empirically test for the prevalence of BECL pairs using the condition established in Remark A1. We consider two major field crops: corn and soybeans. For each county-crop combination, we first calculate the yearly acre-weighted $P(\phi, s(\phi))$ and $G(\phi)$ for each $\phi \in \{50\%, 55\%, 60\%, 65\%, 70\%, 75\%, 80\%, 85\%\}$. To address potential selection bias and ensure robust estimation, we exclude coverage levels with less than 1,000 insured acres in any year for each county-crop combination. We then compute the average acre-weighted $P(\phi, s(\phi))$ and $G(\phi)$ across years for each county-crop combination. Finally, for each county-crop combination, we investigate whether there exists any $\phi^1, \phi^2 \in \{50\%, 55\%, 60\%, 65\%, 70\%, 75\%, 80\%, 85\%\}$ with $\phi^1 \neq \phi^2$ such that $P(\phi^2, s(\phi^2)) - P(\phi^1, s(\phi^1)) = G(\phi^2) - G(\phi^1)$, where the average acre-weighted measures across years are used.

Our analysis finds no county-crop combination meeting the condition specified in Remark A1, suggesting the absence of BECL pairs in aggregated county-level data.[23] While the theoretical possibility of BECL pairs carries important implications for understanding farmers'

[23] Using farm-level or unit-level data may increase the likelihood of identifying BECL pairs. Specifically, because individual risks aggregate and often offset each other at the county level, the increase in the crop insurance premium with coverage level is generally more pronounced at the farm or unit level than at the county level. As a result, the necessary condition in Remark A1 is more likely to hold at the farm or unit level.

crop insurance coverage level decisions, its empirical rarity suggests limited practical significance.

IV. Proof for strictly increasing marginal expected utility function in Equation (7)

Since $W(r;c,\phi,s) = r + n(\phi) - C(\phi, s(\phi))$, then

$$\mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right] = \frac{\partial \mathrm{E}[u(W(r;c,\phi,s))]}{\partial \phi}$$
$$= \frac{\partial \int_0^{\phi\bar{r}} u[\phi\bar{r} - C(\phi, s(\phi))]dF(r)}{\partial \phi} + \frac{\partial \int_{\phi\bar{r}}^{\hat{r}} u[r - C(\phi, s(\phi))]dF(r)}{\partial \phi}.$$

Applying Leibniz Integral Rule then:

$$\mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right] = \bar{r}u[\phi\bar{r} - C(\phi)] + \left[\bar{r} - C_\phi(\phi)\right]\int_0^{\phi\bar{r}} u_W[\phi\bar{r} - C(\phi)]dF(r)$$
$$-\bar{r}u[\phi\bar{r} - C(\phi)] - C_\phi(\phi)\int_{\phi\bar{r}}^{\hat{r}} u_W[r - C(\phi)]dF(r)$$
$$= \bar{r}\int_0^{\phi\bar{r}} u_W[\phi\bar{r} - C(\phi)]dF(r)$$
$$-C_\phi(\phi)\left[\int_0^{\phi\bar{r}} u_W[\phi\bar{r} - C(\phi)]dF(r) + \int_{\phi\bar{r}}^{\hat{r}} u_W[r - C(\phi)]dF(r)\right].$$

Since $C_\phi(\phi, s(\phi)) = P_\phi(\phi, s(\phi)) = H_\phi(\phi) - S_\phi(\phi)$ and $H_\phi(\phi) = \bar{r}F(\phi\bar{r})$ then:

$$
\begin{aligned}
\mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right] &= \overline{r}F(\phi\overline{r})u_W[\phi\overline{r}-C(\phi)] \\
&\quad -\left[H_\phi(\phi)-S_\phi(\phi)\right]\left[\int_0^{\phi\overline{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)+\int_{\phi\overline{r}}^{\hat{r}} u_W[r-C(\phi)]dF(r)\right] \\
&= \overline{r}F(\phi\overline{r})u_W[\phi\overline{r}-C(\phi)] \\
&\quad -\left[\overline{r}F(\phi\overline{r})-S_\phi(\phi)\right]\left[\int_0^{\phi\overline{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)+\int_{\phi\overline{r}}^{\hat{r}} u_W[r-C(\phi)]dF(r)\right] \\
&= \overline{r}F(\phi\overline{r})\left[\int_0^{\phi\overline{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)+\int_{\phi\overline{r}}^{\hat{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)\right] \\
&\quad -\overline{r}F(\phi\overline{r})\left[\int_0^{\phi\overline{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)+\int_{\phi\overline{r}}^{\hat{r}} u_W[r-C(\phi)]dF(r)\right] \\
&\quad +S_\phi(\phi)\left[\int_0^{\phi\overline{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)+\int_{\phi\overline{r}}^{\hat{r}} u_W[r-C(\phi)]dF(r)\right] \\
&= \overline{r}F(\phi\overline{r})\left[\int_{\phi\overline{r}}^{\hat{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)-\int_{\phi\overline{r}}^{\hat{r}} u_W[r-C(\phi)]dF(r)\right] \\
&\quad +S_\phi(\phi)\left[\int_0^{\phi\overline{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)+\int_{\phi\overline{r}}^{\hat{r}} u_W[r-C(\phi)]dF(r)\right] \\
&> S_\phi(\phi)\left[\int_0^{\phi\overline{r}} u_W[\phi\overline{r}-C(\phi)]dF(r)+\int_{\phi\overline{r}}^{\hat{r}} u_W[r-C(\phi)]dF(r)\right],
\end{aligned}
$$

where the third equation holds because $u_W[\phi\overline{r}-C(\phi)]$ is a constant and the inequality holds because $u''(\cdot)<0$. Consequently, if $S_\phi(\phi)\geq 0$ then we must have $\mathrm{E}\left[u_W(W(\cdot))W_\phi(\cdot)\right]>0$.

In addition, with a unique BECL ϕ^{be} we obtain:

$$
\frac{\partial \mathrm{E}\ u(W(\cdot))I(W(\cdot)<0)}{\partial\phi}=\frac{\partial\int_0^{\phi\overline{r}} u[\phi\overline{r}-C(\phi,s(\phi))]dF(r)}{\partial\phi}+\frac{\partial\int_{\phi\overline{r}}^{C(\phi^{be},s(\phi^{be}))} u[r-C(\phi,s(\phi))]dF(r)}{\partial\phi}.
$$

Again, by Leibniz Integral Rule we obtain:

$$\begin{aligned}
\frac{\partial \mathrm{E}\ u(W(\cdot))I(W(\cdot)<0)}{\partial\phi} &= \bar{r}u[\phi\bar{r}-C(\phi)]f(r)+\left[\bar{r}-C_{\phi}(\phi)\right]\int_0^{\phi\bar{r}} u_W[\phi\bar{r}-C(\phi)]dF(r) \\
&\quad -\bar{r}u[\phi\bar{r}-C(\phi)]f(r)-C_{\phi}(\phi)\int_{\phi\bar{r}}^{C(\phi^{be},s(\phi^{be}))} u_W[r-C(\phi)]dF(r) \\
&= \bar{r}F(\phi\bar{r})u_W[\phi\bar{r}-C(\phi)] \\
&\quad -\left[H_{\phi}(\phi)-S_{\phi}(\phi)\right]\left[\int_0^{\phi\bar{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)+\int_{\phi\bar{r}}^{C(\phi^{be},s(\phi^{be}))} u_W[r-C(\phi)]dF(r)\right] \\
&= \bar{r}F(\phi\bar{r})\left[\int_0^{\phi\bar{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)+\int_{\phi\bar{r}}^{\hat{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)\right] \\
&\quad -\bar{r}F(\phi\bar{r})\left[\int_0^{\phi\bar{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)+\int_{\phi\bar{r}}^{C(\phi^{be},s(\phi^{be}))} u_W[r-C(\phi)]dF(r)\right] \\
&\quad +S_{\phi}(\phi)\left[\int_0^{\phi\bar{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)+\int_{\phi\bar{r}}^{C(\phi^{be},s(\phi^{be}))} u_W[r-C(\phi)]dF(r)\right] \\
&= \bar{r}F(\phi\bar{r})\left[\int_{\phi\bar{r}}^{\hat{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)-\int_{\phi\bar{r}}^{C(\phi^{be},s(\phi^{be}))} u_W[r-C(\phi)]dF(r)\right] \\
&\quad +S_{\phi}(\phi)\left[\int_0^{\phi\bar{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)+\int_{\phi\bar{r}}^{C(\phi^{be},s(\phi^{be}))} u_W[r-C(\phi)]dF(r)\right] \\
&> S_{\phi}(\phi)\left[\int_0^{\phi\bar{r}} u_W[\phi\bar{r}-C(\phi)]dF(r)+\int_{\phi\bar{r}}^{C(\phi^{be},s(\phi^{be}))} u_W[r-C(\phi)]dF(r)\right],
\end{aligned}$$

which is strictly positive if $S_{\phi}(\phi)\geq 0$.

Then $\mathrm{E}\left[u_W(W(\cdot))W_{\phi}(\cdot)\right]>0$ for any $\phi\in[\phi^{be},\hat{\phi}]$ and $\mathrm{E}\left[u_W(W(\cdot))W_{\phi}(\cdot)\right]+$

$\lambda\dfrac{\partial \mathrm{E}\ u(W(\cdot))I(W(\cdot)<0)}{\partial\phi}>0$ for any $\phi\in[0,\phi^{be})$ if $S_{\phi}(\phi)\geq 0$. *Q.E.D.*

V. Number of farmers participating in the survey from each county

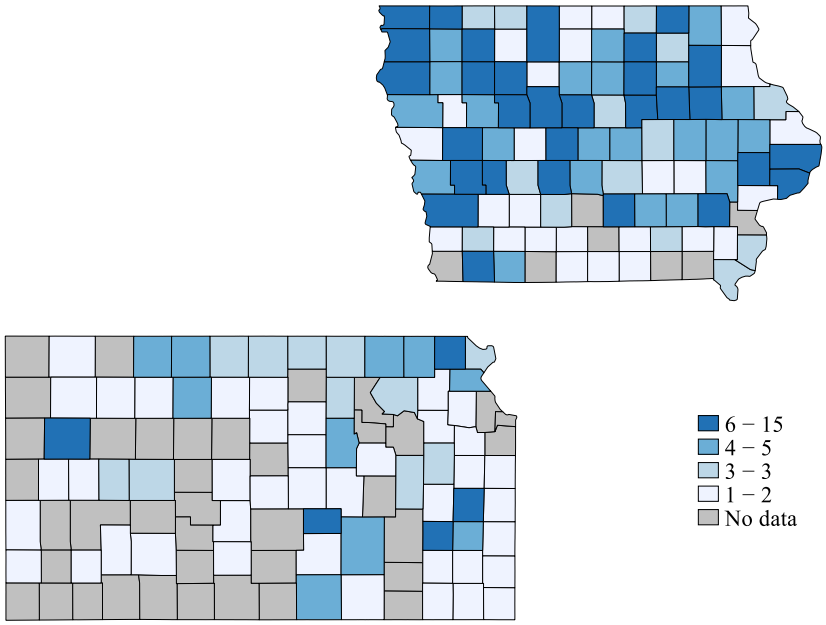


Figure A1. Number of farmers participating in the survey from each county in the states of Iowa and Kansas
Data source: Survey conducted by the authors.

VI. Compare self-reported BECL with BECL calculated from state-wise budget data

We collected state-level corn budget data for both Iowa and Kansas for the years 2018–2022, representing the five years prior to our survey period. The Iowa budget data include different yield levels and two rotation types: corn following corn and corn following soybeans. In contrast, the Kansas data do not differentiate by rotation type but are disaggregated by region. To align with the county distribution of our survey participants, we focus on the Northwest, Southwest, and Central regions of Kansas.

For both states, the original budget data provide estimates of total costs as well as detailed cost categories. We calculate projected revenue for each state-year-scenario by

multiplying the projected yield (from the original budget data) by the projected price obtained from the *Farmdoc Daily* website.

We calculate BECL by dividing the projected total cost by the projected revenue. The average BECL across all years and scenarios is 89% for Iowa and 81% for Kansas. It is important to note that this BECL includes 100% of all projected costs, such as full cash rent. However, many farmers may operate owned land and may not factor the opportunity cost of rent into their break-even analysis. Therefore, these BECL estimates are most comparable to the self-reported BECLs of farmers who do include all opportunity costs in their calculations. Among those farmers, the average self-reported BECL is 77% for both Iowa and Kansas. Thus, the Kansas results are closely aligned, while the Iowa estimate appears noticeably higher. This discrepancy may be due to the significantly higher rent costs in the Iowa budget data compared to those for Kansas. When rent is completely excluded from the cost calculation, the average BECL drops to 61% for Iowa and 67% for Kansas.

To account more accurately for rent exposure and align with survey data, we adjust the cost estimates by deducting rent in proportion to the percentage of land that farmers own: 51.9% for Iowa and 54.7% for Kansas. The resulting adjusted BECLs are 74% for Iowa and 73% for Kansas, which align closely with the sample means of 71% for both Iowa and Kansas farmers who did not include the opportunity cost of owned land in their break-even calculations. This close correspondence demonstrates that despite not collecting detailed farm-level cost and revenue data, our survey-based BECLs are well-validated against objective state-level budget assessments, particularly when adjusted for typical land ownership patterns.

VII. Components of Farmers' break-even revenue

In the second wave of the survey, we asked all the 323 farmers the following question regarding components of break-even revenue:

> "*In stating that X (the self-reported BECL) of the expected corn revenue would allow you to break even in a typical year, which elements do you take into account when calculating this break-even value? Please select all that apply.*"

Table A1 lists the options provided to survey participants, along with the number and share of farmers who identified each option as part of their break-even revenues. About 98% of farmers included the direct costs of growing the crop while around 82% included the out-of-pocket premium for crop insurance. Additionally, about 75% of farmers considered land cash rents and 66% regarded overhead costs as part of break-even revenue. Only 45% included the opportunity cost of owned land and equipment, and only 21% considered the opportunity cost of own and family member time. These findings indicate that farmers have diverse perspectives on what constitutes break-even revenue. Nevertheless, most farmers' definitions of break-even revenue closely align with our definition that includes only farm operational costs and crop insurance costs. Opportunity costs, particularly those associated with the time invested by farmers and their family members, are considered by a minority of farmers when reporting their break-even revenue.

Table A1. Share of farmers reporting a specific cost as a component of their break-even revenues

Categories	N	Share
Direct costs of growing the crop (e.g., seeds, fertilizer, pesticides, drying, fuel, etc.).	315	98%
Out-of-pocket premium of crop insurance.	266	82%
On rented land, land cash rents.	242	75%
Overhead costs (e.g., building repair/rent/depreciation, and loan interest).	213	66%
Opportunity cost of owned land and equipment.	144	45%
Opportunity cost of own and family member time.	69	21%

Data source: Survey conducted by the authors.

Note: This table reports summary data on responses to the question: "In stating that X (the self-reported BECL) of the expected corn revenue would allow you to break even in a typical year, which elements do you take into account when computing this break-even value? Please select all that apply." Only farmers in the second survey wave were asked this question.

Table A2 compares average BECLs according to whether specific opportunity costs are included in break-even calculations. Compared to farmers who exclude both types of opportunity costs from break-even revenue calculations, farmers who account for the opportunity cost of owned land and equipment but not their own or family members' time report a slightly higher average BECL. In contrast, farmers who consider the opportunity cost of their own or family members' time but not owned land and equipment report a lower average BECL, though this finding should be interpreted cautiously as it is based on only 10 respondents. Including both types of opportunity costs leads to a substantial increase in the average BECL. These patterns suggest that whether and how opportunity costs are factored into break-even revenue calculations can significantly impact the estimated BECL.

Table A2. Average BECL based on whether considering opportunity cost as part of the break-even revenue

Categories	*N*	Average BECL
For those who:		
Do not include any opportunity cost	168	71.2
Include only the opportunity cost of owned land and equipment	85	73.3
Include only the opportunity cost of own and family member time	10	67.0
Include both opportunity costs	59	77.4

Data source: Survey conducted by the authors.

VIII. Estimation results on the probability of insuring at or above the break-even coverage level

Table A3. Estimation results on the probability of insuring at or above the break-even coverage level, conditional on $70\% < \phi^{be} \leq 85\%$

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Insured at or above the BECL					
VARIABLES	Probit	Probit	Probit	Probit	Probit	Probit
BECL	-0.040***	-0.032***	-0.050***	-0.038***	-0.028***	-0.045***
	(0.005)	(0.008)	(0.006)	(0.005)	(0.008)	(0.007)
Moderately LA	0.116			0.153**		
	(0.077)			(0.072)		
Strongly LA	0.236***			0.247***		
	(0.073)			(0.066)		
Extremely LA	0.264***			0.272***		
	(0.079)			(0.074)		
Moderately PA	-0.043			-0.054		
	(0.062)			(0.057)		
Strongly PA	-0.083			-0.092		
	(0.072)			(0.063)		
Extremely PA	-0.185**			-0.253***		
	(0.078)			(0.074)		
More LA		0.141***	-1.161		0.138***	-0.606
		(0.041)	(0.830)		(0.038)	(0.854)
More PA		1.632*	-0.083*		1.827**	-0.114**
		(0.932)	(0.047)		(0.932)	(0.048)
More PA * BECL		-0.022*			-0.024**	
		(0.012)			(0.012)	
More LA * BECL			0.017			0.009
			(0.010)			(0.011)
Male	0.054	0.043	0.048	0.048	0.048	0.048
	(0.102)	(0.098)	(0.101)	(0.110)	(0.106)	(0.112)
Age < 50	0.030	0.040	0.045	0.004	0.014	0.020
	(0.060)	(0.061)	(0.058)	(0.059)	(0.059)	(0.058)
At least some college	0.085	0.065	0.067	0.083	0.068	0.069
education	(0.058)	(0.056)	(0.056)	(0.056)	(0.057)	(0.058)
Farming as main	-0.020	-0.039	-0.035	0.061	0.034	0.050
occupation:	(0.069)	(0.070)	(0.068)	(0.061)	(0.060)	(0.063)
Farm acreage (100	-0.001	-0.001	-0.001	-0.000	0.000	-0.000
acres)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Share of farm acreage	0.002	0.002	0.002	0.001	0.002	0.002
in corn: %	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Corn yield (10 bu/acre)	0.001*	0.001	0.001*	0.001*	0.001*	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Total farm sales:	0.098	0.131	0.116			

$250,000-$499,999	(0.099)	(0.100)	(0.097)			
Total farm sales:	0.057	0.075	0.064			
$500,000-$999,999	(0.101)	(0.100)	(0.096)			
Total farm sales: >	0.059	0.075	0.083			
$1,000,000	(0.105)	(0.108)	(0.101)			
Share of land rented	0.000	0.000	0.000			
from others	(0.001)	(0.001)	(0.001)			
Leverage rate: 26% -	-0.067	-0.084*	-0.088*			
50%	(0.045)	(0.045)	(0.045)			
Leverage rate: > 50%	-0.049	-0.065	-0.060			
	(0.073)	(0.069)	(0.068)			
Purchased named peril	-0.119**	-0.112**	-0.130**			
insurance	(0.054)	(0.054)	(0.055)			
Used forward /future	0.021	0.024	0.036			
/option contracts	(0.060)	(0.059)	(0.059)			
Participated in other	0.065	0.064	0.074			
government risk	(0.053)	(0.051)	(0.053)			
management programs						
Invested in risk	-0.002	0.003	-0.010			
management	(0.045)	(0.046)	(0.046)			
technologies or						
practices						
Iowa	0.128	0.153*	0.121	0.121	0.140*	0.117
	(0.083)	(0.086)	(0.084)	(0.074)	(0.080)	(0.078)
First wave	-0.012	0.002	-0.003	0.010	0.031	0.030
	(0.039)	(0.040)	(0.040)	(0.041)	(0.041)	(0.042)
Observations	277	277	277	305	305	305
Pseudo R2	0.377	0.370	0.367	0.329	0.308	0.297

Data source: Survey conducted by the authors.

Notes: 1. *** p<0.01, ** p<0.05, * p<0.1.

2. Numbers in parentheses are robust standard errors clustered at the county level.

3. The base group of the LA comparisons is farmers with the least LA level.

4. The base group of the PA comparisons is farmers with the least PA level.

5. “More LA” is a binary variable that equals one if the farmer is categorized as strongly or extremely LA, and zero otherwise.

6. “More PA” is a binary variable that equals one if the farmer is categorized as strongly or extremely PA, and zero otherwise.

7. The base group for total farm sales comparisons is farmers with sales < $250,000.

8. The base group for total leverage rate comparisons is farmers with leverage rate < 26%.

IX. Primary reason given for insuring at or above the BECL but below the 85% coverage level in 2022

Table A4. Summary statistics on the primary reason given for insuring at or above the BECL but below the 85% coverage level in 2022

	Farmers who insured at or above their BELCs but below 85%	
Choice options	N	%
The additional out-of-pocket premium required is too high relative to the value that I derived for the additional protection from a coverage level higher than the one that I chose.	106	78%
I used other risk management tools in 2022.	3	2%
I believed that I could handle the situation in which my actual corn revenue fell below the break-even revenue in 2022.	24	18%
Other	3	2%

Data source: Survey conducted by the authors.

Notes: 1. This table presents summary data for responses to the question asking farmers why insured below the 85% coverage level in 2022. Each farmer was asked to select one from the four options listed in the first column of the table.

2. Only the second wave surveyed farmers who insured at or above their BECLs but below the 85% coverage level were asked this question.

X. Screenshots of the survey questions used in the paper

1. Screenshots of the survey questions related to farmers' actual coverage level choices:

For any of the years **2020–2022**, did you purchase any crop insurance policies for corn?

- ○ No
- ○ Yes

Please select **each** of the years in which you purchased crop insurance policies for corn.

- ☐ 2020
- ☐ 2021
- ☐ 2022

Please select the coverage level that was used on the largest portion of your corn acres in **2022**.

- ○ 50%
- ○ 55%
- ○ 60%
- ○ 65%
- ○ 70%
- ○ 75%
- ○ 80%
- ○ 85%

2. Screenshots of the survey question related to BECL and the importance of covering the break-even revenue with crop insurance revenue guarantee:

What is the **percentage** of your expected corn revenue that would allow you to break even in a typical year? **Please give your best estimate.**

[ ] %

In any given year, how important is it to you that your corn insurance revenue guarantee allows you to break even?

- ◯ Not important at all
- ◯ Slightly important
- ◯ Quite important
- ◯ Very important
- ◯ Extremely important

3. Screenshot of the survey question related to premium aversion:

For the years **2018–2022**, how much impact did the following factors typically have on the coverage level choices of your corn crop insurance policies? **Please select one answer per line.**

	No impact	Slight impact	Some impact	Significant impact	Great impact
Lenders'/agents' recommendations	○	○	○	○	○
Long-term net indemnity (indemnity less premium) for each coverage level	○	○	○	○	○
Neighbors'/friends' choices	○	○	○	○	○
Subsidy rate for each coverage level	○	○	○	○	○
Revenue guarantee for each coverage level	○	○	○	○	○
Your out-of-pocket premium for each coverage level	○	○	○	○	○
Likelihood of receiving an indemnity for each coverage level	○	○	○	○	○

4. Screenshot of the survey questions related to the component of the break-even revenue:

In stating that **80%** of the expected corn revenue would allow you to break even in a typical year, which elements do you take into account when computing this break-even value? **Please select all that apply.**

- [ ] Direct costs of growing the crop (e.g., seeds, fertilizer, pesticides, drying, fuel, etc.).
- [ ] Overhead costs (e.g., building repair/rent/depreciation, and loan interest).
- [ ] On rented land, land cash rents.
- [ ] Out-of-pocket premium of crop insurance.
- [ ] Opportunity cost of owned land and equipment.
- [ ] Opportunity cost of own and family member time.
- [x] Other. Please specify:

5. Screenshot of the survey question related to the reason for insuring below the BECL:

You indicated that your break-even corn revenue is **80%** of your expected corn revenue in a typical year, and it is **Very important** to have insurance revenue guarantee to allow you to break even. However, you also reported that you used the **75%** coverage level policy on the largest share of your corn acres in 2022. What is the main reason for you to choose the insurance coverage level to fall below your break-even revenue level?

- ○ The additional out-of-pocket premium required is too high relative to the value that I derive for the additional protection from a coverage level higher than 75%.
- ○ I used other risk management tools in 2022.
- ○ I believed that I could handle the situation in which my actual corn revenue fell below the break-even revenue in 2022.
- ○ Other. Please specify

6. Screenshot of the survey question related to the reason for insuring below the 85% coverage level:

The maximal insurance coverage level is **85%**. You reported that you chose the **75%** coverage level policy on the largest share of your corn acres in 2022. What is the main reason for you **not** to choose the maximal insurance coverage level available?

- ○ The additional out-of-pocket premium required is too high relative to the value that I derive for the additional protection from a coverage level higher than 75%.
- ○ I used other risk management tools in 2022.
- ○ I believed that I could handle the situation in which my actual corn revenue fell below 85% in 2022.
- ○ Other. Please specify: