Drivers of Livestock Risk Protection Utilization

Milan Chauhan

Department of Agricultural Economics,

University of Nebraska-Lincoln

mchauhan2@huskers.unl.edu

Brad Lubben

Department of Agricultural Economics,

University of Nebraska-Lincoln

brad.lubben@unl.edu

Elliott Dennis

Department of Agricultural Economics,

University of Nebraska-Lincoln

elliott.dennis@unl.edu

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Abstract

In recent years, participation in Livestock Risk Protection (LRP), a federally subsidized price insurance tool for United States cattle producers, has surged dramatically. We examine key economic, policy, and risk management education variables that partially drive LRP utilization using state-level data from 2003 through 2023. We proxy the insurance utilization by three different metrics: market volume (policies earning premium), product market share, and producer market share, and employ two-part models to analyze the decision to participate in LRP (i.e., extensive margin) and intensity of the insurance use (i.e., intensive margin). Results show that feeder cattle price, educational efforts, and herd size significantly affect the extensive margin, while both magnitude and statistical significance vary at the intensive margin depending upon the chosen metrics of LRP utilization.

Keywords: Risk Management, Insurance, Livestock Risk Protection, Education

JEL Classification: Q18; Q28

1. Introduction

Federally supported risk management programs for the United States (U.S.) livestock producers have existed for two decades. Among these programs, Livestock Risk Protection (LRP) is a federally subsidized insurance tool available for cattle producers to manage downside price risk (Turner et al., 2023). Participation in LRP remained minimal until a series of changes came into effect in and after 2018. First, *the Bipartisan Budget Act of 2018* removed the $20 million annual funding cap for federal support for livestock insurance (Glauber, 2022). Second, the United States Department of Agriculture Risk Management Agency (USDA-RMA) increased the maximum subsidy rate for LRP from 13% to 55%, depending upon various coverage levels, and adjusted insurance specifications. Increased subsidy rates reduced insurance costs for producers (Boyer & Griffith, 2023). Third, *the Agricultural Improvement Act of 2018*, commonly referred to as the 2018 Farm Bill reauthorized livestock insurance programs and enhanced USDA-RMA's activities in risk management education efforts (Hagerman et al., 2025), which made the product more accessible and understood among producers.

U.S. cattle producers receive risk management education primarily through extension initiatives of land grant universities, producers' associations, and private sources. These initiatives aim to enhance producers' understanding of various risks, including financial and production risks, helping them to mitigate economic losses and improve profitability. For instance, the Extension Risk Management Education (ERME) program began funding risk management education projects and workshops on LRP for feeder cattle producers shortly after the introduction of LRP. However, paradoxically, the impact of education on insurance utilization can be uncertain. Initially, there is a chance

that education may encourage producers to participate in insurance as they get information about the product (Nakano et al., 2018). On the other hand, via education, producers may learn about overall risk and risk management strategies, which might shift insurance demand inward (Osiemo et al., 2025). It is, however, not well understood how risk management education affects the utilization of livestock insurance products in U.S. In this study, our focus is not merely on the adoption decision of LRP but rather on the role of continued risk management education programs and other plausible economic and policy variables to drive LRP utilization.

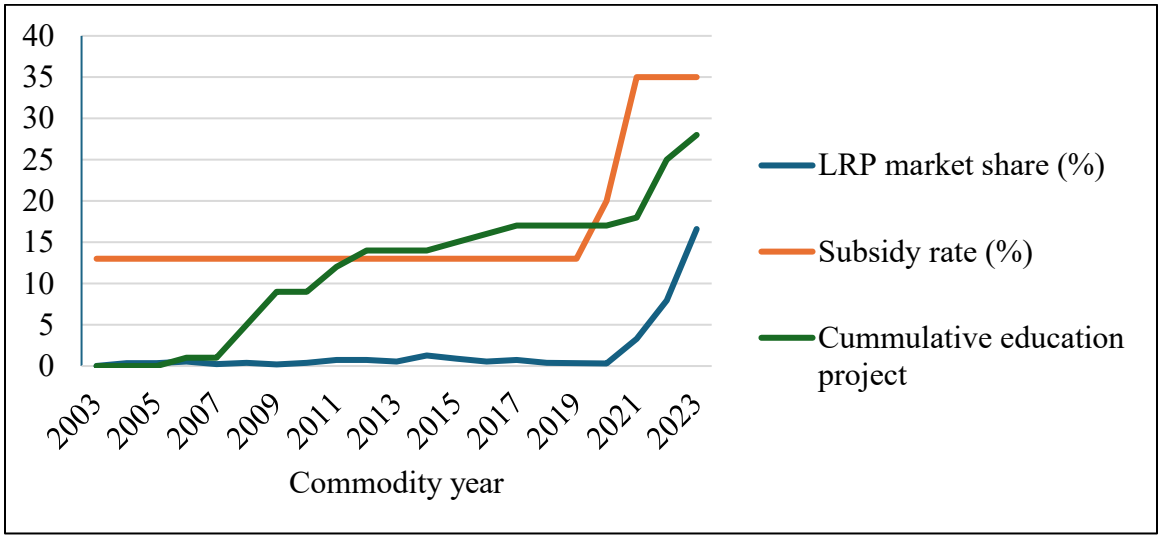
The objective of this paper is to quantify the role of education in the adoption decision of LRP. Using a nationwide database of LRP usage at state level, we conduct national analysis using a two-part model that incorporates economic and policy drivers and analyzes how continued risk management education efforts interact with the subsidy rate, a major policy change. This approach extends the pool of literature by accounting for the incentives of risk management educational efforts on LRP utilization. Results show that the usage of LRP is largely concentrated in a few states, and large variations exist between states. We find that feeder cattle price, risk management education positively and significantly, and herd size significantly influence participation decisions in LRP (i.e., extensive margin). The intensity of the insurance utilization (i.e., intensive margin) greatly varies with financial risks like feeder cattle price or price volatility, economic incentives created by the subsidy rate, and producers' knowledge base created by educational efforts over the years. Although statistically non-significant at $p<0.1$, education effects also vary depending on the insurance utilization metrics chosen in the intensive margin. We find that educational efforts on market volume (policies earning

premium) are enhanced by higher subsidy rates, while the effects are less significant on the intensive margin of product market share and producer market share under higher subsidy environments.

Our results help explain a large existing body of literature on LRP that seeks to explain producers' LRP adoption decisions. Prior studies suggest the importance of policy and insurance design, and economic factors in LRP uptake. For example, policy factors such as subsidy rate, coverage level, and contract characteristics in LRP uptake (Boyer et al., 2024; Boyer & Griffith, 2023; Merritt et al., 2017). We find that the subsidy rate was associated with the intensive margin rather than the extensive margin. Other research highlights economic indicators, such as cattle prices (Boyer et al., 2024), that affect LRP uptake, while market volatility (Coelho et al., 2008) affects the effectiveness of LRP usage. While consistent with findings of Boyer et al. (2024) that higher cattle prices are associated only with the extensive margin, we, in contrast, find positive effects on the intensive margin of LRP utilization, as measured by product market share and producer market share, but not on market volume (policies earning premium). Additionally, we find that feeder cattle price volatility is associated positively with the intensive margin of the insurance utilization as measured by policies earning premium but not on the extensive margin. Beyond economic and policy factors, prior studies in crop and livestock insurance report mixed effects of producers' risk aversion on insurance uptake (Boyer et al., 2024; Hellerstein et al., 2013; Sherrick et al., 2004). However, the role of risk management education in LRP usage remains largely unexplored. Our findings address this gap by quantifying the effect of educational efforts on LRP utilization.

2. Background

In this section, we highlight the growing usage of LRP, key policy changes, and risk management educational efforts that might affect the insurance usage. Figure 1 shows LRP utilization as measured by product market share (%), subsidy rate (%) for LRP coverage above 95%, and the cumulative number of education projects completed by Extension Risk Management (ERME) program on educating feeder cattle producers on LRP.



Sources: Extension Risk Management Education (2025) and USDA Risk Management Agency (2024b)

Figure 1. LRP market share, subsidy rate, and education projects

2.1 Utilization of LRP

There had been negligible participation in LRP over most of the past two decades (Figure 1), but in recent years, participation rates have increased. While there is no exact measure of utilization[1] of LRP, proxying with the insured proportion of total eligible

[1] We further discuss the measure of insurance utilization in section 4.

feeder cattle, referred to as product market share, Figure 1 shows that the national average utilization reached to 16% in 2023 (USDA Risk Management Agency, 2024b) growing from almost negligible before 2021.

2.2 Major policy changes

As with general crop insurance, LRP is administered under the Federal Crop Insurance Program (FCIP), jointly administered by the United States Department of Agriculture Risk Management Agency (USDA-RMA) and the Federal Crop Insurance Corporation (FCIC). The FCIP provides subsidized LRP policies to cattle producers through private insurance companies. Insurance companies, in turn, get support on operational and administrative costs by FCIP (USDA Risk Management Agency, 2024a). A major policy change in 2018 significantly shaped the overall risk management efforts in livestock. *The Bipartisan Budget Act of 2018* removed the annual funding cap on livestock insurance (Glauber, 2022), enabling USDA-RMA to reform and expand LRP. Later in 2019, USDA-RMA increased a subsidy rate from 13% to 20%, and further to 35% in 2020, for coverage levels above 95% (Figure 1).

2.3 Other policy changes

Additionally, USDA-RMA expanded its availability over the years and reached all fifty states by 2019 (USDA Risk Management Agency, 2025). In the years 2019 and 2020, it also increased insurable head limits per commodity year (June 1-July 31) and shifted the premium payment due date to the end of the insurance period (RightRisk, 2020), which offered improved liquidity to producers.

2.4 Risk management education

A significant effort has been made by the USDA to educate cattle producers about risk management in the United States. Figure 1 proxies the educational efforts made on educating producers about LRP for feeder cattle with the cumulative number of relevant projects funded by Extension Risk Management Education (ERME) program, representing the knowledge base of producers about the product that has been growing over the years.

3. Data

We use data from four sources: 1) the summary of business (SOB) from the United States Department of Agriculture Risk Management Agency (USDA-RMA), 2) the QuickStats from the United States Department of Agriculture National Agricultural Statistics Service (USDA-NASS), 3) the Chicago Mercantile Exchange (CME), and 4) the Extension Risk Management Education (ERME) program to create a longitudinal dataset for state-year observations of LRP-feeder cattle usage spanning from 2003 through 2023. Since not all states were eligible for LRP until 2019, we restrict the dataset to only eligible states by year, using Grunewald et al. (2005), Larson & Jose (2003), and RMA's map viewer (USDA Risk Management Agency, 2025) to determine LRP availability by state by year. We then construct various economic, policy, risk management educational, and production variables as predictors of LRP utilization.

3.1 Economic variables

Since LRP coverage is based on the CME Feeder Cattle Index (FCI), we use the commodity year average of the index as a reference for feeder cattle prices. Similarly, we measure price volatility using the standard deviation (SD) of the FCI. We expect that

producers will be more likely to adopt LRP policies as cattle prices rise, as the higher prices offset the realized insurance costs because of greater return on investment. Additionally, larger (smaller) price volatility is expected to increase (decrease) insurance uptake.

3.2 Policy variables

As mentioned earlier, two major policy shocks influenced LRP utilization. First, *the Bipartisan Budget Act of 2018* lifted the funding cap on livestock insurance, a change later authorized by the 2018 Farm Bill. Following this suite, USDA-RMA increased subsidy rates from the existing 13% to 20–35% in 2019 and 35–55% in 2020, while also providing an additional 10% subsidy for beginning producers. Second, the insurable head limits for livestock doubled twice, first in 2019 and again in 2020. Additionally, in 2020, the policy shifted the premium due date to the end of the contract period, reducing upfront financial burdens on producers. However, over 90% of LRP policies purchased are above 95% coverage, and the other policy changes may be overwhelmed by the changes in the subsidy rate for the >95% coverage level (i.e., the holistic policy change is largely dominated by the base subsidy rate), which we call ‘base subsidy rate’ in this study. We expect that an increase in the base subsidy rate by reducing the cost of the premium per head, affects LRP utilization positively.

3.3 Risk management education variables

U.S. cattle producers primarily receive information about LRP products through risk management extensional efforts, which we proxy using the number of completed ERME projects. Although several other institutions such as USDA-RMA and other

organizations also support education programs and add to the total educational effort, the ERME program provides the best documented measure of educational efforts. Thus, the completed ERME projects on LRP for feeder cattle producers serve as a proxy for practical knowledge of the producers gained via education programs over the observation period, which we expect to be positively associated with the utilization of the insurance product.

3.4 Production variables

We allow for a non-linear relationship between insurance utilization and herd size. We expect that states with smaller to mid-sized herds are more likely to utilize LRP compared to those with very large operations.

3.5 Summary statistics

Summarized statistics are shown in Table 1. There is significant variation in LRP utilization among states. The low state-year averages and a larger variation of usage (i.e., 2311 policies earning premium in one state and 0 in some other states), indicates that the insurance usage is concentrated in certain regions. Graphically visualizing, Figure 2 also supports this argument, showing large variations in usage. The data is zero-inflated, which reveals that utilization of LRP in most states by year is almost zero to negligible, and right-skewed, showing few states buying a greater volume of insurance. Similarly, the average product market share (2%) and near-zero producer market share, with maximum values of 60% and 22%, respectively, indicate a similar variation as of market volume, and show that only a small fraction of the cattle inventory or operations nationwide uses LRP. This could be due to barriers such as cost of insurance, regional

effects, limited licensed livestock insurance agents, lack of risk management education, or the complexity of the product.

Despite high cattle price volatility ($10.59/cwt.), which might create an economic need for risk management, LRP utilization remains modest. This could be linked with the limited risk management education efforts when most states receive little to no education. Additionally, since the base subsidy rate by state by year averages 18%, higher than the lower end of 13%, it is worth analyzing the incentives created by this policy adjustment and their impact on LRP utilization.

Table 1. Summary statistics

Variable	Definitions	Min	Mean (SD)	Max
LRP utilization variables				
Policies earning premium (market volume)	LRP policies sold that earned premium	0	44.99 (143.72)	2311
Product market share	Total number of insured head by LRP-feeder cattle/total number of feeder cattle inventory	0	0.02 (0.05)	0.60
Producer market share	Total number of LRP-feeder cattle policies earning premium/total number of beef cow operations	0	0 (0.01)	0.22
Economic variables				
Feeder cattle price	Annual average of CME Feeder Cattle Index (FCI) (dollars per hundred pounds)	89.5	145.42 (35.21)	217.7
Feeder cattle price volatility	Standard deviation of FCI in the given year (dollars per hundred pounds)	3.1	10.59 (6.73)	26.9
Risk management educational variables				
Educational efforts	Number of completed projects on LRP-feeder cattle funded by ERME	0	0.04 (0.22)	3
Policy variables				

Base subsidy rate	Subsidy rate determined for >95% coverage LRP	0.13	0.18 (0.09)	0.35
Production variables				
Herd size	Beef cow inventory/total beef cow operations	8	52.16 (40.78)	206
Herd size^2	Square of herd size	0.064	4.38 (7.34)	42.436

Notes: Min = minimum, Max = maximum, SD = standard deviations, and herd size^2 is scaled to 0.001 for regression purposes.

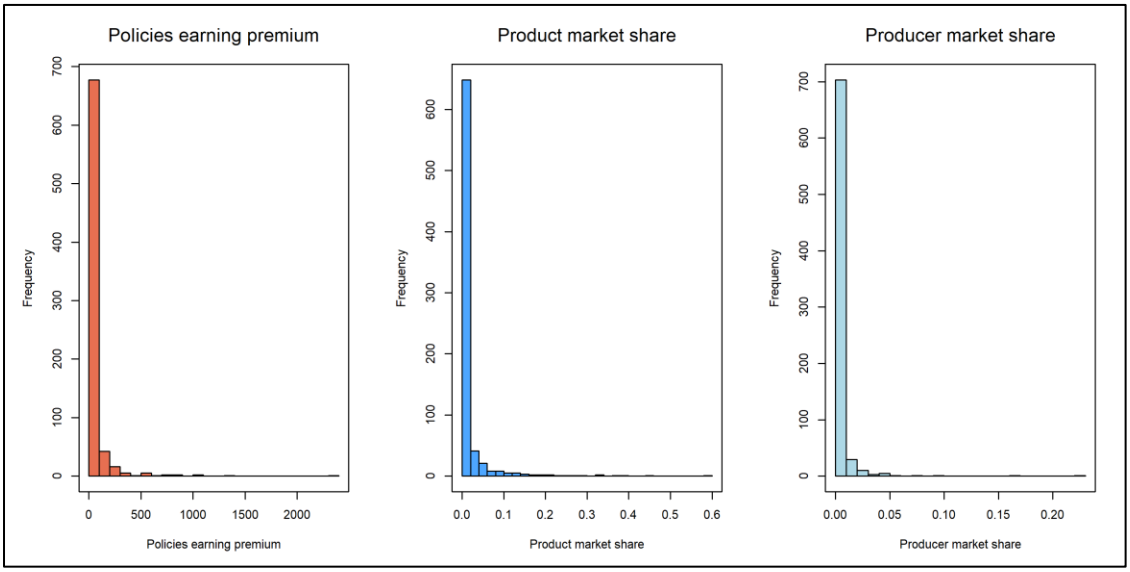


Figure 2. Distributions of LRP utilization metrics by state-year

4. Econometric strategy

4.1. Review of econometric models and the measure of insurance participation

We closely review econometric methods, and insurance participation measures used in both crop and livestock insurance literature. Researchers have long utilized counties as representative of farms in crop insurance studies in the absence of farm-level data (Goodwin, 1993; O'Donoghue, 2014; Yi et al., 2020; Yu et al., 2018). While this approach provides practical advantages, it also reduces and masks variations at the individual farm level (O'Donoghue, 2014; Yi et al., 2020). There is no exact measurement of insurance participation. Instead, economists use both qualitative and quantitative proxies to estimate insurance participation. In qualitative variables, a common approach is to indicate the insurance choice as 1 if insured and 0 otherwise (Boyer et al., 2024; Coble et al., 1997; Knight & Coble, 1997; Richards, 2000). However,

quantitative measures of insurance participation vary greatly. For example, Goodwin (1993) used two different measures to estimate participation in Multi-Peril Crop Insurance (MPCI): 1) insured proportion of planted acres and 2) total liability per planted acre. Our approach to constructing product market share of LRP as a proxy for utilization is analogous to the first quantitative approach of Goodwin (1993). Hagerman et al. (2025) used the number of policies sold from USDA-RMA's summary of business (SOB) as a measure of crop insurance use in their analysis. Yet, the number of policies sold does not represent the final count of insurance policies at USDA-RMA's SOB, because some policies may be canceled or never earn premium (i.e., premium is never paid by the producer). Therefore, we use the number of policies earning premium as a more accurate measure of insurance utilization in this study. In crop insurance, a typical approach to estimate insurance participation is to work with explanatory variables that affect the expected utility of producers under a given production environment (Goodwin, 1993). In their study analyzing the acreage impact of subsidies, Yu et al. (2018) used the subsidy rates for the two mostly purchased coverages in crop insurance, 65% and 75%, as instrumental variables of the subsidy received per dollar liability. In our study, we choose the subsidy rate corresponding to coverages above 95%, known as the base subsidy rate, as the measure of subsidy and we focus on the impacts of changes in the base subsidy rate, which is exogenously determined by legislation, to provide a clear understanding of how this policy factor influences LRP utilization. In addition, researchers have both modeled risk management decisions jointly and separately in the presence of alternative risk management tools (McKendree et al., 2021). Modeling the adoption decision separately can introduce correlation issues between the use of alternative risk

management tools, potentially leading to biased estimation. However, the multinomial probit analysis approach, as used by Velandia et al. (2009), offers a significant advantage in addressing correlation issues by allowing simultaneous estimation of multiple risk management alternatives while accounting for their interdependence. In this study, we proxy LRP utilization by using three different metrics: 1) the total number of policies earning premium (market volume), 2) product market share, and 3) producer market share. We then define product market share as the insured proportion of the total eligible feeder cattle inventory, while producer market share is measured as the number of policies earning premium divided by the number of beef cow operations.

4.2 Conceptual framework

Following Goodwin (1993) and Sherrick et al. (2004), we employ standard expected utility maximization theory in this study. We consider representative cattle producers that maximize their expected utility of the end-of-period wealth subject to economic, environmental, and production constraints. Established literature on theory of risk bearing by Arrow (1965) suggests that variability of returns matter for risk-averse producers due to the concave nature of the utility function. This means that the cattle producers may prefer lower but more certain end-of-period wealth through insurance tools, like LRP, rather than face the possibility of a sharp decline. Thus, LRP is demanded not because it increases expected wealth but because it reduces variability and increases the expected utility of end-of-period wealth. In this study, we analyze the utilization of LRP as a function of several key observable variables: structural, economic, policy, risk management education, and production factors:

Utilization of LRP = f (regional characteristics, year, individual characteristics, contract characteristics, market, production, risk management education) (1)

4.3 Empirical Model

We assume that the utilization of LRP follows two stages: stage 1 is the uptake of at least one policy in the given year (or whether to participate in LRP), also known as extensive margin, and stage 2 is the intensity of policy usage, also known as intensive margin. Further, our dataset contains LRP utilization metrics with lots of zeros (25%) in outcome variables. Since we rule out ineligible states during data procurement, we consider remaining zeros as 'true zeros,' meaning that the participation is 'zero' due to economic reasons, not because of structural constraints, like unavailability of insurance products, etc. Based on the numerical nature of outcome variables: count (policies earning premium) and proportions (product market share and producer market share), we employ two-part models with negative binomial and fractional logistic distributions, respectively.

4.3.1 Two-part negative binomial model

We estimate the number of LRP policies earning premium (market volume) with a two-part model with a negative binomial distribution[2] also known as a hurdle model (Boyer et al., 2024; Cragg, 1971; Hofstetter et al., 2016). This type of model is applicable for 'count' outcome variables (Farbmacher, 2011; Shonkwiler & Shaw, 1996), and the negative binomial distribution fits well with the right-skewed data that exhibits over-

[2] The standard Poisson model for count data is not appropriate for the outcome variable here given the over-dispersion and many zeros in the number of policies earning premium data. We provide the details about the goodness of fit and model selection in table A1 in appendix.

dispersion, (i.e., the variance is greater than the mean) (Mullahy, 1986). A recent work on estimating crop insurance participation by Turner et al. (2025) also follows a similar approach as ours. The model estimates two stages simultaneously: 1) stage 1 (extensive margin) and 2) stage 2 (intensive margin). It also allows a mixed distribution and offers flexibility to accommodate different predictors in those two stages. Stage 1 estimates the log-likelihood of an observation to be greater than 0 (i.e., the probability of participating in LRP) and stage 2 estimates the intensity of insurance utilization conditional on insurance participation based on the zero-truncated negative binomial (ZTNBin) distribution of the positive values of data.

Therefore, for a given state i in year t, if Y_{it} denotes LRP utilization determined by a matrix of explanatory variables X_{it}, the two stages of insurance utilization are:

Stage 1: decision to participate in LRP (extensive margin)

The probability of participation (i.e., utilization being greater than zero) is given by:

$$P(Y_{it} > 0 \mid X_{it}) = \frac{\exp(X_{it}\beta_1)}{1+\exp(X_{it}\beta_1)} \quad (2)$$

where, β_1 is the associated vector of coefficients.

Stage 2: intensity of LRP utilization (intensive margin)

The expected intensity of the insurance utilization, as measured with the number of policies earning premium, conditional on LRP participation ($Y_{it} > 0$) is:

$$\log(E[Y_{it} \mid Y_{it} > 0, X_{it}]) = X_{it}\beta_2, \quad Y_{it} \sim \text{ZTNBin}(\mu_{it}, \theta) \quad (3)$$

where ZTNBin refers to zero-truncated negative binomial distribution, μ_{it} is the conditional mean of Y_{it}, θ is overdispersion parameter, and β_2 is the associated vector of coefficients.

4.3.2 Two-part fractional logit model

We estimate product market share and producer market share of LRP separately by creating two separate datasets for each part of utilization following two-part modelling approaches (Duan et al., 1983). These outcome variables are proportions bounded between 0 and 1, with a non-trivial mass at zero and a continuous distribution over positive value.

While our estimation for stage 1 for the two-part fractional model is the same as equation (2), we estimate stage 2 (intensive margin) of both market shares with two separate fractional logistic regressions following Papke & Wooldridge, (1996). Therefore, the expected intensity of LRP utilization, as measured with market shares in state i and year t, is:

$$E(Y_{it} \mid X_{it}) = \frac{\exp(X_{it}\gamma)}{1+\exp(X_{it}\gamma)} \quad (4)$$

where, $Y_{it} \in [0, 1]$ and γ is the associated vector of coefficients.

5. Results

5.1 Influence on LRP participation decision

The estimates from stage 1 (extensive margin) of the two-part negative binomial model are reported in Table 2. We exclude the results from stage 1 of the two-part fractional model. These models also yield qualitatively similar results as the first part of

the two-part negative binomial model since both methods work on the binary part of the dataset in their first parts[3].

The log-odd coefficients in stage 1 (Table 2) provide important insights into the factors influencing the decision to participate in LRP (extensive margin). The results indicate that LRP participation decisions are affected significantly by economics: feeder cattle price ($p<0.001$); risk management education: educational effort ($p<0.001$); and production: herd size ($p<0.001$). These findings are consistent with the hypothesized associations except for feeder cattle price volatility and the base subsidy rate, which don't affect LRP participation decisions significantly. Figure 3 gives further insights into the marginal effects of significant variables on the probability of LRP participation, keeping the rest of the predictors at the mean. These graphs show that the probability of insurance participation increases as feeder cattle price increases but the increasing rate is diminished after reaching higher level. For instance, as the feeder cattle price increases to $217.7/cwt. from the mean of $145.42/cwt., the probability of participation of LRP increases by 7%. The figure also shows that there is an 82% chance of participation even without an educational effort but additional education projects enhance participation. At all three levels of the base subsidy rate, risk management educational efforts monotonically increase the probability of participation. Figure 5.1 shows that having one educational project in the observations years increases the probability of LRP participation by 17%. Herd size shows a non-linear effect on LRP participation. I find that as the state-average herd size gets bigger to a herd size of 100 head from the mean of

[3] The binary parts of the models have similar qualitative results because of same magnitude, signs, statistical significance of the coefficients, however, the standard errors are different.

52 head, the probability of the insurance participation increases by 5%, while increasing to a larger herd size of 206 head, decreases the probability by 40%.

Table 2. Estimates from the two-part negative binomial model on the extensive margin of policies earning premium

	Policies earning premium	
	Stage 1 (extensive margin)	
Variable	Coefficient (SE)	*P*-value
Intercept	-2.776 (0.995)	<0.001
Economic variables		
Feeder cattle price	0.018 (0.006)	<0.001
Feeder cattle price volatility	-0.042 (0.026)	0.11
Risk management education		
Educational efforts	16.178 (0.653)	<0.001
Policy variables		
Base subsidy rate	0.068 (1.913)	0.97
Production variables		
Herd size	0.057 (0.022)	<0.001
Herd size^2	-0.277 (0.109)	0.01
Interaction variables		
Educational efforts × base subsidy rate	-7.527 (3.278)	0.02
Observations	755	
Log-likelihood	-2778	

Notes: SE = Robust standard errors clustered by state. The estimates are results for the extensive margin of LRP utilization (i.e., decision to participate in LRP) as measured with the number of policies earning premium.

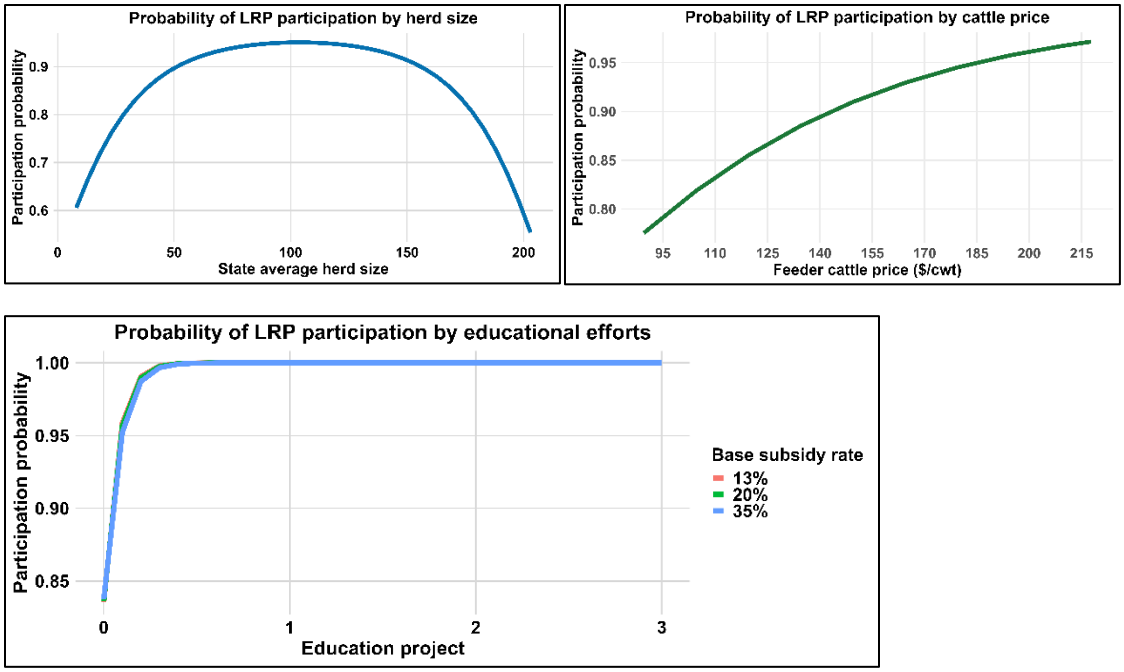


Figure 3. Probability of LRP participation by cattle price, herd size, and educational efforts by state by year

5.2 Effect on the intensive margin of LRP utilization as measured with the number of policies earning premium

Just like the interpretation of log-odds in stage 1, estimates in stage 2 in Table 3, give factors that significantly affect the intensity of the insurance utilization, as measured with number of policies earning premium (market volume of insurance). Except for educational efforts, all other significant variables at the participation stage, and additionally, feeder cattle price volatility exhibit similar relationships with the number of policies earning premium at the second stage.

Table 3. Two-part negative binomial regression results for the intensive margin of the LRP utilization as measured with the number of policies earning premium

	Policies earning premium	
	Stage 2 (intensive margin)	
Variable	Coefficient (SE)	*P*-value
Intercept	-2.324 (0.538)	<0.001
Economic variables		
Feeder cattle price	0.005 (0.003)	0.07
Feeder cattle price volatility	0.032 (0.013)	0.01
Risk management education		
Educational efforts	-0.020 (0.418)	0.96
Policy variables		
Base subsidy rate	5.752 (0.946)	<0.001
Production variables		
Herd size	0.100 (0.012)	<0.001
Herd size^2	-0.475 (0.059)	<0.001
Interaction variables		
Educational efforts × base subsidy rate	1.100 (1.654)	0.50
Observations	755	
Log-likelihood	-2778	

Figure 4 presents the expected number of LRP policies earning premium, derived by combining the probability of participation (extensive margin) with the expected number of policies earning premium conditional on participation (intensive margin). The results illustrate that the intensity of the number of policies earning premium increases with increased feeder cattle price, feeder cattle price volatility, and the base subsidy rate. Although the educational efforts are not statistically significant (p= 0.96) in stage 2, they exhibit association in stage 1 of the model, reflecting their role in the overall expected number of policies earning premium.

The model predicts 21 policies earning premium in each state in each year when the feeder cattle price is at $89.5/cwt, 37 policies at the mean price of $145.42/cwt, and 62 policies

at $217.7/cwt. Similarly, for price volatility (SD), the number of policies increases from 31 at a volatility of $3.10/cwt. to 37 at the mean ($10.59/cwt.), and 51 at the high end of the range ($26.90/cwt.). The relationship with herd size is non-linear. A state with a small average herd size of 8 head is associated with only 1 policy, while the average herd size of 52 head corresponds to 37 policies.

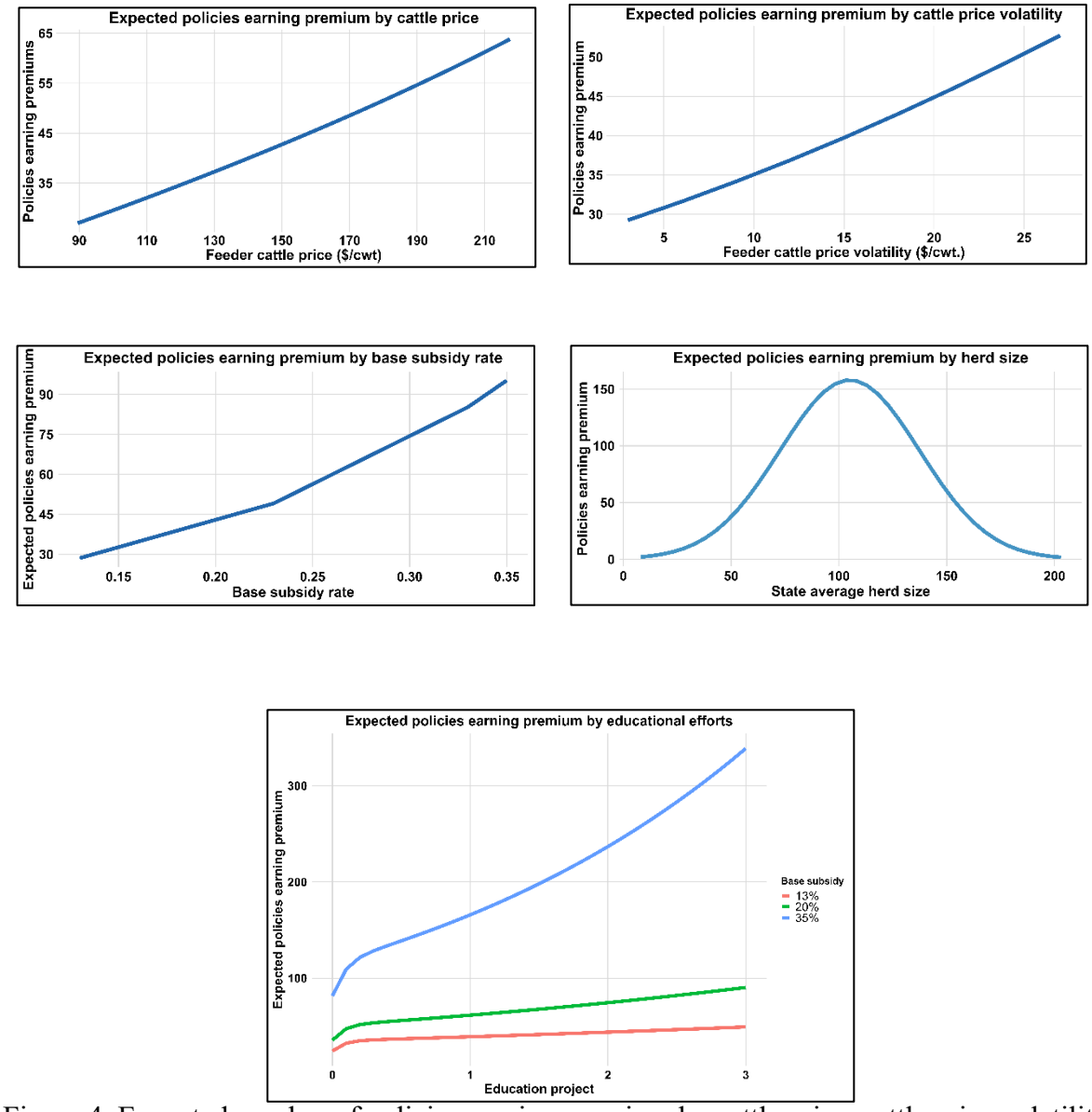


Figure 4. Expected number of policies earning premium by cattle price, cattle price volatility, base subsidy rate, herd size, and educational efforts by state by year

States with an average herd size of 100 head by year are associated with 149 policies, whereas states with very large operations (200 head average) correspond to just 1 policy, indicating a potential shift to alternative risk management tools among states with the larger producers. Policy factors exhibit a strong positive effect: the number of policies earning premium increases from 29 at a 13% base subsidy rate to 42 at 20%, and 95 at 35%. Although statistically non-significant at $p<0.1$, educational efforts suggest a positive effect with the number of policies earning premium, particularly in the presence of higher subsidy rates. For instance, one project at 13% subsidy rate is associated with 39 policies earning premium, while the number increases to 62 policies at 20% and 166 policies earning premium at 35%.

5.3 Effect on intensive margin of LRP utilization as measured with product market share and producer market share of LRP

Table 4 provides the results of the intensity of LRP utilization (intensive margin) at market and operator levels (i.e., product market share and producer market share, respectively) using a fractional logistic model. The results indicate that the intensity of both market shares is significantly affected by the same set of predictors: feeder cattle price, base subsidy rate, and herd size at $p=0.1$.

Table 4. Two-part fractional logit estimates for the intensive margin of LRP utilization as measured with product market share and producer market share

	Product market share			Producer market share		
	Stage 2 (intensive margin)			Stage 2 (intensive margin)		
Variable	Coefficient	SE	*P*-value	Coefficient	SE	*P*-value
Intercept	-11.20	0.71	<0.001	-12.63	0.60	<0.001
Economic variables						
Feeder cattle price	0.05	0.01	<0.001	0.01	0.00	<0.001
Feeder cattle price volatility	0.01	0.02	0.44	0.02	0.01	0.11
Risk management educational variables						
Educational efforts	0.36	0.32	0.26	0.45	0.31	0.14
Policy variables						
Base subsidy rate	10.42	0.69	<0.001	6.95	0.53	<0.001
Production variables						
Herd size	0.06	0.09	<0.001	0.08	0.01	<0.001
Herd size^2	-0.20	0.05	<0.001	-0.29	0.04	<0.001
Interaction variables						
Educational efforts × base subsidy rate	-0.84	0.84	0.31	-1.19	0.81	0.13
Observations	561			561		

Note: SE = robust standard errors clustered by state.

Further insights could be drawn from the estimation of the expected product market share and producer market share by taking account of the extensive margin (stage 1) and intensive margin (stage 2) as predicted by covariates as in figure 5 and figure 6 respectively.

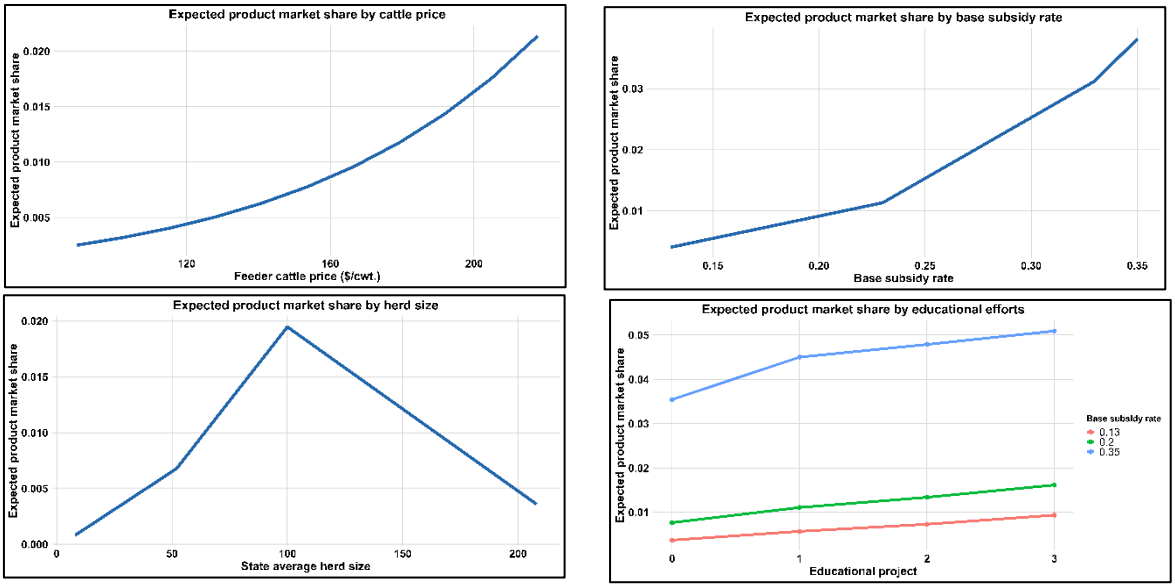


Figure 5. Expected LRP product market share by cattle price, base subsidy rate, herd size, and educational efforts

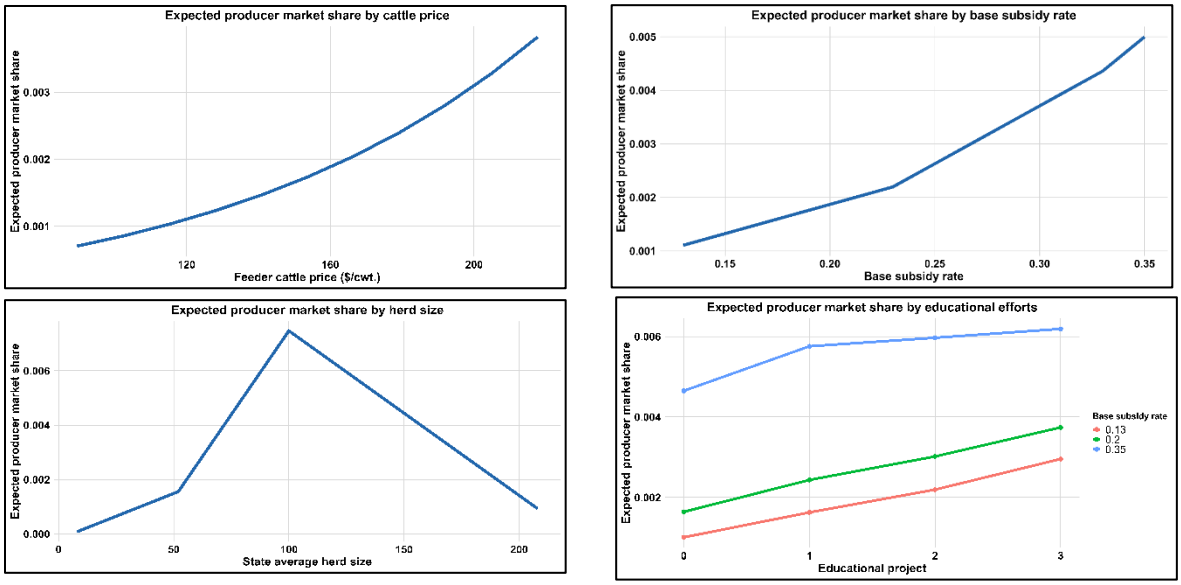


Figure 6. Expected LRP producer market share by cattle price, base subsidy rate, herd size, and educational efforts by state by year

The results also show that both product market share and producer market share rise with higher feeder cattle prices. At the minimum observed price of $89.5/cwt., the expected product market share and producer market share in each state in each year are 0.26% and 0.07%,

respectively. At the mean price of $145.42/cwt., these values increase to 0.7% and 0.17%, respectively, and at the maximum price of $217.7/cwt., they reach 2.1% and 0.38%, respectively. Similarly, product market share and producer market share increase with higher base subsidy rates. At a base subsidy rate of 13%, the expected product market share and producer market share in each state in each year are 0.41% and 0.11%, respectively. At a 20% subsidy rate, these values rise to 0.83% and 0.18%, and at a 35% subsidy rate, they reach 3.81% and 0.5%, respectively. Herd size exhibits non-linear relationships with the expected market shares. For a state with an average herd size of 8 head, the expected product market share and producer market share in each year are 0.1% and 0.01%, with 100 head are 2% and 0.75% and with 200 head are 0.56% and 0.16% respectively. Although statistically not significant at p=0.1, educational efforts exhibit positive effects on market shares but the marginal returns diminish in higher subsidy environments.

6. Robustness of the results

We further conduct a robustness check of the main findings based on both economic relevance and statistical consistency. We subset the data into pilot versus non-pilot states[4] (Table A2 to A4 in Appendix), recognizing that LRP was introduced as a pilot program in ten major cattle-producing states in 2003. This distinction is important as it may lead to long-term familiarity and adoption of LRP within these states. Across the robustness check, the results remain consistent with the primary findings with the variable of interest, educational efforts showing positive and significant effects on LRP participation (at p=0.1) and positive and non-significant effects at p=0.1 on market volume and market share.

[4] The LRP pilot program covered ten states: Colorado, Iowa, Kansas, Nebraska, Nevada, Oklahoma, South Dakota, Texas, Utah, and Wyoming (Larson & Jose, 2003).

7. Discussion

All three metrics of LRP utilization used in this study are complementary but not equivalent. Policies earning premium represent the market volume of LRP contracts sold. Assessing insurance utilization only with the number of policies earning premium could obscure meaningful information about its coverage of the market and scale of use at the operator level. For example, a single producer can insure multiple animals on a single policy or vice-versa. The product market share and producer market share, on the other hand, frame the insurance utilization in terms of the relative proportions of market coverage and producers (operations). That is to say, the predictors that affect LRP participation decisions could have different effects on the intensity of insurance utilization corresponding to the metrics that are used.

7.1 Effect of economic and policy variables

Among economic variables, feeder cattle price affects both the decision to participate in LRP (extensive margin) and the intensity of utilization of policies earning premium and market shares (intensive margin). Cattle producers, who often operate under tight margins, are highly price sensitive. The greater uptake of insurance as cattle prices increase could be because the higher price increases the potential revenue at risk, thereby amplifying the expected benefit from insuring against price declines (Hart et al., 2001). The positive association between feeder cattle prices and LRP participation aligns with the findings of Boyer et al. (2024), who also report that producers are more likely to adopt insurance when expected market prices are high. In addition, we find that higher price volatility leads to a higher number of policies earning premium (i.e., market volume) but does not have a significant impact on market shares. The relationship between price volatility and insurance uptake is mixed in literature. Higher volatility may expose producers to risks, thereby increasing the expected utility of insurance but could also increase the

premium cost (Coble & Barnett, 2013; Knight & Coble, 1997). Producers appear to be incentivized by increases in the base subsidy rate, as higher subsidies are associated with a greater number of policies earning premium and expanded product market share and producer market share. Higher subsidy rates reduce the out-of-pocket costs of producers for premium. The findings complement the paper by Boyer & Griffith, (2023), who reported the decreased premium costs of LRP when subsidy rates increased in 2019 and 2020 but did not answer the greater purchase of LRP. While higher subsidy rates appear to support higher policy volumes and higher product market share and producer market share, we did not find evidence of the base subsidy rate significantly influencing the initial decision to participate in LRP (extensive margin).

7.2 Effect of risk management education variables

We find that educational efforts significantly encourage producers to participate in LRP (p<0.1). Literature suggests that education improves understanding of the product among those with limited experience or risk literacy and reduces behavioral biases (Anderson & Feder, 2004; Boyer et al., 2024). Although not significant at p= 0.1, educational efforts show a positive effect on the market volume (i.e., the number of policies earning premium) and a greater effort in the presence of financial incentives, like higher subsidy rates. While additional education projects expand both product market share and producer market share, the marginal returns diminish at higher subsidy levels (e.g., 35%) compared to lower levels (e.g., 13% or 20%). The educational efforts also broaden participation by reaching underserved producers (Nakano et al., 2018), particularly small and medium-sized operations (Harou et al., 2022). Yet, as producers become more informed, they increasingly rely on financial tools like subsidies to offset cost barriers (Osiemo et al., 2025). This substitution pattern suggests that high subsidy rates may crowd out

the informational effect of education, pointing to diminishing returns to the educational efforts in high-subsidy environment.

7.3 Effect of production variables

The production variables herd size exhibits a quadratic relationship with LRP participation decisions (extensive margin), and the number of policies earning premium (market volume), however, it does not affect market share significantly. The result suggests that producers in states with more small and medium-sized operations are likely to insure with LRP and utilize the product more than those in states with more large operations. The findings are consistent with the literature that suggest smaller operations are less capital intensive and opt for less administrative burdensome while adopting risk management tools (Knight & Coble, 1997; Sherrick et al., 2004). This might also imply that larger operations use alternative price risk management tools, like futures and options because of more scale efficiency (Schroeder et al., 1989).

8. Conclusion

This study analyzed the utilization of LRP using state-level data, creating a panel of 21 years of observations. The findings suggest that important economic, policy, education, and production factors could have varied size and qualitative effects depending on the utilization metrics used in the analysis. Among all, the factors in the study, cattle price, risk management education, and herd size influence participation decisions in LRP (i.e., extensive margin). The intensity of the insurance utilization (i.e., intensive margin) greatly varies with financial risks like cattle price or price volatility, economic incentives created by the base subsidy rate, producers' knowledge base created by educational efforts over the years. Although statistically

non-significant statistically at $p < 0.1$, the results also indicate that the impact of educational efforts vary depending on the chosen insurance utilization metrics on intensive margin. Effects of educational efforts on market volume is enhanced by higher subsidy rates. Education effects are less significant on the intensity of usage as measured by product or producer market share and suggest decreasing effects under higher subsidy rates, pointing to a potential substitution effect between education and subsidy levels. Future work could address the economic and policy implications of the potential trade-offs between educational efforts and the subsidy rate on LRP utilization. This framework could also be extended to analyze impacts of localized educational efforts at the county level where data is available.

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Appendix

Table A1. Goodness of fit of various models for the number of policies earning premium

Model	AIC	BIC	Log-Likelihood	Dispersion ratio
Poisson	47988.247	48025.261	-23986.124	60
Negative Binomial	5595.87	5637.511	-2788.935	1.14
Hurdle Negative Binomial	5590.186	5668.84	-2778.093	

Since the outcome variable of the number of policies earning premium exhibits overdispersion (variance > mean), with a variance of 20,655.99 that is much larger than the mean of 44.9947 and the initial Poisson model reveals a dispersion ratio of 60 (well above the rule-of-thumb threshold of 1.5), the standard Poisson model is not appropriate for this data. In comparison with other statistical indicators, the negative binomial hurdle model demonstrates a better fit.

Table A2. Two-part negative binomial model estimates for extensive margin of LRP utilization in pilot Vs non-pilot states as measured with the number of policies earning premium

	Policies earning premium					
	Stage 1 (extensive margin)					
	Pilot states (N = 210)			Non-pilot states (N = 545)		
Variable	Coefficient	SE	P-value	Coefficient	SE	P-value
Intercept	-31.39	6.34	0.00	-2.40	1.13	0.03
Economic variables						
Feeder cattle price	0.02	0.01	0.00	0.02	0.01	0.00
Feeder cattle price volatility	-0.09	0.04	0.03	-0.05	0.03	0.07
Risk management educational variables						
Educational efforts	36.12	1.37	< 2.2e-16	15.45	0.87	< 2.2e-16
Policy variables						
Base subsidy rate	230.23	44.30	0.00	-0.99	1.99	0.62
Production variables						
Herd size	0.05	0.04	0.20	0.03	0.03	0.32
Herd size^2	-0.30	0.19	0.12	-0.10	0.20	0.62
Interaction variables						
Educational efforts × base subsidy rate	-135.91	13.95	< 2.2e-16	-3.78	4.50	0.40

Table A3. Two-part negative binomial model estimates for intensive margin of LRP utilization in pilot Vs non-pilot states as measured with the number of policies earning premium

	Policies earning premium					
	Stage 2 (Intensive margin)					
	Pilot states ($N = 210$)			Non-pilot states ($N = 545$)		
Variable	Coefficient	SE	*P*-value	Coefficient	SE	*P*-value
Intercept	-1.75	0.98	0.08	-1.57	0.77	0.04
Economic variables						
Feeder cattle price	0.02	0.00	0.00	0.00	0.00	0.67
Feeder cattle volatility	-0.02	0.02	0.34	0.05	0.02	0.00
Risk management educational variables						
Educational efforts	0.10	0.42	0.82	0.55	0.50	0.27
Policy variables						
Base subsidy rate	6.98	1.51	0.00	5.41	1.02	0.00
Production variables						
Herd size	0.07	0.02	0.00	0.08	0.03	0.01
Herd size^2	-0.38	0.07	0.00	-0.37	0.18	0.04
Interaction variables						
Educational efforts × base subsidy rate	-0.31	1.36	0.82	-3.23	2.71	0.24

Table A4. Two-part fractional logit model estimates for intensive margin of LRP utilization in pilot Vs non-pilot states as measured with product market share and producer market share

	Product market share											
	Stage 2 (Intensive margin)											
	Pilot states ($N = 210$)			Non-pilot states ($N = 545$)			Pilot states ($N = 210$)			Non-pilot states ($N = 545$)		
Variable	Coefficient	SE	*P*-value	Coefficient	SE	*P*-value	Coefficient	SE	*P*-value	Coefficient	SE	*P*-value
Intercept	-10.87	1.12	< 2.2e-16	-10.59	0.71	< 2.2e-16	-12.85	1.39	< 2.2e-16	-12.05	0.98	< 2.2e-16
Economic variables												
Feeder cattle price	0.02	0.00	0.00	0.01	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.01
Feeder cattle volatility	0.00	0.02	0.79	0.04	0.02	0.02	-0.01	0.01	0.48	0.05	0.01	0.00
Risk management educational variables												
Educational efforts	0.16	0.35	0.65	0.56	0.51	0.27	0.22	0.38	0.57	0.76	0.19	0.00
Policy variables												
Base subsidy rate	11.20	1.01	< 2.2e-16	9.82	0.81	< 2.2e-16	7.58	0.80	< 2.2e-16	6.68	0.64	< 2.2e-16
Production variables												
Herd size	0.04	0.02	0.03	0.05	0.02	0.00	0.07	0.02	0.00	0.07	0.02	0.00
Herd size^2	-0.14	0.06	0.03	-0.21	0.11	0.05	-0.28	0.08	0.00	-0.29	0.13	0.03
Interaction variables												

Educational efforts × base subsidy rate	-0.90	0.90	0.32	2.78	2.36	0.24	-0.99	0.95	0.30	-1.23	1.21	0.31