Timing, Trading Frictions, and the Limits of Subsidy Capture in Livestock Risk Protection*

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Abstract

Premium subsidies in the USDA's Livestock Risk Protection (LRP) program may create incentives for subsidy capture, in which producers combine subsidized coverage with exchange-traded positions designed to retain part of the subsidy. Using county-level LRP endorsement data and matched CME options data from 2020 to 2025, we observe clustering of endorsements around CME option expiration dates. In the absence of observed offsetting CME trades at the producer level, this pattern is suggestive of strategic timing but not direct evidence of subsidy capture. To determine whether this pattern reflects economically meaningful subsidy-capture opportunities, we simulate returns to combined LRP and CME positions under realized market conditions and realistic trading frictions. We find that the premium wedge between LRP and comparable private-market instruments is observable *ex ante*, while simulated net gains are commodity- and volatility regime-specific, arising only in low volatility-ratio cases. Even in the favorable cases, the combined strategy carries substantial downside risk. At 100% coverage in the low-volatility regime, average net returns are −\$0.18/cwt for feeder cattle, −\$0.04/cwt for live cattle, and \$0.09/cwt for lean hogs, while the worst 5% outcomes are −\$29.82/cwt, −\$21.77/cwt, and −\$18.63/cwt, respectively.

Keywords: Livestock Risk Protection; subsidy capture; expiration clustering; Monte Carlo simulation; put options; market frictions; institutional timing

JEL codes: G22; Q14; Q18

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1. Introduction

The Livestock Risk Protection (LRP) program, administered by the U.S. Department of Agriculture's Risk Management Agency (USDA-RMA), expanded rapidly after the removal of the $20 million annual funding cap in the 2018 Bipartisan Budget Act and subsequent subsidy reforms in 2019 and 2020. By 2025, LRP covered more than $22 billion in insured liability across feeder cattle, live cattle, and lean hogs, making it a central component of the federal livestock safety net. The increase in subsidy support and program scope expanded access to flexible and affordable price risk management for livestock producers. At the same time, however, it raised concerns about whether the program's design creates arbitrage opportunities for strategic use of federal funds.

LRP is unusual within the federal agricultural safety net as it insures livestock price declines through a contract that closely resembles private-market derivative protection. If the actual ending value falls below the coverage price, the program pays an indemnity equal to the difference. This payoff structure makes an LRP contract economically similar to a long put option on the corresponding futures price (Diersen 2004). If the producer-paid LRP premium is lower relative to the premium on a comparable CME put, a producer could, in principle, purchase subsidized coverage and take an offsetting market position to retain part of the subsidy. This possibility poses a challenge to program integrity as federal support may yield financial gain without delivering the intended risk protection.

Motivated by concerns about potential subsidy arbitrage, USDA-RMA updated the LRP Handbook, effective for the 2026 and succeeding crop years to define subsidy capture as "the practice of exploiting the differences between premium owed by you for a Specific Coverage Endorsement (SCE) and the cost of a privately traded livestock contract such as a put option, for the purpose of your financial gain" (USDA-RMA 2025). Section 25 of the revised LRP Basic Provisions outlines three conditions that, if jointly satisfied, constitute presumed subsidy capture: (1) the CME option expiration is within four calendar days of the LRP endorsement end date; (2) the CME put is sold within two trading days before and five trading days after the LRP effective date; and (3) the CME put premium exceeds 80% of the LRP premium (USDA-RMA 2025). These criteria establish a narrow regulatory definition of suspect activity. Our empirical approach uses them as the foundation for testing whether a subset of LRP endorsements exhibits timing patterns and financial incentives consistent with those conditions.

Concerns about how premium subsidies affect behavior in agricultural insurance markets are not new. A standard rationale for public intervention in crop insurance is that private markets can be difficult to sustain when losses are highly correlated across producers and reinsurance is costly (Miranda and Glauber 1997). Once insurance is publicly subsidized, however, the subsidy changes the relative prices of alternative risk-management tools and may distort producer decisions over acreage, coverage level, and instrument choice. Subsidized crop insurance has been shown to influence acreage decisions and coverage choices, while also generating broader program costs (Goodwin and Smith 2013; Yu et al. 2017). Babcock (2015) also shows that poorly aligned subsidy structures can lead to inefficient uptake and misallocation of public resources. Since LRP is tied to futures-based price discovery, the relevant benchmark is exchange-traded derivatives. Adjemian and Ramsey (2026) develop a formal model in which subsidized LRP can invite subsidy-capturing behavior through offsetting options-market positions. Feuz (2025) finds that feeder cattle and lean hogs LRP activity clusters disproportionately on CME option expiration dates, a pattern consistent with subsidy capture, but emphasizes that these estimates represent upper bounds instead of direct evidence of misuse.

Using a simulation approach, we examine whether subsidy-capture incentives are reflected in LRP purchasing behavior and whether such strategies are economically attractive in practice. Using county-level data on all LRP endorsements from 2020 to 2025, we first examine whether endorsement activity clusters around CME option expiration dates. We find clear clustering patterns, particularly for feeder cattle and lean hogs, although the timing pattern for live cattle is less direct. This finding is consistent with Feuz (2025).

The empirical challenge, however, is that subsidy capture is not directly observed in LRP endorsement data. As a result, timing patterns alone cannot be used as evidence of its presence. Therefore, we evaluate the economic profitability of such behavior using a simulation framework for combined LRP-CME positions under realized market conditions and realistic trading frictions. With access to daily contract-level CME options data, we can match LRP endorsements to comparable CME option trades, under USDA-RMA's definition of "presumed violations." This creates a subset of endorsements that can be viewed as most plausible for attempting subsidy capture. We then simulate returns to the combined LRP-CME position under realistic frictions, including bid-ask spreads, margin requirements, and financing costs. The simulation results show that the premium wedge between LRP and comparable private-market instruments is observable at the time of purchase, but its realized value becomes more limited once implementation frictions are taken into account. Because the value of combining a short put with LRP depends in part on the relationship between implied volatility and realized volatility, simulated net gains are not uniform across market environments. Instead, they are commodity- and volatility-regime-specific. Such gains arise only in low volatility-regime cases where realized volatility falls below implied volatility, and market conditions are generally more favorable to arbitrage-type strategies. In addition, those gains are often associated with significant downside risk. For example, at 100% coverage, the average net return is \$0.09/cwt for lean hogs, while the worst 5% outcome is −\$21.77/cwt.

The distinction between an observable premium wedge and limited realized gains also connects our analysis to the livestock and agricultural derivatives pricing literature. In live cattle markets, implied volatility from nearby options has been shown to be a biased and inefficient predictor of subsequent realized volatility (Manfredo and Sanders 2004). Later work finds upward bias in implied-volatility forecasts for both live and feeder cattle, with the bias more pronounced in live cattle (Brittain et al. 2011). More recent evidence shows that cattle options exhibit pronounced left skew and relatively expensive downside protection, especially in out-of-the-money puts (McKenzie et al. 2022). In lean hogs, options-based density forecasts outperform historical time-series methods, with results consistent with short-term risk premia, especially during turbulent periods (Trujillo-Barrera et al. 2017). In other agricultural markets, evidence from corn and soybeans likewise shows that option-implied volatility tends to exceed realized volatility on average (Xi et al. 2019). These findings illustrate the importance of volatility regimes, option pricing, and downside-tail behavior when evaluating the economic viability of subsidy capture.

Our study contributes to the livestock risk management literature by developing, to our knowledge, the first simulation framework for evaluating LRP subsidy-capture strategies under realistic trading frictions. We combine county-level LRP endorsement data with a rich contract-level CME options dataset that includes detailed information on strikes, expirations, settlement prices, implied volatilities, and related option characteristics. These data allow us to match endorsements to comparable CME instruments and calibrate the simulation to observed market conditions. We then reconcile the timing evidence with the simulation results by showing that the premium wedge is visible *ex ante*, but not readily harvestable *ex post* once realized market conditions and trading frictions are taken into account. The persistence of clustering across market environments further suggests that the observed timing patterns may reflect broader institutional and risk-management practices.

2. Conceptual Framework

A producer selects a coverage price K_{LRP} and an endorsement period that ends on date T. If the USDA-reported ending value S_T^{LRP} falls below the coverage price, the policy pays out the difference:

$$\text{Indemnity} = \max\{K_{\text{LRP}} - S_T^{\text{LRP}}, 0\}\,. \tag{1}$$

Let π_{prod} denote the total producer-paid premium charged for the contract, defined as the total premium after applying the government subsidy rate $s \in (0,1)$. Suppose the same producer sells a CME put option on the corresponding futures contract, with a strike price K_{CME} and expiration close to T, obtaining a premium P. The payoff from this short put position is:

$$P - \max\{K_{\text{CME}} - F_T, 0\}\,, \tag{2}$$

where F_T denotes the terminal price of the CME futures contract at expiration.

When F_T and S_T^{LRP} are closely aligned, as is typically observed near expiration, the LRP indemnity and the short put obligation approximately offset one another. Combining the two positions yields:

$$\Pi_{\text{Combo}} = e^{-r\tau}\left[\max\{K_{\text{LRP}} - S_T^{\text{LRP}}, 0\} - \max\{K_{\text{CME}} - F_T, 0\}\right] + P - \pi_{\text{prod}}\,. \tag{3}$$

If $S_T^{\text{LRP}} \approx F_T$ and $K_{\text{LRP}} \approx K_{\text{CME}}$, this difference is negligible, and the net return simplifies to:

$$\Pi_{\text{Combo}} \approx P - \pi_{\text{prod}}\,. \tag{4}$$

This quantity defines the subsidy wedge, the price gap between the CME option premium and the producer-paid LRP premium:

$$\text{Subsidy Wedge} = P - \pi_{\text{prod}}\,. \tag{5}$$

The subsidy wedge represents the potential gain from combining subsidized LRP coverage with an offsetting CME put under frictionless conditions. For an endorsement covering W hundredweight (cwt), the total potential gain implied by the subsidy wedge equals:

$$\text{Total Subsidy Wedge} = W \cdot \big(P - \pi_{\text{prod}}\big)\,. \tag{6}$$

A positive subsidy wedge does not require that the position be motivated by price risk management. When the CME put premium exceeds the producer-paid LRP premium, the combined position can appear to generate a gain not driven by price movements given that the strike, timing, and settlement terms are closely aligned. Because the subsidy is applied proportionally to the underlying premium, the dollar value of the wedge is greatest at high coverage levels where comparable option premiums are also relatively large.

While this setup may appear low-risk, it carries practical concerns. For example, the short put is subject to daily margin requirements. If prices fall, the producer may face cash flow pressure even if the overall strategy is profitable at expiration. Differences between the coverage and strike prices, or between the settlement conventions of LRP and CME contracts, can also introduce deviations in payoffs.

These features lead to two empirical implications. First, endorsement activity may cluster near CME put-option expiration dates when the market premium most directly reflects the insured price level. Second, the subsidy wedge, $P - \pi_{\text{prod}}$, defines a measurable upper bound on the subsidy that could, in principle, be captured through offsetting trades.

3. Clustering Patterns for Subsidy Capture

The conceptual framework implies that if producers respond to the subsidy wedge in practice, endorsement activity should display timing patterns consistent with opportunities for subsidy capture. This section investigates whether producers time LRP endorsements in ways consistent with subsidy capture, a strategy where the producer simultaneously purchases a subsidized LRP endorsement and sells an offsetting CME put option to extract the premium subsidy.

For much of its history, participation in LRP was modest. The Federal Crop Insurance Act limited total funding for livestock insurance plans to $20 million per fiscal year, which placed a hard ceiling on program size. On February 9, 2018, the Bipartisan Budget Act of 2018 removed this limitation, and a series of reforms followed quickly thereafter (Glauber 2022). In July 2019, USDA-RMA increased the flat subsidy rate from 13% to 20%. One year later, USDA-RMA introduced a five-tier subsidy schedule with rates ranging from 35% at the highest coverage levels (95% to 100%) to 55% at lower coverage levels (70% to 79.99%) alongside increased per-producer and per-endorsement head limits (Parsons 2021). These adjustments made the program accessible to larger operations that had previously been constrained. These changes effectively decreased producer-paid premiums. Using daily LRP offering data from 2017 to 2021, Boyer and Griffith (2022) estimate that the 2019 subsidy increase lowered average premiums by $1.31 per hundredweight (cwt) for feeder cattle and $0.79/cwt for live cattle. The 2020 expansion reduced costs further by $0.11/cwt to $0.59/cwt for feeder cattle and $0.16/cwt to $0.77/cwt for live cattle, depending on coverage level. Because higher coverage levels start from a larger base premium, the same percentage subsidy results in a larger absolute reduction in cost, even though the relative rate increase is greater for lower coverage levels.

The response in program participation was immediate. As shown in Figure 1, both federal subsidy expenditures and total insured weight increased significantly across all three commodities after 2020. By 2025, annual subsidy expenditures reached about $196 million for feeder cattle, $59 million for live cattle, and $160 million for lean hogs, while total insured weight rose to about 50 million cwt, more than 20 million cwt, and around 70 million cwt, respectively. These patterns indicate that higher subsidy rates substantially expanded program use. The rapid increase in insured volume and subsidy expenditures is consistent with earlier evidence that demand for agricultural insurance responds strongly to premium subsidies (Goodwin 1993; Serra et al. 2003).

Therefore, we use county-level Summary of Business records from USDA-RMA covering all LRP endorsements sold between July 2020 and June 2025. This window begins after the 2020 subsidy reforms and ends before the revised handbook language took effect, allowing us to focus on the period when subsidy-capture incentives were most likely to operate without regulatory restrictions. Each record includes the endorsement's sales date, coverage price, end date, total insured weight, and associated premium and subsidy amounts. Table 1 summarizes LRP endorsement characteristics by commodity, focusing on premium structure and subsidy rates. Note that in all three commodities, average subsidy rates fall between 33% and 35%, indicating a relatively uniform selection of high coverage levels (95% to 100%), where subsidy rates are lowest.

The possibility of subsidy capture raises concerns about program integrity and market functioning. If subsidized insurance is combined with offsetting derivatives positions, it can undermine the intended purpose of LRP by converting subsidized insurance into opportunities for financial arbitrage, distorting price signals by inflating put option selling unrelated to genuine hedging needs, and exposing producers to hidden financial risks. A necessary feature of such a strategy is close temporal alignment between the LRP end date and the corresponding CME option expiration, since the payoff comparison is most direct when the two positions mature near the same time. To test for clustering of LRP endorsements around CME livestock option expiration dates, we match each endorsement to the nearest CME expiration for the same commodity and contract month and measure the number of days between the endorsement end date and the corresponding option expiration date. This allows us to examine whether insured weight concentrates disproportionately near expiration, where the alignment between LRP and CME put payoffs is closest.

Figure 2 plots total insured weight by days relative to the nearest CME option expiration, measured on the endorsement end date and separated by policy size. For small and medium-sized endorsements, the distributions are relatively spread out. In contrast, large endorsements, defined as those in the top quartile of insured weight within commodity, display pronounced spikes near expiration for feeder cattle and lean hogs. Live cattle exhibits a different pattern, with elevated insured weight near expiration but less concentrated exactly at day 0. This figure suggests that endorsement timing is not uniform across commodities and that the strongest clustering is concentrated among larger endorsements.

To quantify these patterns, we estimate Poisson pseudo-maximum-likelihood (PPML) regressions of daily insured weight on an indicator for whether the endorsement end date falls within four calendar days of a CME option expiration, consistent with USDA-RMA's presumed-violation provision. The model is estimated separately for each commodity. Year-by-month fixed effects absorb common seasonal and short-run time shocks, and standard errors are clustered at the year-by-month level. Table 2 reports PPML estimates of the effect of the near-expiration window on daily insured weight. For feeder cattle, insured weight is approximately 67.15% higher on dates within four calendar days of CME option expiration than on other dates. For lean hogs, the corresponding increase is approximately 155.15%. Both estimates are statistically significant. In contrast, the estimated effect for live cattle is 1.48% and statistically insignificant, indicating little evidence of systematic clustering in the same window.

We have shown that clustering in LRP endorsement is evident in feeder cattle and lean hogs, but this should not be considered as direct evidence of subsidy capture. Because derivative positions are not observed in the LRP endorsement data, we cannot determine whether offsetting trades were actually taken. Whether such timing would remain economically rational depends on the net profitability of the implied combined position once real-world frictions are taken into account. The next section evaluates that question through a Monte Carlo simulation of returns to combined LRP-CME strategies under realistic market conditions.

4. Monte Carlo Simulation for Evaluating Subsidy Capture

The LRP program provides downside price protection that is economically similar to an option written on the relevant livestock price. In a frictionless setting, a producer could combine an LRP endorsement with a short position in a comparable CME put, exchanging part of LRP's protection for a premium gain, which is the wedge created by the federal subsidy. In practice, implementing this combined strategy is not costless. Execution costs, margin requirements, and the possibility of forced liquidation following adverse price moves would reduce or even eliminate any apparent gain.

Given these frictions, the relevant benchmark is not whether the combined strategy has a positive payoff, but whether it improves net outcomes relative to purchasing LRP alone.

We address this question through a Monte Carlo simulation calibrated to observed market conditions and realistic frictions to evaluate the economic implications of combining subsidized LRP endorsements with exchange-traded derivatives. This approach is motivated by our access to a rich panel of CME livestock options settlements, which makes it possible to match endorsement-level contract terms to the contemporaneous option market environment, including strikes, maturities, settlement prices, and implied volatility, and to evaluate strategy payoffs under the same information set available at purchase.

This simulation exercise is not intended to describe realized producer transactions or to infer actual trading behavior. Instead, it constructs a set of feasible candidate attempts at monetizing the premium subsidy, defined mechanically by the USDA-RMA Basic Provisions criteria for presumed subsidy capture. We then ask whether these candidate attempts would be economically attractive once standard trading frictions, margin financing, and the possibility of distress liquidation are taken into account.

The simulation evaluates a set of benchmark and combined strategies. The baseline case is *"LRP only"*, which provides the distribution of outcomes under subsidized insurance. The main combined strategy is *"LRP + Short put"*, which represents the basic subsidy-capture mechanism. When the strike and horizon are closely matched, the short put offsets the LRP downside payoff at expiration, so net performance is driven primarily by the premium wedge and frictions. We use this strategy to assess whether the premium wedge translates into higher net NPV relative to holding LRP alone once execution costs, margin financing, and liquidation risk are taken into account.

We also consider two related combined strategies. The first is *"LRP + Synthetic short put"*, in which a producer replicates a short put by combining a short call with a long futures position. This allows us to compare the direct short-put strategy with its synthetic equivalent. The second is *"LRP + Short put spread"*, which replaces the naked short put with a vertical put spread by adding a long out-of-the-money put. This structure caps the maximum loss on the CME position and can reduce margin requirements under spread treatment, although it requires paying the premium on the long option position.

Finally, we include two private-market benchmarks that do not rely on subsidy support. *"Long CME put"* represents a market-based reference of downside protection at a comparable strike and horizon, while *"short CME futures"* represents a conventional forward-price hedge implemented through the futures market. These constructions reflect the main ways a producer could offset, replicate, or replace LRP protection in the presence of the subsidy wedge.

4.1 Data and Simulation Design

The simulation draws on two primary data sources matched at the endorsement level. The first is USDA-RMA Summary of Business data on individual LRP endorsements for crop years 2020 to 2025. Each endorsement record reports the sales effective date, coverage period, coverage level, expected ending value (EEV), coverage price (K_{LRP}), gross premium, federal subsidy, and producer-paid premium. The second source is CME Group option settlement data, which we match to LRP endorsements using the comparability criteria in USDA-RMA's 2026 LRP Basic Provisions (Section 25). A CME option is eligible if its expiration date falls within ± 4 calendar days of the endorsement end date and its trade date falls within $[-2, +5]$ trading days of the sales effective date. Among eligible contracts, we select the option whose strike is closest to the endorsement coverage price. If there are multiple eligible candidates, we rank them by proximity in expiration date, then trade date, and finally strike. From the matched option, we extract put and call settlements, days to expiration, and CME-reported implied volatility, and recover the entry-day implied futures price F_0 via put-call parity.[1] This matching procedure assigns each endorsement to a single CME option record.

Each simulation run proceeds in the following steps. First, we match each endorsement to a CME option using timing and expiration windows that follow the logic in USDA-RMA's Basic Provisions. We then recover the entry-state variables from both datasets, including the endorsement's coverage price, expected ending value, premium, and subsidy, as well as the matched CME strike, settlement

[1] The matched LRP-CME dataset does not include a separately stored entry-day futures series, so we recover the entry futures price from near-the-money option quotes using put-call parity. This is approximate as CME livestock options are American-style, yet it keeps the entry price consistent with the option data used throughout the analysis.

values, and days to expiration, and use these inputs to compute the parity-implied futures price F_0. Next, we calibrate the stochastic price process and trading frictions using historical returns and CME microstructure data. Using these calibrated inputs, we simulate terminal settlements for both CME and LRP. We then compute path-by-path payoffs and net present values for each strategy, incorporating trading costs, margin financing, and forced liquidation costs. Finally, we aggregate endorsement-level outcomes within commodity-by-coverage bins to obtain expected values and risk profiles for each strategy.

The stochastic price process follows geometric Brownian motion (GBM), consistent with the Black–Scholes framework (Black 1976).[2]

For each endorsement, the terminal futures price is simulated as

$$S_T = F_0 \exp\left(-\tfrac{1}{2}\sigma^2\tau + \sigma\sqrt{\tau}, Z\right) , \tag{7}$$

where $Z \sim N(0,1)$ and F_0 is the parity-implied forward price at entry, σ is the simulation volatility, τ is time to expiration.

Each strategy j generates a path-specific net present value (NPV) that incorporates premiums, transaction costs, and financing charges:

$$\text{NPV}_j = e^{-r\tau}\left[\text{Indemnity}_j - \text{Premium}_j - \text{Friction Costs}_j\right] , \tag{8}$$

where r is the annual risk-free rate, measured using the Secured Overnight Financing Rate (SOFR) published by the Federal Reserve. All cash flows are discounted to present value using $e^{-r\tau}$. Expected values are calculated from the simulated distribution of NPVs.

[2] Livestock prices may exhibit seasonality and occasional jumps that GBM does not capture (Stojkoski et al. 2020). However, we argue that the standard GBM is sufficient for our purpose of evaluating the economic viability of subsidy-capture-type strategies under a transparent and tractable baseline. We also experimented with alternative jump specifications, but these did not significantly affect the simulation results.

The incremental value of strategy j relative to the LRP baseline is

$$\Delta\text{NPV}_j = \text{NPV}_j - \text{NPV}_{\text{LRP}} \,. \tag{9}$$

Table 3 summarizes the simulation inputs and Table 4 reports the NPV formulas used for each strategy.

We model execution costs through bid-ask half-spreads constructed from CME settlement data. Since our data do not include intraday quotes, we estimate effective spreads from daily high-low prices using the Corwin and Schultz (2012) estimator. Since the spread widens as options become more expensive, we map the estimated spreads into a linear half-spread model,

$$hs(P_{\text{settle}}) = \max\left(hs_{\min},\ \beta_0 + \beta_1 P_{\text{settle}}\right) \,, \tag{10}$$

where P_{settle} is the option settlement price and $hs_{\min}$ imposes a minimum half-spread equal to half the tick size.[3] Calibrated parameter values are reported in Table A.1.

Participation in exchange-traded derivatives creates margin exposure. Initial margin (IM) requirements are set based on CME's minimum performance requirement for each commodity.[4] Initial margin financing is calculated as

$$C_{\text{IM}} = IM \cdot r_{\text{fin}} \cdot \tau \,, \tag{11}$$

where r_{fin} is the annual financing rate and τ is time to expiration in years.

In addition to the initial margin requirement, producers may face additional financing stress when the market conditions fluctuate while trying to retain their positions. Therefore, we model variation

[3] CME's minimum price fluctuation for the livestock options considered here is \$0.025/cwt, so we set $hs_{\min} =$ \$0.0125/cwt.

[4] As of November 2025, CME margin requirements are \$6,000 (feeder cattle), \$3,300 (live cattle), and \$1,700 (lean hogs) per contract. Using contract sizes of 50,000 lb for feeder cattle and 40,000 lb for live cattle and lean hogs, these correspond to initial margin requirements of \$12.00/cwt, \$8.25/cwt, and \$4.25/cwt, respectively.

margin cost similar to a maximum adverse excursion measure.[5] Let V denote the variation margin excursion (in \$/cwt), and let φ denote the carry fraction, defined as the share of the $T = 20$ steps for which the position is on the loss side of the strike price.[6] Then the base variation margin financing cost is

$$C_{\text{base}} = r_{\text{fin}} \cdot \tau \cdot V \cdot \varphi \,, \tag{12}$$

To capture liquidity stress on paths with large margin needs, we allow the effective annual financing rate to increase by 5% when total margin requirements exceed an account buffer to capture higher borrowing costs under liquidity stress. Let the buffer be $B = \kappa \cdot IM$, where $\kappa = 2$ is the cash-buffer multiple. Define the margin shortfall as

$$\Delta M = \max\left(0,\, IM + V - B\right) \,, \tag{13}$$

and define stress severity as $s = \min\left(s_{\max},\, \Delta M/B\right)$ with $s_{\max} = 2$. The stress increment to the financing rate is $\Delta r = \lambda s$, where $\lambda = 0.05$ is a stress-rate parameter. Then the associated stress financing cost is calculated as

$$C_{\text{stress}} = \Delta r \cdot \tau \cdot \Delta M \cdot \varphi \,. \tag{14}$$

Total variation margin financing costs are therefore $C_{\text{VM}} = C_{\text{base}} + C_{\text{stress}}$. This design assumes positions are maintained through expiration, but allows financing costs to rise when margin requirements exceed the account buffer. In practice, some producers may be unable to meet large margin calls, which can lead to forced position closure.

While NPV and ΔNPV summarize average profitability, they do not fully describe the tradeoff involved in subsidy capture. A combined strategy may generate additional premium relative to

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[5] Maximum adverse excursion measures the largest intraday loss from the entry price to the most adverse price reached before closing a position. Because our data do not include intraday transactions, we approximate MAE using simulated CME price paths generated under GBM dynamics with $T = 20$ intermediate steps over the contract horizon. For each Monte Carlo path, we use the resulting MAE to construct a path-dependent proxy for variation margin exposure based on the peak adverse movement relative to the strike.

[6] The "loss side" depends on the position. For a short put, losses occur when the futures price falls below the strike price, while for a short call, losses occur when the futures price rises above the strike price.

holding LRP alone on average, but a positive mean ΔNPV does not imply that subsidy capture is worth pursuing. By giving up some of the downside protection provided by LRP, the producer may obtain small gains in some cases while facing concentrated losses in others, particularly under adverse price realizations. We therefore report two measures intended to characterize the attractiveness of the subsidy-capture tradeoff.

The first measure is the Omega ratio, following Keating and Shadwick (2002), which summarizes the balance between gains and losses relative to a chosen threshold using the full distribution of outcomes. In this application, the threshold is set to zero, so the benchmark is no improvement relative to holding LRP alone. Let $\Delta\pi$ denote the NPV difference relative to LRP-only. We compute

$$\Omega = \frac{E\Big[\max(\Delta\pi, 0)\Big]}{E\Big[\max(-\Delta\pi, 0)\Big]}\,. \tag{15}$$

$\Omega > 1$ indicates that expected gains relative to LRP-only exceed expected losses, while $\Omega < 1$ indicates the reverse.

The second measure is expected shortfall at the 5-percent level, reported as ES5($\Delta\pi$) (Artzner et al. 1999; Rockafellar and Uryasev 2002). This is calculated by first identifying the 5th percentile of the distribution of NPV differences relative to LRP-only and then taking the average of all simulated outcomes at or below that cutoff. Formally,

$$\text{ES5}(\Delta\pi) = E\Big[\Delta\pi \mid \Delta\pi \leq Q_{0.05}(\Delta\pi)\Big]\,, \tag{16}$$

where $Q_{0.05}(\Delta\pi)$ denotes the 5th percentile of the distribution of NPV differences relative to LRP-only. ES5 focuses on the lower tail of the distribution of NPV differences relative to LRP-only and measures the average severity of unfavorable outcomes in the worst 5% of simulated cases, assessing the downside exposure associated with giving up protection provided by LRP. These measures provide a more comprehensive assessment of whether the premium wedge can be converted into economically meaningful gains, and whether those gains are sufficient to justify the associated loss of downside protection.

Another important component of the simulation is the volatility environment because it affects whether the premium wedge can be converted into gains. A producer entering the private financial position pays or receives option premia at market prices on the purchase date, and those premia reflect the market's implied volatility. The value of the combined strategy, therefore, depends in part on whether the volatility realized over the endorsement period was lower or higher than what was priced into the option at purchase.

Volatility is endorsement-specific. We obtain implied volatility σ_{iv} from CME-reported option implied volatility matched to each endorsement. σ_{iv} is treated as the market volatility at entry and is therefore the volatility embedded in the observed option premium. Simulated terminal prices are then generated with the volatility parameter

$$\sigma_{\text{sim}} = \sigma_{\text{iv}} \times \xi \,, \tag{17}$$

where ξ is defined as the volatility ratio

$$\xi = \frac{\sigma_{\text{realized}}}{\sigma_{\text{iv}}} \,. \tag{18}$$

When realized volatility is lower than implied volatility, the premium collected at entry is high relative to the price risk that is realized, which is favorable for producers holding the combined strategy, such as a short-option position. When realized volatility meets or exceeds implied volatility, that advantage becomes smaller or disappears because the premium collected at entry is no longer large relative to the realized price risk. This gap between implied and realized volatility is commonly referred to as the variance risk premium (VRP) (Carr and Wu 2008). Instead of using ξ to estimate a structural VRP, it is a reduced-form scenario parameter that scales simulated realized volatility relative to the implied volatility embedded in the observed premium. This interpretation is consistent with evidence that option-implied volatility often exceeds realized volatility in agricultural markets, including corn and soybeans (Xi et al. 2019), and with livestock-options evidence showing that live-cattle options tend to overpredict realized volatility and display left skew and relatively expensive downside protection (Manfredo and Sanders 2004; Brittain et al. 2011; McKenzie et al. 2022).

Under this design, the option premium paid or received at purchase is held fixed at its observed market value, while the realized payoff of the option position varies with the volatility environment assumed in the simulation. This structure provides a transparent way to incorporate the economic intuition behind the VRP without imposing a structural model of how the VRP is priced. In this sense, we ask the question of how strategy performance changes when realized volatility turns out to be lower than, equal to, or higher than the volatility embedded in observed option prices.

We apply this parameterization in two ways. First, we report results for fixed values $\xi \in \{0.9, 1.0, 1.1\}$. The $\xi = 1$ case sets $\sigma_{\text{sim}} = \sigma_{\text{iv}}$ and provides a transparent reference case in which simulated price dynamics are aligned with implied volatility. The $\xi = 0.9$ case scales volatility down relative to the implied level, while $\xi = 1.1$ scales volatility up, allowing us to evaluate how combined-strategy outcomes vary across lower- and higher-volatility environments. These correspond, respectively, to a favorable environment in which realized volatility is 10% below implied volatility, a benchmark case in which realized and implied volatility are equal, and an unfavorable environment in which realized volatility exceeds implied volatility by 10%.

Second, we use endorsement-specific ξ values constructed from observed data. For each trading date t, we compute realized volatility from a rolling 30-day window of daily log returns on the parity-implied futures price. Let F_t denote the daily futures price recovered via put-call parity from the selected at-the-money (ATM) option settlements, and define the daily log return as

$$r_t = \ln(F_t) - \ln(F_{t-1}) = \ln\left(\frac{F_t}{F_{t-1}}\right), \tag{19}$$

Realized volatility is then computed as the annualized sample standard deviation of the most recent 30 non-missing returns,

$$\sigma_{\text{realized},t} = \sqrt{252} \cdot \text{sd}(\, r_s \,)_{s=t-29}^{t} = \sqrt{252} \cdot \sqrt{\frac{1}{n_t - 1} \sum_{s \in \mathcal{W}_t} (r_s - \bar{r}_t)^2}\,, \tag{20}$$

where $\mathcal{W}_t$ denotes the set of non-missing returns in the 30-day window, $n_t = |\mathcal{W}_t|$, and $\bar{r}_t$ is the mean return over that window.[7] We smooth CME-reported ATM implied volatility using a 5-day

[7] In the implementation, we require at least 10 finite returns within the 30-day window to compute $\sigma_{\text{realized},t}$.

rolling average, denoted $\bar{\sigma}_{\text{iv},t}$.

The daily volatility ratio is defined as

$$\xi_t \;=\; \frac{\sigma_{\text{realized},t}}{\bar{\sigma}_{\text{iv},t}}\,, \tag{21}$$

where $\bar{\sigma}_{\text{iv},t} = \frac{1}{5}\sum_{j=0}^{4}\sigma_{\text{iv},t-j}$. Each endorsement is assigned a volatility ratio based on the realized-to-implied volatility relationship observed on its purchase date. Observations with values below one, indicating that realized volatility was lower than implied volatility, are classified as the low-volatility regime, while observations with values above one are classified as the high-volatility regime. We report results separately for these two regimes and for a pooled specification that combines all endorsements. In the pooled case, the average volatility ratio is weighted by the number of observations in each regime.

Each endorsement is simulated with $M = 1{,}000$ Monte Carlo paths, yielding endorsement-level NPV distributions and risk metrics. We report results by commodity and coverage level (85%, 90%, 95%, 100%) by first computing statistics within each endorsement and then averaging those statistics across endorsements in each bin.

4.2 Simulation Results

Table 5 reports summary statistics for the matched dataset from July 1, 2020, to June 30, 2025. This period covers the crop years after the tiered subsidy rates were introduced and before the formal subsidy-capture definition took effect. Several patterns are worth noting.

First, the matching procedure identifies a relatively narrow subset of endorsements, covering about 6.19% of feeder cattle endorsements, 8.77% of live cattle endorsements, and 8.00% of lean hogs endorsements to CME options data. This subset is intentionally selective and is designed to isolate the endorsements that most plausibly satisfy the conditions relevant for attempted subsidy capture. Because the LRP endorsement data are matched by linking the coverage price (coverage level multiplied by the expected ending value, or EEV) to the closest available CME strike price, the question becomes whether the matched contracts are reasonably comparable. In most cases, they are. The average difference between the LRP coverage price and the matched CME strike is only a few cents. The largest mismatch appears in feeder cattle, which is not surprising because LRP-Feeder Cattle covers a broader set of cattle types, including calves, steers, heifers, and Brahman cattle, each of which can have a different EEV. By contrast, CME feeder cattle options are written on a single standardized feeder cattle contract. Some additional mismatch is therefore expected for this commodity.

Second, implied volatility differs across commodities. Lean hogs have the highest average implied volatility at 24.2%, followed by feeder cattle at 15.3% and live cattle at 13.3%. At the same time, the average coverage level is about 97.5% across all three commodities, with an average subsidy rate of 36.4%. This indicates that most matched endorsements are purchased at very high coverage levels, typically close to full coverage.

Lastly, the LRP gross premium averages about one dollar per cwt more than the matched CME put premium. However, once the federal subsidy is applied, the producer-paid LRP premium falls below the CME put settlement price. In other words, the subsidy creates a premium wedge between the cost of the insured producer and the price of a comparable market-based hedge. This wedge provides the economic basis for concerns about subsidy capture. The relevant question, therefore, is not whether a premium gap exists, but whether that gap can be realized in practice after accounting for realistic trading frictions.

The simulation results address this question directly. Figure 3 provides a concise summary at the 100% coverage level. Tables 6 to 8 report the full set of results by commodity, volatility scenario, and coverage level.[8] The results show that the presence of a subsidy-created premium wedge does not, by itself, imply that the wedge can be converted into economically meaningful gains. Across commodities, the relative performance of the combined strategies varies with the simulated volatility environment, and the few gains that do appear are generally small and are concentrated in favorable

[8] We also simulated lower coverage levels. However, most matched endorsements are concentrated at coverage levels above 95%, with relatively few observations available at lower coverage levels. Because results for those lower coverage levels are based on a much smaller matched sample (< 20), we limit the reported results to the higher coverage levels.

low-volatility cases.[9]

As both the figure and the tables show, the value of holding LRP alone increases with the volatility scale. For feeder cattle, live cattle, and lean hogs, the mean NPV under the LRP-only strategy is lowest when $\xi = 0.9$ and highest when $\xi = 1.1$. This is expected. Higher realized volatility raises the expected value of the indemnity, while the producer-paid premium is fixed at purchase. As the volatility environment becomes less favorable to short-option positions, the relative profitability of subsidy-capture-type strategies tends to weaken. At the 100% coverage level shown in Figure 3, feeder cattle and live cattle show no evidence that the pairing of a short-put strategy improves on holding LRP alone, even in the favorable low-volatility case. Lean hogs provide the only case in which the combined short-put strategy generates a positive mean gain under the low-volatility scenario, although the gain is modest at \$0.09/cwt. Moving from the 100% coverage level to a lower coverage level sometimes makes the combined strategies less negative or slightly positive in some of the low-volatility cases. This occurs because lowering coverage reduces the marginal value of the protection provided by LRP alone, so the additional premium collected from the option position offsets the benchmark by a relatively larger amount. But those improvements are generally small.

The results across strategies tell a similar story. Among the combined strategies intended to monetize the premium wedge, the direct short put generally performs best, but even that strategy rarely improves on LRP-only outside the favorable low-volatility case. The synthetic short put performs worse than the direct short put in every commodity and scenario, which is economically sensible because the synthetic construction requires additional positions and therefore introduces additional trading frictions. The put spread typically performs slightly better than the synthetic short put because the added lower-strike put limits extreme downside exposure, but that same protection also limits any gains available from selling option premium. This pattern across combined strategies

[9] When the volatility ratio is equal to one, the simulated volatility used to generate terminal prices is equal to the implied volatility embedded in the observed option premium, so the matched short put is approximately fairly priced relative to the simulated payoff distribution. As a result, for the "LRP + Short put" strategy, the expected gain from the added short put position is close to zero before frictions, and the reported ΔNPV is therefore driven primarily by the trading frictions introduced in the simulation. Because the comparison is made relative to holding LRP alone, the subsidy benefit embedded in LRP is present in both strategies and cancels in the relative NPV calculation.

suggests that different implementations of strategies do not lead to persistent profit because the underlying wedge is too limited and too sensitive to volatility conditions after realistic execution costs are taken into account. The "Long put" and "Short future" hedging strategies are included as private-market comparisons to the protection provided by LRP. As expected, both underperform LRP-only in nearly all cases, reflecting the fact that they provide similar downside protection without a federal premium subsidy.

A strategy can appear attractive on average while still producing unfavorable outcomes in low-price states when producers value insurance protection the most. Therefore, Table 6 to Table 8 also report two measures of downside performance: the Omega ratio (Ω) and the 5th-percent expected shortfall, ES5($\Delta\pi$). These measures are computed from the distribution of relative to holding LRP alone, evaluating the tradeoff of exchanging downside protection for the small gain.

The Omega ratio summarizes the balance of gains and losses relative to the LRP-only benchmark. Values above one indicate that positive outcomes outweigh negative outcomes in expectation, whereas values below one indicate that losses dominate. Across the reported results, Ω provides little evidence that the combined strategies offer an attractive improvement over holding LRP alone. For the direct short-put strategy, Ω exceeds one only in low-volatility cases by a small margin. For example, at 100% coverage and $\xi = 0.9$, Ω is 1.02 for feeder cattle, 1.02 for live cattle, and 1.04 for lean hogs. Those values indicate only a slight tilt toward positive relative outcomes, which is consistent with the small positive or near-zero mean ΔNPV observed in the same cases.

The expected shortfall reports the average outcome in the worst 5% of cases relative to holding LRP alone. A more negative value indicates a larger deterioration in lower-tail producer outcomes. It is expected that combined strategies reintroduce the downside risk, yet the magnitude is still striking. At 100% coverage, ES5 for "LRP + Short put" ranges from −29.82 to −37.70 \$/cwt for feeder cattle, from −21.77 to −27.62 \$/cwt for live cattle, and from −18.63 to −23.34 \$/cwt for lean hogs, as ξ increases from 0.9 to 1.1. These are large losses relative to the LRP-only benchmark, especially when compared with the fact that only very small mean gains were observed in favorable cases. The restoration of lower tail risk is visible in Figure 5. The LRP-only distribution remains tightly anchored near the coverage floor, while the LRP + Short put distribution shows a larger and fatter left-tail. This result implies that the combined strategies exchange a small average gain for substantially worse outcomes in the worst states, suggesting that the premium wedge cannot be exploited in an economically efficient way once lower-tail losses are taken into account.

The scenario analysis above varies the volatility scale exogenously to show how the profitability of combined strategies changes under more or less favorable pricing environments. We next turn to an empirical regime-based analysis that uses observed variation in realized and implied volatility from CME data to classify endorsement dates into low- and high-volatility regimes, where the realized volatility is computed as described in Equation 20. This allows us to link the simulation more directly to the market conditions producers actually faced at the time of purchase. Instead of imposing alternative values of ξ, we assign each matched endorsement to a regime (high or low) based on the empirical volatility ratio observed on its purchase date and then evaluate strategy performance within those subsamples.

Table A.2 summarizes the empirical regime classification.[10] The low-volatility regime subsample is defined by $\xi < 1$, and the high-volatility regime subsample is defined by $\xi > 1$. Across commodities, the low regime has average empirical volatility ratios between 0.86 and 0.90, whereas the high regime has mean values between 1.18 and 1.27. The distribution of observations across regimes is uneven. Feeder cattle and lean hogs endorsements are concentrated in the high regime, while live cattle has a larger share of observations in the low regime. The empirical ξ series is plotted in Figure A.1. For feeder cattle and lean hogs, ξ is above one for much of the sample period, indicating that realized volatility generally exceeded implied volatility. By contrast, live cattle is more often observed in the low-volatility regime, with ξ below one for a larger share of the sample. This is consistent with earlier evidence that live-cattle implied volatility tends to overpredict realized volatility at short horizons, and with more recent evidence of left skew and expensive downside protection in cattle

[10] The empirical volatility-regime analysis uses a reduced subset of the matched endorsement sample because each endorsement must have a valid empirical volatility ratio, $\xi_t = \sigma_{\text{realized},t}/\sigma_{\text{implied},t}$, on its purchase date. Observations are excluded when near-ATM implied volatility is unavailable, when the realized-volatility window contains too few non-roll trading days, or when the date falls in a temporary regime excluded by the persistence filter. This removes about 17% of feeder cattle observations, 10% of live cattle observations, and 9% of lean hogs observations from the matched sample. The main simulation results under the imposed volatility-scale scenarios use the full matched dataset.

options (Manfredo and Sanders 2004; Brittain et al. 2011; McKenzie et al. 2022). This imbalance implies that the favorable low-volatility cases identified in the scenario analysis do not necessarily correspond to the market environment most commonly observed for each commodity.

Similar to the previous analysis, Figure 4 summarizes mean ΔNPVs at the 100% coverage level across the empirical volatility regimes, while Table A.3 to Table A.5 report the full commodity-level results. Among the three commodities, lean hogs provide the strongest evidence of a favorable environment for collecting the premium wedge, with a mean ΔNPV equal to $0.43/cwt at the 100% coverage level in the low-volatility regime. If one interprets this value as the average gain available to a sophisticated trader who systematically enters only in favorable low-volatility periods, the total amount that could be extracted is still small relative to aggregate subsidy payments. For lean hogs, there are 389 endorsements in the low-volatility regime, with an average endorsement size of 7,916 cwt. Applying the estimated gain of $0.43/cwt implies total gains after frictions of roughly $1.32 million. Relative to the $497.5 million in total LRP subsidy paid for lean hogs between 2020 and 2025, this amounts to about 0.26% of total subsidy expenditures. A similar calculation for feeder cattle leads to the same conclusion. In the low-volatility regime, mean ΔNPV is $0.17/cwt at the 100% coverage level. Using the corresponding low-volatility endorsements implies total gains of roughly $0.53 million. Relative to the total LRP subsidy payments of $159 million, this amounts to approximately 0.33% of the subsidy expenditures. These illustrative aggregation calculations suggest that even under conditions most favorable to subsidy capture, the aggregate amount that could be extracted remains economically small relative to the total subsidy provided through LRP.

5. Discussion and Reconciliation

The simulation results show that the relative performance of the combined strategies depends largely on the volatility environment. Under favorable low-volatility conditions, some strategies can generate positive gains from attempting to monetize the premium wedge. However, those gains are small, not robust across commodities or volatility scenarios, and are associated with substantial downside risk exposure. This raises a broader question: if a premium wedge is visible at the time of purchase, why does it not translate into large or reliable gains in practice?

The answer lies in the difference between an *ex ante* pricing wedge and *ex post* realized profitability.

In a mechanical sense, the wedge is real: subsidized LRP coverage can be paired with private-market short positions in a way that makes the premium difference visible at entry. But realized profitability depends on what happens afterward, including the subsequent price path, the realized volatility environment, margin and financing needs, and other trading frictions. Once those factors are taken into account, the wedge no longer resembles a stable arbitrage opportunity.

This implies that, although clustering near CME option expiration dates is consistent with the temporal alignment needed for subsidy-capture-type strategies, it is not unique to that explanation. A more plausible interpretation is that alignment with the CME calendar has value beyond collecting option premiums. This becomes clearer when the clustering window is extended beyond the date range used in the RMA definition of suspected subsidy capture. Figure 6 shows a clear concentration in insured weight approximately 14 days after the option expiration date used as the reference point. This indicates that live cattle producers are clustering around a different point in the contract cycle.

One plausible explanation is that live cattle differ from feeder cattle and lean hogs in the relationship between option expiration and futures termination. For feeder cattle, both futures and options terminate on the last Thursday of the contract month. For lean hogs, both futures and options terminate on the 10th business day of the contract month. Live cattle differs in that options terminate on the first Friday of the contract month, while futures trading terminates on the last business day of the contract month. The visible clustering at roughly day +14 is therefore consistent with endorsements ending closer to the live cattle futures termination date than to the option expiration date used in the baseline event-time analysis. While this does not prove that live cattle endorsements are driven by hedging practice, it does suggest that an option-expiration-centered interpretation does not fully explain the pattern.

Combined strategies involving short options perform better when realized volatility is low relative to implied volatility. If endorsement timing were driven primarily by attempts to monetize the wedge, one might expect stronger clustering in endorsements purchased under those more favorable volatility conditions. To examine this, we divide endorsements into high- and low-volatility subsets based on the empirical volatility ratio and then compare clustering patterns across those subsamples. Because the number of observations differs across subsets, we normalize insured weight by expressing it as a share of total insured weight within each subset, which allows for a cleaner comparison of timing patterns across regimes. The results, plotted in Figure 7, show no pronounced difference in clustering behavior between the two regimes. Endorsements continue to cluster around the same parts of the contract cycle, even when market conditions are less favorable for harvesting. This suggests that, for most producers, endorsement timing is not primarily driven by waiting for a favorable volatility environment in which the wedge is easier to monetize.

We also examine whether the introduction of subsidy-capture language in the LRP Handbook, effective for the 2026 crop year, coincided with any visible change in timing patterns. To do so, we repeat the same normalized clustering analysis for subsamples defined before and after July 1, 2025, plotted in Figure A.2. Note that the post-change period covers only eight months of endorsements (July 2025 through February 2026) and may not fully capture longer-run producer behavior. Within this limit, the before-and-after patterns do not show an obvious break in clustering following the handbook revision. This persistence is inconsistent with an interpretation in which clustering is driven by deliberate attempts to arbitrage subsidies.

These patterns support the interpretation that alignment with the CME calendar may reflect operational hedging practice. Producers, particularly larger ones, may use LRP together with CME contracts as part of a broader risk-management strategy, in which contract timing matters for execution, position management, and avoidance of slippage. Under that interpretation, clustering can arise both from attempts to exploit the wedge and from ordinary risk-management considerations associated with contract alignment and marketing convenience.

6. Conclusion

The design of the LRP program raises an important question for policy evaluation: Does a subsidized contract that closely parallels a private-market option create opportunities for subsidy capture? Because LRP indemnities are tied to CME futures prices, producers can, in principle, pair LRP with exchange-traded instruments to construct related positions. Using county-level endorsement data published by RMA Summary of Business, we show that LRP purchases are disproportionately concentrated around CME options expiration dates, a pattern that could initially be interpreted as strategic timing to exploit differences between LRP and CME premiums. To evaluate whether such timing reflects economically meaningful harvesting, we simulate returns from paired LRP-CME strategies under realistic assumptions about trading costs, financing, and basis risk. The results show that the premium wedge is real and observable *ex ante*, but it is not readily harvestable *ex post* once realized market conditions and trading frictions are taken into account. Across commodities and coverage levels, positive gains appear only in favorable low-volatility cases and are small and coupled with worse lower-tail outcomes relative to holding LRP alone.

These findings contribute to the broader literature on policy-induced behavior in subsidized insurance markets (Goodwin and Smith 2013; Babcock 2015). Prior work has emphasized that generous subsidies may distort behavior through moral hazard or adverse selection. Our results highlight a different mechanism. In the LRP context, the relevant issue is whether subsidy support affects timing and product choice when a subsidized contract closely overlaps with exchange-traded derivatives. That overlap can generate a visible premium wedge and clear timing patterns, but it does not by itself imply that producers can systematically convert the wedge into stable gains. The empirical regime analysis shows that the profitability of subsidy-capture-type strategies depends heavily on the volatility environment, whereas the clustering evidence persists even outside the conditions in which those strategies perform best. This suggests that timing patterns that resemble arbitrage need not reflect widespread or economically important harvesting.

This interpretation also has implications for regulatory design. Recent revisions to the LRP Basic Provisions classify certain timing-based endorsement practices as presumptive violations, reflecting concern over subsidy capture. Our results do not rule out isolated opportunistic behavior, and they do not imply that timing patterns should be ignored. However, they suggest that observed clustering, by itself, should not be interpreted as evidence of widespread or economically meaningful subsidy capture. In particular, the persistence of clustering across volatility regimes, together with the shifted clustering pattern for live cattle, is more consistent with a broader set of operational and risk-management considerations than with a single uniform harvesting strategy. If clustering partly reflects contract alignment, execution convenience, or other structural features of program use, then timing patterns alone may not be sufficient to distinguish subsidy capture from other risk-management behaviors.

Several limitations remain. Without transaction-level data, we cannot observe whether individual producers actually enter offsetting CME positions, nor can we identify the role of agents, reinsurance arrangements, or firm-level marketing practices. More detailed data on futures and options positions with agent-level information would help distinguish direct harvesting from broader hedging activity. Future research could also examine whether similar timing patterns arise in other subsidized livestock or revenue insurance products, including Dairy Revenue Protection, and whether the same distinction between an *ex ante* wedge and *ex post* harvestability applies in those settings.

References

Adjemian, M. and A. F. Ramsey 2026. A theory of subsidy harvesting in livestock price insurance. *SSRN Electronic Journal*.

Artzner, P., F. Delbaen, J.-M. Eber, and D. Heath 1999. Coherent measures of risk. *Mathematical Finance 9*, 203–228.

Babcock, B. A. 2015. Using cumulative prospect theory to explain anomalous crop insurance coverage choice. *American Journal of Agricultural Economics 97*, 1371–1384.

Black, F. 1976. The pricing of commodity contracts. *Journal of Financial Economics 3*, 167–179.

Boyer, C. N. and A. P. Griffith 2022. Livestock Risk Protection subsidies changes on producer premiums. *Agricultural Finance Review 83*, 201–210.

Brittain, L., P. Garcia, and S. H. Irwin 2011. Live and feeder cattle options markets: Returns, risk, and volatility forecasting. *Journal of Agricultural and Resource Economics 36*, 28–47.

Carr, P. and L. Wu 2008. Variance risk premiums. *Review of Financial Studies 22*, 1311–1341.

Corwin, S. A. and P. Schultz 2012. A simple way to estimate bid-ask spreads from daily high and low prices. *The Journal of Finance 67*, 719–760.

Diersen, M. A. 2004. Livestock Risk Protection: Feeder cattle, fed cattle, and swine. *SDSU Extension Fact Sheets 115*.

Feuz, R. 2025. Subsidy capture in livestock risk protection insurance: Assessing prevalence and program exposure. *Applied Economic Perspectives and Policy*.

Glauber, J. W. 2022. The US animal insurance program: Rapid expansion at a growing cost to taxpayers. *American Enterprise Institute*.

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

Goodwin, B. K. and V. H. Smith 2013. What harm is done by subsidizing crop insurance? *American Journal of Agricultural Economics 95*, 489–497.

Keating, C. and W. F. Shadwick 2002. A universal performance measure. *Journal of Performance Measurement 6*, 59–84.

Manfredo, M. R. and D. R. Sanders 2004. The forecasting performance of implied volatility from live cattle options contracts: Implications for agribusiness risk management. *Agribusiness 20*, 217–230.

McKenzie, A. M., M. R. Thomsen, and M. K. Adjemian 2022. Characterizing implied volatility functions from agricultural options markets. *American Journal of Agricultural Economics 104*, 1605–1624.

Miranda, M. J. and J. W. Glauber 1997. Systemic risk, reinsurance, and the failure of crop insurance markets. *American Journal of Agricultural Economics 79*, 206–215.

Parsons, J. 2021. LRP-feeder cattle insurance usage up with recent changes. *Cornhusker Economics*.

Rockafellar, R. and S. Uryasev 2002. Conditional value-at-risk for general loss distributions. *Journal of Banking & Finance 26*, 1443–1471.

Serra, T., B. K. Goodwin, and A. M. Featherstone 2003. Modeling changes in the U.S. demand for crop insurance during the 1990s. *Agricultural Finance Review 63*, 109–125.

Stojkoski, V., T. Sandev, L. Basnarkov, L. Kocarev, and R. Metzler 2020. Generalised geometric brownian motion: Theory and applications to option pricing. *Entropy 22*, 1432.

Trujillo-Barrera, A., P. Garcia, and M. L. Mallory 2017. Short-term price density forecasts in the lean hog futures market. *European Review of Agricultural Economics 45*, 121–142.

USDA-RMA 2025. Livestock Risk Protection handbook (FCIC 20010): 2026 and succeeding crop years.

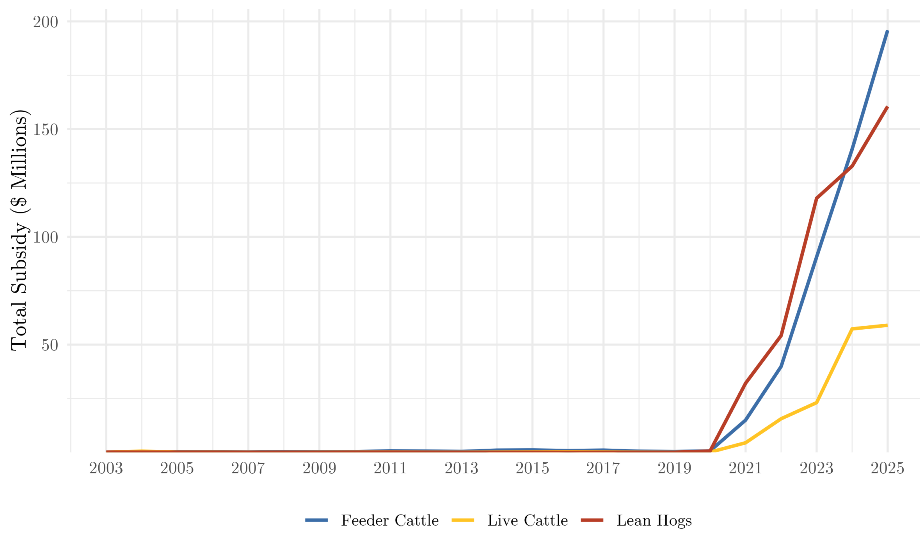
Xi, W., D. Hayes, and S. H. Lence 2019. Variance risk premia for agricultural commodities. *Agricultural Finance Review 79*, 286–303.

Yu, J., A. Smith, and D. A. Sumner 2017. Effects of crop insurance premium subsidies on crop acreage. *American Journal of Agricultural Economics 100*, 91–114.

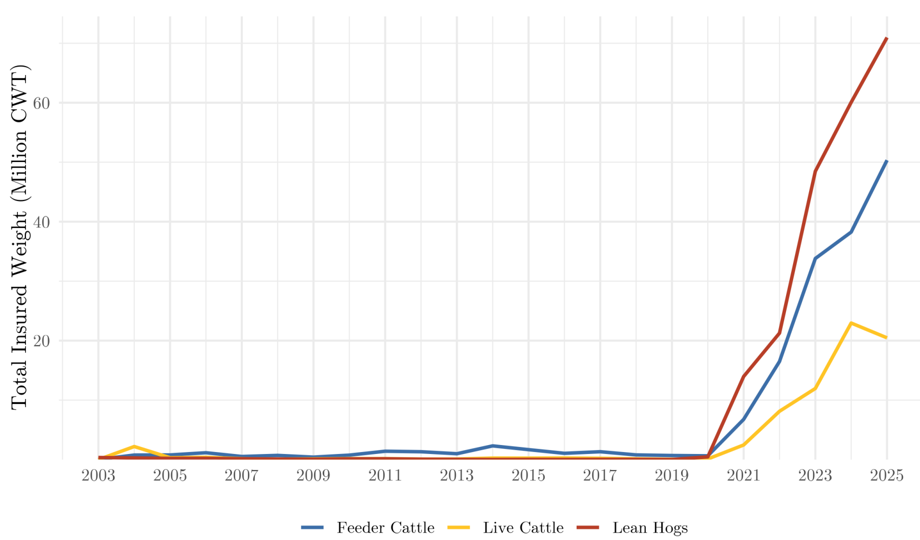
7. Figures and Tables

Figure 1: Trends in LRP Subsidy Expenditures and Participation

Panel A: Federal Subsidy Expenditures ($ Millions)

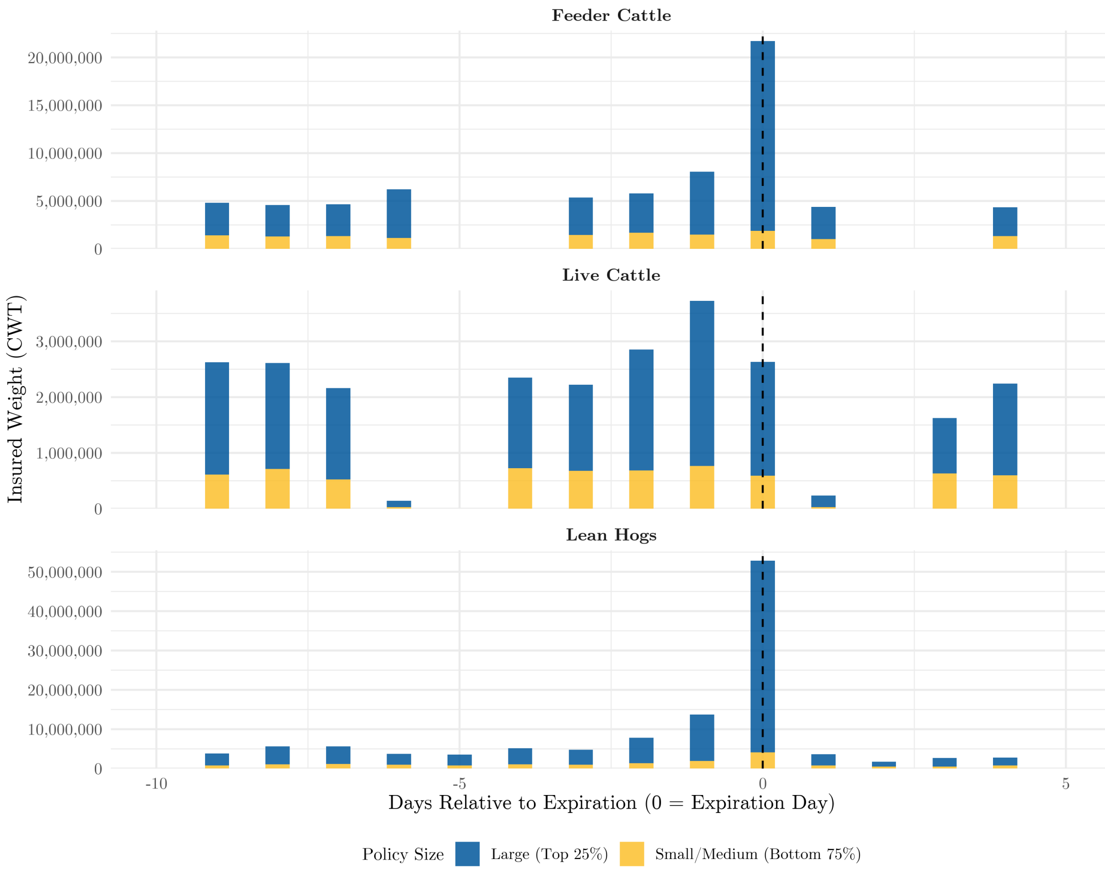


Panel B: Total Insured Weight (Million CWT)



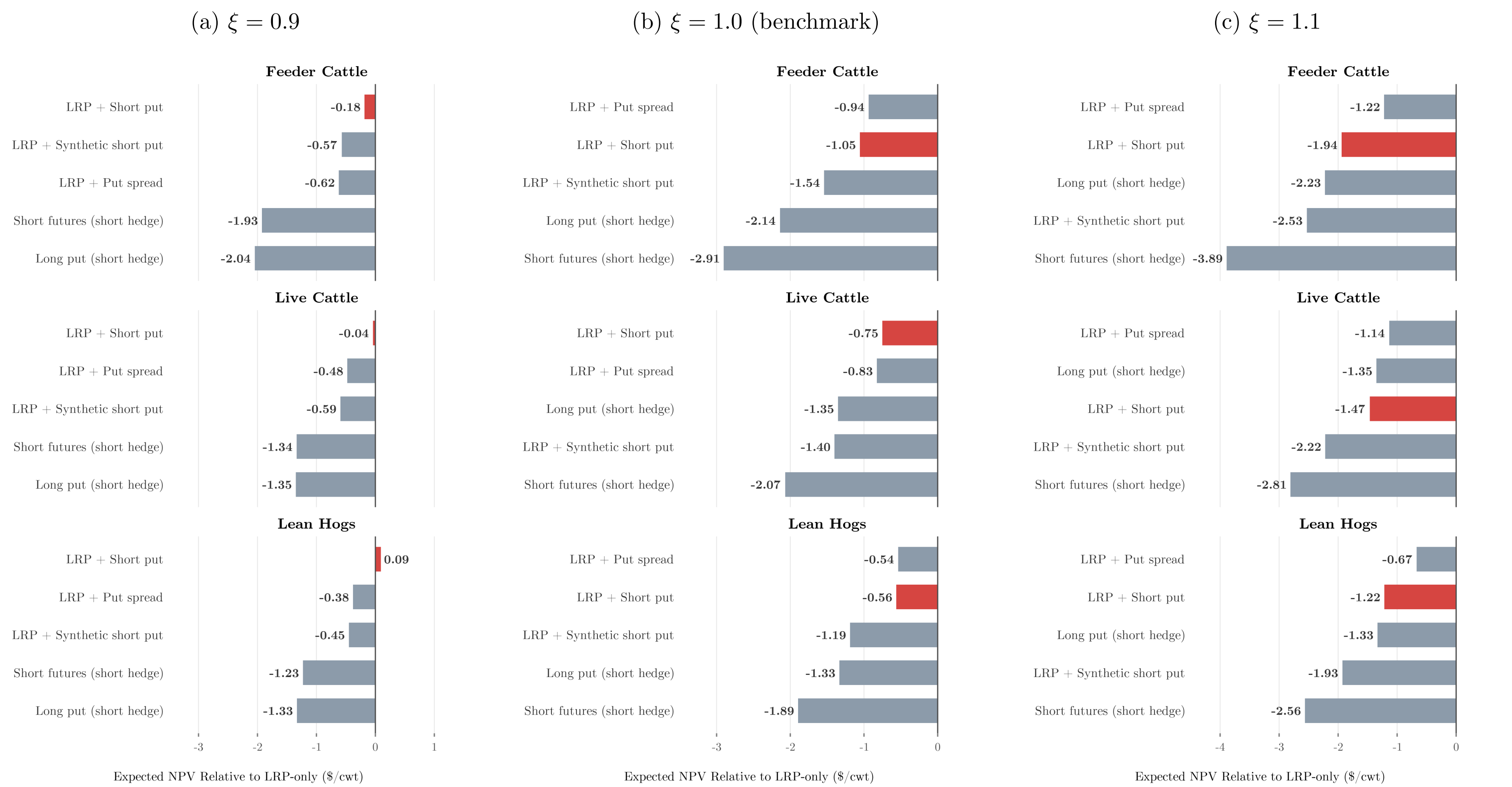
Note: This figure displays annual trends in the Livestock Risk Protection program from 2003–2025. The top panel shows federal subsidy expenditures in millions of dollars by commodity. The bottom panel shows the total insured weight in millions of hundredweight (cwt).

Figure 2: LRP Endorsement Clustering Around CME Option Expiration



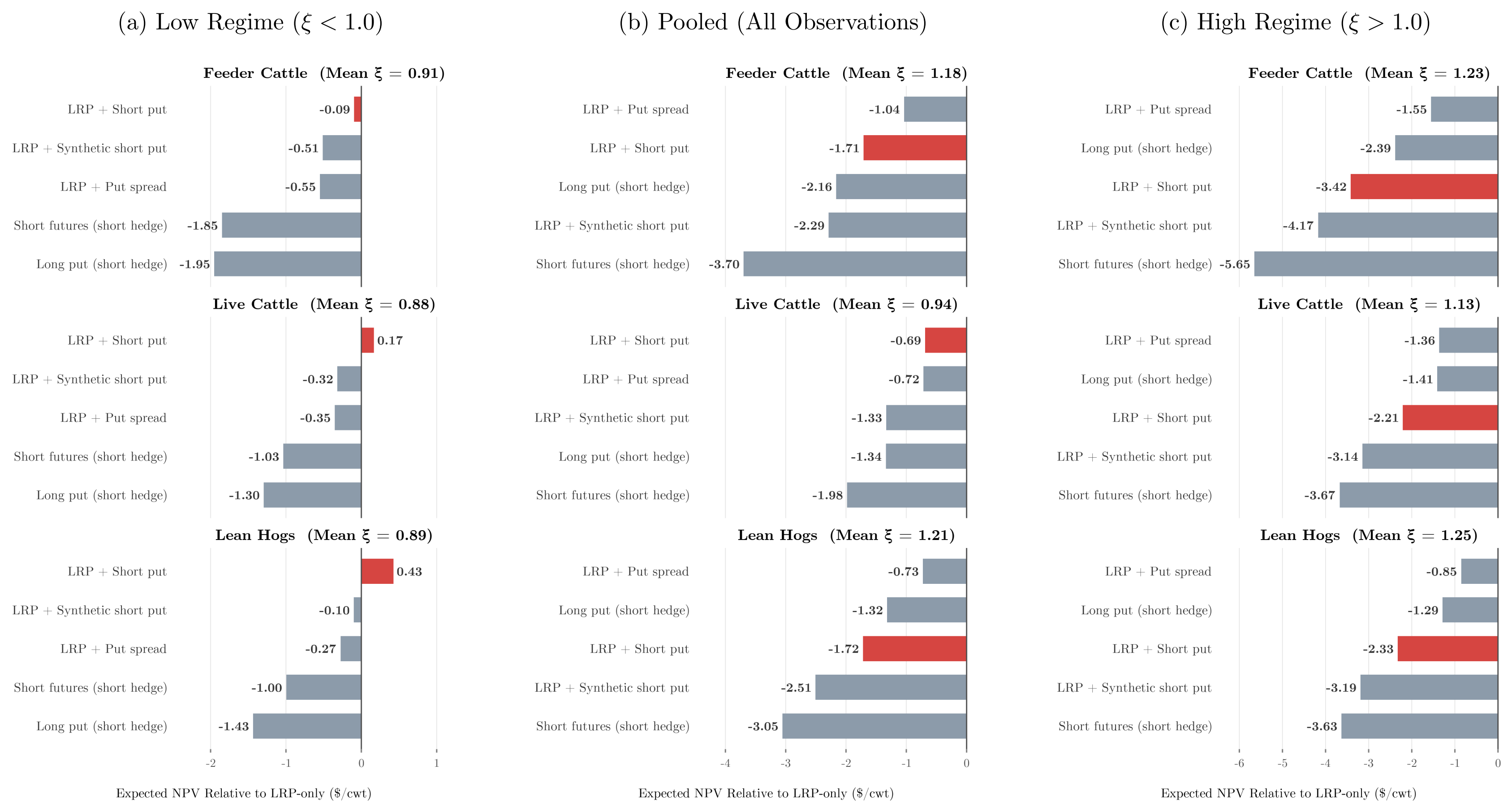
Note: This figure plots total insured weight (CWT) by days relative to the nearest CME option expiration, measured on the LRP end date. Each bar aggregates all endorsements whose end date falls on that relative day across the study period (July 2020–June 2025). The vertical dashed line at 0 marks the CME expiration day.

Figure 3: Mean ΔNPV Relative to LRP-Only by Strategy and Volatility Scenario ($/cwt)



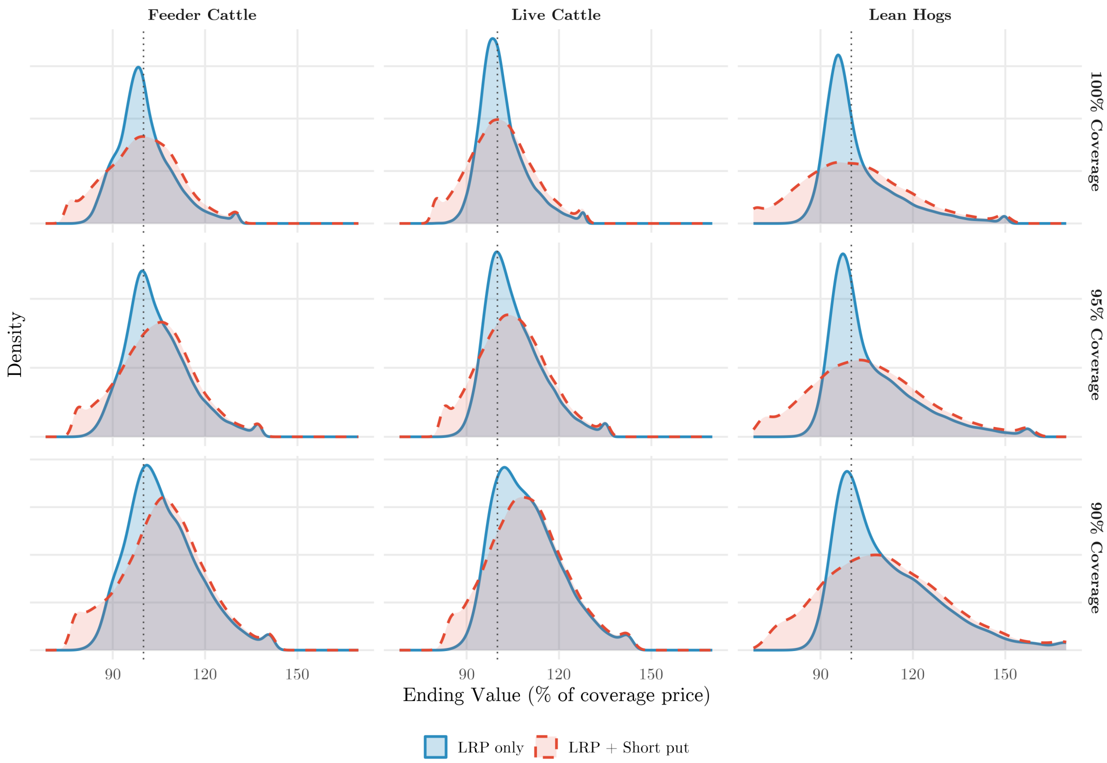
Note: Each panel plots the mean change in NPV relative to LRP-only ($Δ$NPV, $/cwt) for five alternative strategies across three commodities at 100% coverage level, averaged across all matched endorsement observations. Strategies are ordered by the mean outcome within each commodity panel. $\xi = \sigma_{\text{sim}}/\sigma_{\text{iv}}$ is the ratio of simulated realized volatility to implied volatility.

Figure 4: Mean ΔNPV Relative to LRP-Only by Strategy and Empirical Volatility Regime ($/cwt)



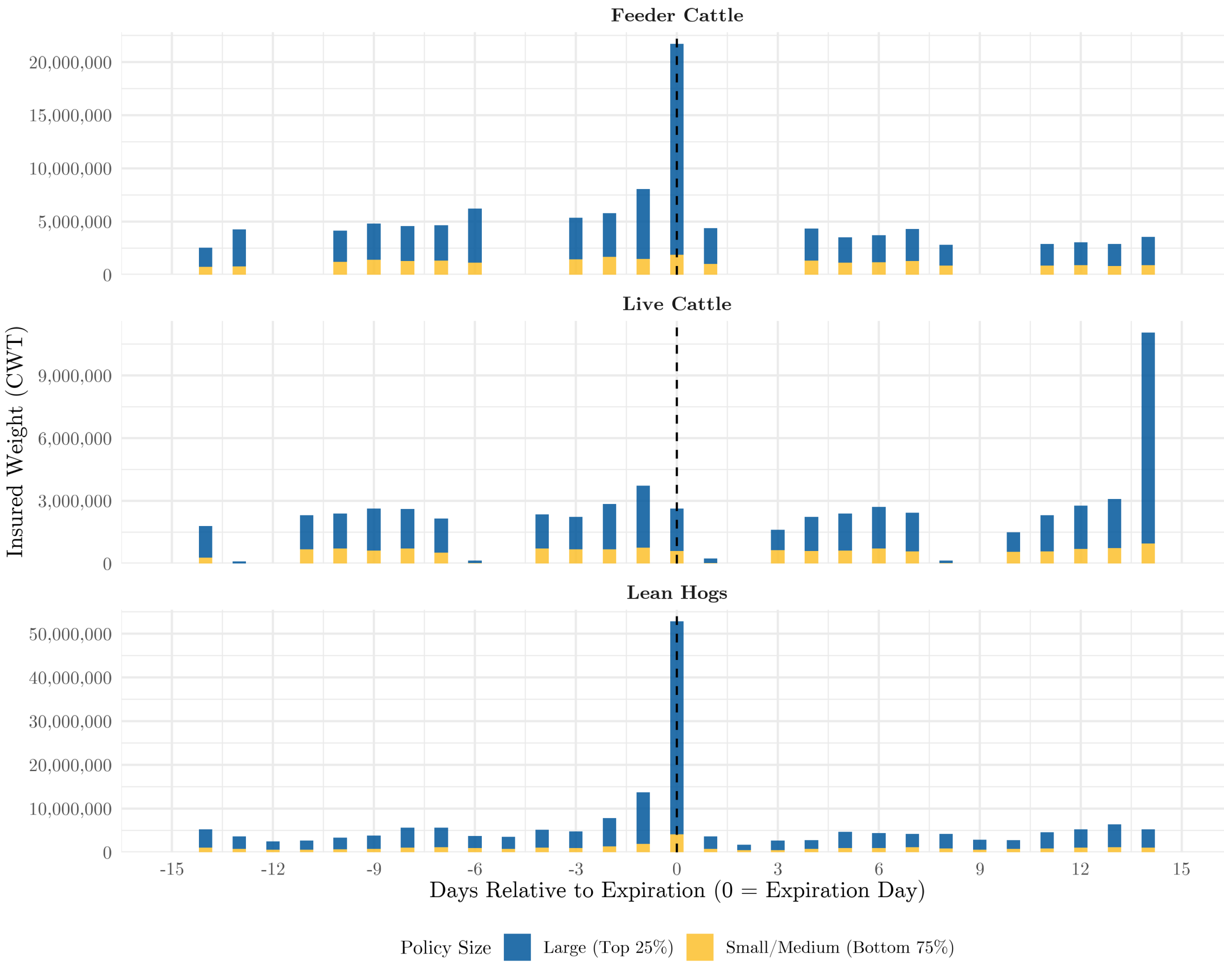
Note: Each panel plots the mean change in NPV relative to LRP-only (ΔNPV, $/cwt) for five alternative strategies across three commodities at the 100% coverage level, averaged across all matched endorsement observations in the indicated empirical volatility regime. Strategies are ordered by the mean outcome within each commodity panel. The full statistics of the empirical volatility ratios are reported in Table A.2.

Figure 5: Distribution of Simulated Ending Value: LRP Only vs. LRP + Short Put



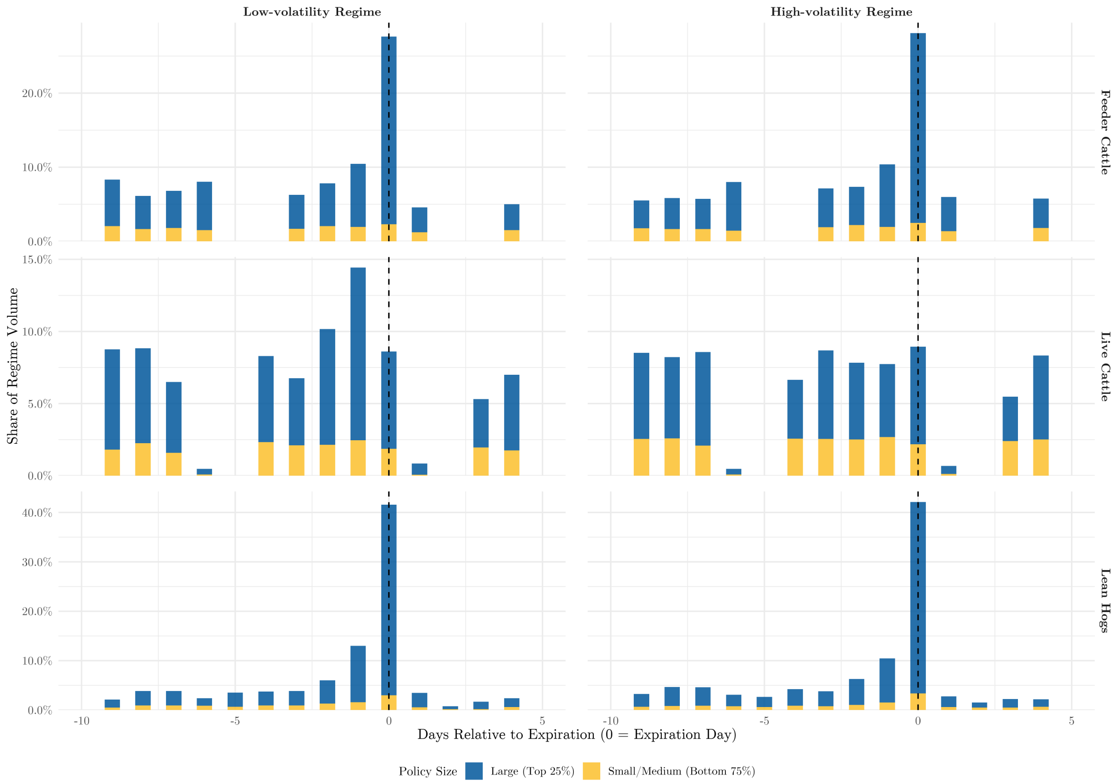
Note: Each panel plots the simulated distribution of ending value, expressed as a percentage of the LRP coverage price, for LRP only and LRP plus a short put. Columns denote commodities and rows denote coverage levels. Results are shown under the benchmark volatility case, $\xi = 1$, where simulated realized volatility equals implied volatility.

Figure 6: Timing Distribution of LRP Insured Weight



Note: This figure plots the distribution of total insured weight (CWT) by days relative to the nearest CME option expiration, measured on the LRP end date. Day 0 marks the CME option's last trade date. Sample period: July 2020–June 2025.

Figure 7: Timing Distribution of LRP Insured Weight by Volatility Regime



Note: This figure plots the share of each volatility regime's total insured weight (CWT) by days relative to the nearest CME option expiration, measured on the LRP end date. Each bar represents the fraction of that regime's cumulative insured weight falling on that relative day, so columns sum to 100% within each commodity-regime panel. The low-volatility regime is defined as $\xi < 1$, meaning realized volatility below implied volatility. The high-volatility regime is defined as $\xi > 1$, meaning realized volatility above implied volatility. The vertical dashed line at 0 marks the CME expiration day. Sample period: July 2020–June 2025.

Table 1: Descriptive Statistics of LRP Endorsements, July 2020-June 2025

Variable	Mean	SD	Min	Max
Feeder Cattle				
Total Weight (cwt)	1,042.94	2,955.71	3.00	280,000.00
Total Premium ($)	9,817.96	25,449.62	5.00	1,990,696.00
Producer Premium ($)	6,366.62	16,552.81	2.00	1,293,952.00
Subsidy Rate	0.35	0.03	0.00	0.60
Coverage Price ($/cwt)	236.95	44.23	68.06	344.17
Endorsements (N)				139,668
Live Cattle				
Total Weight (cwt)	2,571.36	6,452.08	12.00	212,000.00
Total Premium ($)	17,657.74	47,442.07	23.00	1,697,861.00
Producer Premium ($)	11,447.28	30,831.77	14.00	1,103,610.00
Subsidy Rate	0.36	0.03	0.00	0.55
Coverage Price ($/cwt)	174.61	22.40	96.86	219.05
Endorsements (N)				25,658
Lean Hogs				
Total Weight (cwt)	7,138.27	18,177.75	2.00	325,577.00
Total Premium ($)	47,012.46	122,170.73	15.00	2,009,685.00
Producer Premium ($)	30,476.04	79,371.51	10.00	1,306,296.00
Subsidy Rate	0.36	0.02	0.00	0.56
Coverage Price ($/cwt)	86.00	9.63	47.54	124.08
Endorsements (N)				30,084

Note: Summary statistics for all LRP endorsements with sales dates from July 1, 2020 to June 30, 2025, obtained from the USDA-RMA Summary of Business. Total Weight is the total insured weight in hundredweight (cwt). Premium amounts are in U.S. dollars. Subsidy Rate is the ratio of the subsidy amount to the total premium. Coverage Price is the guaranteed minimum price per cwt selected by the producer at enrollment.

Table 2: Effect of Near-Expiration Window on Insured Weight (End Date)

Commodity	Estimate	Std. Error	t-stat	p-value	% Change
Feeder Cattle	0.51	0.06	8.19	0.00	67.15
Live Cattle	0.01	0.08	0.18	0.86	1.48
Lean Hogs	0.94	0.11	8.78	0.00	155.15

Note: Estimates are from commodity-specific Poisson Pseudo-Maximum Likelihood (PPML) regressions. The dependent variable is total insured CWT maturing on a given day. Percentage effects are calculated as $100 \times (\exp(\beta) - 1)$. The near-expiration window equals one if the endorsement end date falls within four calendar days of the nearest CME option expiration date. All models include year-by-month fixed effects, with standard errors clustered at the year-by-month level.

Table 3: Summary of Simulation Notation and Calibration Inputs

Notation	Description	Source/Formula
Data Inputs		
K_{LRP}	LRP coverage price	RMA endorsement (coverage × EEV)
K_{CME}	CME option strike	CME settlement data
P, C	CME put/call settlement ($/cwt)	CME settlement data
π_{prod}	LRP producer premium ($/cwt)	RMA endorsement
τ	Time to expiry (years)	days / 365
r	Risk-free rate	SOFR annual average
Derived Quantities		
F_0	Futures price (parity-implied)	$K_{\text{CME}} + (C - P)/e^{-r\tau}$
σ_{iv}	Implied volatility	CME settlement data
ξ	Volatility scale factor	$\sigma_{\text{realized}}/\sigma_{\text{iv}}$
σ_{sim}	Simulation volatility	$\sigma_{\text{iv}} \times \xi$
$S_T^{\text{CME}}, S_T^{\text{LRP}}$	Terminal prices	Simulated (GBM)
Friction Components		
$\text{hs}(x)$	Half-spread	$\max(\text{floor}, \beta_0 + \beta_1 x)$
c	Option commission ($/cwt)	$1.50/contract
r_{fin}	Financing rate	SOFR + 150 bps
$P^{\text{net}}, C^{\text{net}}$	Premium received (short)	$P - \text{hs}(P) - c$
$P^{\text{cost}}, C^{\text{cost}}$	Premium paid (long)	$P + \text{hs}(P) + c$
IM	Initial margin requirement ($/cwt)	CME SPAN schedule
C_{IM}	Initial margin financing	$IM \times r_{\text{fin}} \times \tau$
Variation Margin and Stress Financing		
V	Peak variation margin requirement	Max adverse excursion over 20 steps
φ	Carry fraction	Steps adversely marked / 20
C_{base}	Base VM financing cost	$r_{\text{fin}} \cdot \tau \cdot V \cdot \varphi$
B	Cash buffer	$\kappa \cdot IM, \quad \kappa = 2$
ΔM	Margin shortfall	$\max(0, IM + V - B)$
s	Stress severity	$\min(s_{\max}, \Delta M/B), \quad s_{\max} = 2$
Δr	Stress rate increment	$\lambda \cdot s, \quad \lambda = 0.05$
C_{stress}	Stress financing cost	$\Delta r \cdot \tau \cdot \Delta M \cdot \varphi$
C_{VM}	Total VM financing cost	$C_{\text{base}} + C_{\text{stress}}$

Note: Half-spread model calibrated from CME Globex high/low prices using Corwin and Schultz (2012) estimator. Volatility scale $\xi = \sigma_{\text{realized}}/\sigma_{\text{iv}}$ computed from 30-day realized volatility relative to implied volatility at endorsement purchase. IM is the CME SPAN margin requirement: $12.00/cwt (feeder cattle), $8.25/cwt (live cattle), $4.25/cwt (lean hogs). Vertical spreads receive a 50% reduction to both C_{IM} and C_{VM}.

Table 4: Strategy NPV Formulas

Strategy	**NPV Formula**
LRP only	$e^{-r\tau}\max(0, K_{\text{LRP}} - S_T^{\text{LRP}}) - \pi_{\text{prod}}$
LRP + Short put	$e^{-r\tau}[\text{LRP} - \text{put}] + P^{\text{net}} - \pi_{\text{prod}} - C_{\text{IM}} - C_{\text{VM}}$
LRP + Synthetic short put	$e^{-r\tau}[\text{LRP} - \text{put}] + C^{\text{net}} - \pi_{\text{prod}} - 0.5(C_{\text{IM}} + C_{\text{IM}}^{\text{fut}}) - C_{\text{VM}} - C_{\text{VM}}^{\text{fut}}$
LRP + Put spread	$e^{-r\tau}[\text{LRP} - \text{put} + \text{OTM put}] + P^{\text{net}} - P_{\text{OTM}}^{\text{cost}} - \pi_{\text{prod}} - 0.5C_{\text{IM}} - C_{\text{VM}}$
Short futures	$e^{-r\tau}(F_0 - S_T^{\text{CME}}) - C_{\text{IM}}^{\text{fut}} - C_{\text{VM}}^{\text{fut}}$
Long put	$e^{-r\tau}\max(0, K_{\text{CME}} - S_T^{\text{CME}}) - P^{\text{cost}}$

Note: Notations and formulas are described in Table 3

Table 5: Summary Statistics: Matched LRP-CME Dataset

	Feeder Cattle	**Live Cattle**	**Lean Hogs**
N endorsements	8,641	2,249	2,404
Insured weight (cwt)	1,137	2,286	6,459
Coverage level (%)	97.5	97.1	97.4
Subsidy rate (%)	36.1	36.4	36.4
Endorsement length (days)	181	217	203
LRP gross premium ($/cwt)	8.04	6.01	6.19
CME put settlement ($/cwt)	6.96	4.92	5.21
Gross premium difference ($/cwt)	1.08	1.09	0.98
Federal subsidy ($/cwt)	2.86	2.14	2.22
Producer premium ($/cwt)	5.18	3.87	3.97
Producer premium difference ($/cwt)	-1.78	-1.05	-1.24
LRP coverage price ($/cwt)	220.01	169.66	87.59
CME strike ($/cwt)	219.70	169.64	87.55
Strike difference ($/cwt)	-0.32	-0.02	-0.04
Implied volatility (%)	15.3	13.3	24.2

Note: All values are means across endorsements in the matched dataset. Gross premium difference is LRP gross premium minus CME put settlement. Producer premium difference is LRP producer-paid premium minus CME put settlement. Strike difference is CME strike minus LRP coverage price. Implied volatility is extracted from CME put settlements data.

Table 6: Simulation Results: Feeder Cattle ($/cwt)

		$\xi = 0.9$				$\xi = 1.0$				$\xi = 1.1$			
Strategy	**Cov**	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)
LRP only	100	1.17	0.00	–	0.00	2.07	0.00	–	0.00	2.96	0.00	–	0.00
	95	0.46	0.00	–	0.00	1.27	0.00	–	0.00	2.10	0.00	–	0.00
	90	0.06	0.00	–	0.00	0.72	0.00	–	0.00	1.43	0.00	–	0.00
LRP + Short put	100	0.99	-0.18	1.02	-29.82	1.01	-1.05	0.83	-33.80	1.02	-1.94	0.70	-37.70
	95	0.58	0.11	1.08	-25.86	0.57	-0.70	0.83	-30.04	0.55	-1.55	0.66	-34.16
	90	0.25	0.19	1.11	-24.59	0.12	-0.60	0.82	-28.99	0.01	-1.42	0.64	-33.33
LRP + Synthetic short put	100	0.60	-0.57	0.90	-30.43	0.53	-1.54	0.73	-34.56	0.43	-2.53	0.62	-38.63
	95	-0.22	-0.68	0.79	-26.96	-0.35	-1.63	0.61	-31.28	-0.50	-2.60	0.49	-35.56
	90	-0.70	-0.76	0.72	-25.83	-0.97	-1.69	0.54	-30.38	-1.23	-2.66	0.42	-34.88
LRP + Put spread	100	0.55	-0.62	0.87	-15.05	1.13	-0.94	0.78	-15.29	1.74	-1.22	0.72	-15.43
	95	0.15	-0.32	0.93	-16.71	0.50	-0.77	0.76	-17.46	0.91	-1.19	0.65	-17.92
	90	-0.21	-0.27	0.93	-16.88	-0.02	-0.74	0.73	-18.04	0.24	-1.19	0.61	-18.71
Long put (short hedge)	100	-0.87	-2.04	0.16	-5.93	-0.07	-2.14	0.15	-5.93	0.74	-2.23	0.13	-5.93
	95	-0.84	-1.30	0.21	-5.02	-0.08	-1.35	0.20	-5.04	0.71	-1.39	0.20	-5.05
	90	-0.81	-0.87	0.33	-4.06	-0.07	-0.79	0.35	-4.08	0.71	-0.72	0.36	-4.08
Short futures (short hedge)	100	-0.75	-1.93	0.69	-39.15	-0.84	-2.91	0.58	-44.62	-0.93	-3.89	0.50	-50.19
	95	-0.82	-1.28	0.84	-44.57	-0.91	-2.18	0.75	-50.37	-1.01	-3.11	0.68	-56.26
	90	-0.86	-0.92	0.91	-49.50	-0.96	-1.68	0.84	-55.73	-1.06	-2.49	0.78	-62.08

Note: Each row reports equal-weighted averages across endorsement observations, each simulated with 1,000 Monte Carlo price paths. NPVs are in dollars per cwt. ΔNPV is the mean difference relative to LRP-only. Ω is the Omega ratio of the strategy's incremental revenue vs. LRP (values below 1 indicate expected losses exceed gains). ES5(Δπ) is the 5th-percentile expected shortfall of the revenue difference vs. LRP including all trading costs, measuring worst-case tail loss after frictions.

Table 7: Simulation Results: Live Cattle ($/cwt)

		$\xi = 0.9$				$\xi = 1.0$				$\xi = 1.1$			
Strategy	**Cov**	**Mean NPV**	**ΔNPV**	Ω	**ES5**($\Delta\pi$)	**Mean NPV**	**ΔNPV**	Ω	**ES5**($\Delta\pi$)	**Mean NPV**	**ΔNPV**	Ω	**ES5**($\Delta\pi$)
LRP only	100	0.59	0.00	–	0.00	1.24	0.00	–	0.00	1.89	0.00	–	0.00
	95	0.25	0.00	–	0.00	0.86	0.00	–	0.00	1.48	0.00	–	0.00
	90	0.10	0.00	–	0.00	0.60	0.00	–	0.00	1.13	0.00	–	0.00
LRP + Short put	100	0.55	-0.04	1.02	-21.77	0.49	-0.75	0.82	-24.71	0.42	-1.47	0.68	-27.62
	95	0.38	0.13	1.09	-19.31	0.33	-0.52	0.82	-22.48	0.28	-1.20	0.64	-25.60
	90	0.25	0.15	1.14	-15.89	0.22	-0.37	0.79	-19.29	0.19	-0.94	0.58	-22.63
LRP + Synthetic short put	100	-0.00	-0.59	0.87	-22.53	-0.16	-1.40	0.69	-25.64	-0.33	-2.22	0.56	-28.70
	95	-0.58	-0.83	0.72	-20.51	-0.76	-1.61	0.53	-23.87	-0.95	-2.42	0.41	-27.19
	90	-0.98	-1.08	0.46	-17.46	-1.17	-1.77	0.32	-21.06	-1.38	-2.50	0.23	-24.62
LRP + Put spread	100	0.12	-0.48	0.85	-12.69	0.41	-0.83	0.74	-12.78	0.75	-1.14	0.67	-12.82
	95	0.02	-0.23	0.91	-13.64	0.21	-0.64	0.73	-14.05	0.45	-1.02	0.62	-14.24
	90	-0.01	-0.11	0.93	-12.89	0.11	-0.49	0.69	-13.95	0.27	-0.85	0.54	-14.53
Long put (short hedge)	100	-0.76	-1.35	0.02	-1.89	-0.11	-1.35	0.02	-1.89	0.54	-1.35	0.02	-1.89
	95	-0.68	-0.93	0.04	-1.36	-0.07	-0.93	0.04	-1.36	0.55	-0.93	0.04	-1.36
	90	-0.55	-0.65	0.07	-1.02	-0.05	-0.65	0.07	-1.03	0.48	-0.64	0.08	-1.03
Short futures (short hedge)	100	-0.74	-1.34	0.71	-28.85	-0.83	-2.07	0.60	-32.90	-0.92	-2.81	0.52	-37.01
	95	-0.84	-1.09	0.82	-33.93	-0.93	-1.79	0.73	-38.36	-1.03	-2.51	0.66	-42.87
	90	-0.91	-1.01	0.86	-38.58	-1.02	-1.61	0.80	-43.44	-1.13	-2.25	0.74	-48.38

Note: Each row reports equal-weighted averages across endorsement observations, each simulated with 1,000 Monte Carlo price paths. NPVs are in dollars per cwt. ΔNPV is the mean difference relative to LRP-only. Ω is the Omega ratio of the strategy's incremental revenue vs. LRP (values below 1 indicate expected losses exceed gains). ES5($\Delta\pi$) is the 5th-percentile expected shortfall of the revenue difference vs. LRP including all trading costs, measuring worst-case tail loss after frictions.

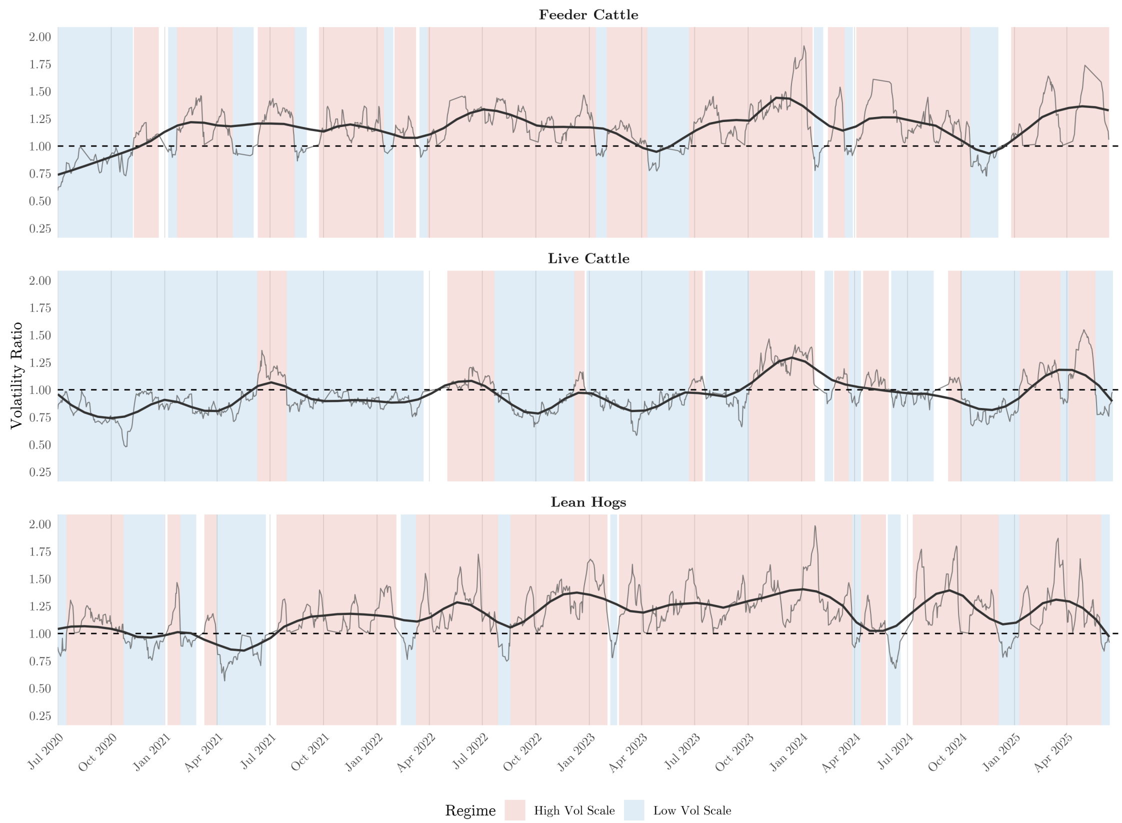
Table 8: Simulation Results: Lean Hogs ($/cwt)

		$\xi = 0.9$				$\xi = 1.0$				$\xi = 1.1$			
Strategy	**Cov**	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)
LRP only	100	0.68	0.00	–	0.00	1.28	0.00	–	0.00	1.87	0.00	–	0.00
	95	0.51	0.00	–	0.00	1.09	0.00	–	0.00	1.67	0.00	–	0.00
	90	0.31	0.00	–	0.00	0.82	0.00	–	0.00	1.34	0.00	–	0.00
LRP + Short put	100	0.78	0.09	1.04	-18.63	0.72	-0.56	0.84	-21.02	0.66	-1.22	0.70	-23.34
	95	0.82	0.31	1.15	-17.03	0.78	-0.31	0.89	-19.48	0.73	-0.93	0.72	-21.86
	90	0.65	0.35	1.23	-15.01	0.63	-0.19	0.91	-17.53	0.60	-0.74	0.70	-19.97
LRP + Synthetic short put	100	0.23	-0.45	0.88	-19.39	0.09	-1.19	0.69	-21.92	-0.06	-1.93	0.57	-24.38
	95	0.21	-0.30	0.90	-17.80	0.09	-1.00	0.68	-20.37	-0.04	-1.70	0.54	-22.86
	90	-0.02	-0.32	0.83	-15.82	-0.13	-0.95	0.60	-18.45	-0.24	-1.59	0.45	-21.01
LRP + Put spread	100	0.30	-0.38	0.81	-5.95	0.74	-0.54	0.74	-5.95	1.20	-0.67	0.69	-5.95
	95	0.25	-0.26	0.84	-6.51	0.61	-0.47	0.74	-6.52	1.01	-0.66	0.66	-6.52
	90	0.13	-0.17	0.86	-6.76	0.41	-0.40	0.71	-6.78	0.73	-0.61	0.61	-6.78
Long put (short hedge)	100	-0.65	-1.33	0.02	-1.54	-0.06	-1.33	0.02	-1.54	0.54	-1.33	0.02	-1.55
	95	-0.62	-1.13	0.02	-1.29	-0.05	-1.13	0.02	-1.29	0.54	-1.13	0.02	-1.29
	90	-0.55	-0.85	0.02	-1.04	-0.04	-0.85	0.02	-1.04	0.49	-0.85	0.02	-1.04
Short futures (short hedge)	100	-0.55	-1.23	0.69	-27.97	-0.62	-1.89	0.59	-32.07	-0.69	-2.56	0.51	-36.28
	95	-0.40	-0.91	0.81	-30.52	-0.45	-1.54	0.71	-34.80	-0.51	-2.18	0.63	-39.19
	90	-0.47	-0.77	0.86	-33.05	-0.53	-1.35	0.78	-37.51	-0.59	-1.94	0.72	-42.10

Note: Each row reports equal-weighted averages across endorsement observations, each simulated with 1,000 Monte Carlo price paths. NPVs are in dollars per cwt. ΔNPV is the mean difference relative to LRP-only. Ω is the Omega ratio of the strategy's incremental revenue vs. LRP (values below 1 indicate expected losses exceed gains). ES5(Δπ) is the 5th-percentile expected shortfall of the revenue difference vs. LRP including all trading costs, measuring worst-case tail loss after frictions.

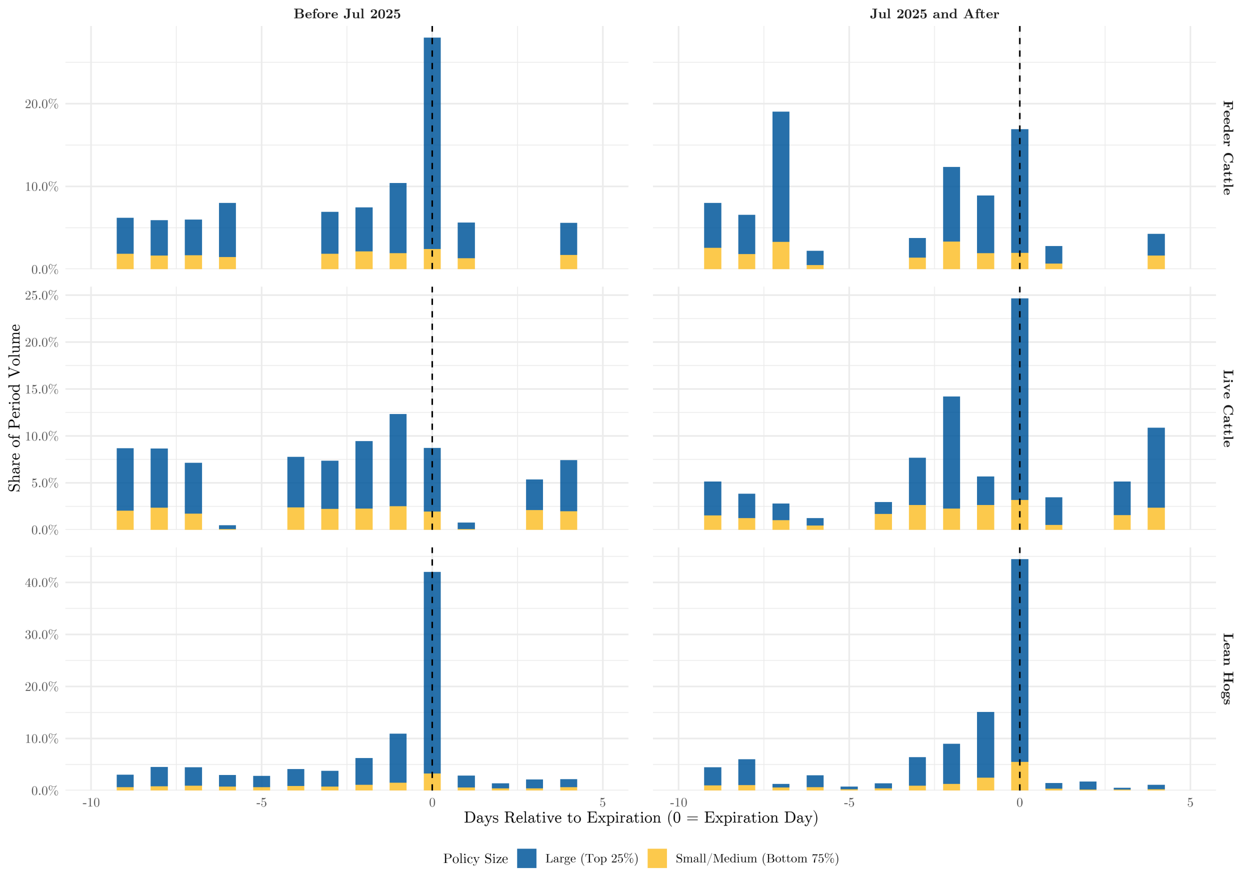
Appendix: Figures and Tables

Figure A.1: Daily Realized-to-Implied Volatility Ratio by Commodity (ξ)



Note: This figure plots the daily volatility ratio $\xi_t = \sigma_t^{\text{realized}}/\sigma_t^{\text{implied}}$ for each commodity over the study period (July 2020-June 2025). The thin gray line shows the daily series, and the bold black curve provides a smoothed visual summary of the underlying pattern over time. The dashed horizontal line $\xi = 1$ separates periods in which realized volatility is below implied volatility ($\xi < 1$) from periods in which realized volatility exceeds implied volatility ($\xi > 1$). Unshaded regions indicate days for which the volatility ratio is not available, most commonly due to contract-roll adjustments or insufficient valid near-ATM options data.

Figure A.2: LRP Endorsement Clustering Before vs. After July 2025



Note: Each bar represents the share of that period's total insured weight (CWT) falling on a given day relative to the nearest CME option expiration, measured on the LRP end date. Bars are stacked by policy size (top 25% vs. bottom 75% of insured weight within each commodity). Day 0 marks the CME option's last trade date. The split date is July 1, 2025, corresponding to the effective date of RMA's LRP handbook language update restricting subsidy capture. The left panels show endorsements with sales effective dates from July 2020 through June 2025; the right panels show July 2025–February 2026.

Table A.1: Calibrated Parameters by Commodity

	Feeder Cattle	**Live Cattle**	**Lean Hogs**
Margin and Trading Costs			
Initial margin, M_{init} (\$/cwt)	12.00	8.25	4.25
Spread intercept, β_0 (\$/cwt)	0.0043	0.0031	0.0103
Spread slope, β_1	0.0095	0.0138	0.0071
Spread floor (\$/cwt)	0.0125	0.0125	0.0125

Note: Initial margin from CME margin requirements (Feeder: $6,000/500 cwt; Live: $3,300/400 cwt; Lean hogs: $1,700/400 cwt). Spread coefficients estimated via Corwin and Schultz (2012) from CME Globex high/low data, 2020-2025.

Table A.2: Empirical Volatility Scale (ξ) and Sample Size by Commodity and Regime

	Low Volatility ($\xi < 1$)	High Volatility ($\xi > 1$)	Pooled (All Observations)
Feeder Cattle			
Mean	0.90	1.27	1.19
Median	0.91	1.22	1.18
Min	0.62	1.00	0.62
Max	0.99	1.92	1.92
Mean insured weight (cwt)	1,257	1,121	1,151
N	1,539	5,569	7,108
Live Cattle			
Mean	0.87	1.18	0.98
Median	0.88	1.13	0.94
Min	0.62	1.01	0.62
Max	1.00	1.55	1.55
Mean insured weight (cwt)	2,400	2,048	2,272
N	1,291	732	2,023
Lean Hogs			
Mean	0.86	1.27	1.19
Median	0.90	1.24	1.19
Min	0.57	1.00	0.57
Max	0.99	1.92	1.92
Mean insured weight (cwt)	7,916	6,141	6,457
N	389	1,801	2,190

Note: $\xi = \sigma_{\text{realized}}/\sigma_{\text{implied}}$. Low Volatility: a low regime in which endorsements are purchased when $\xi < 1$. High Volatility: a high regime in which endorsements are purchased when $\xi > 1$. Pooled: all endorsements with valid ξ, weighted by the number of observations within each regime.

Table A.3: Feeder Cattle: Simulation Results by Empirical Volatility Regime ($/cwt)

		Low Regime ($\xi_{\text{low}} = 0.90$)				Pooled ($\xi_{\text{pooled}} = 1.19$)				High Regime ($\xi_{\text{high}} = 1.27$)			
Strategy	**Cov**	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)
LRP only	100	1.07	0.00	–	0.00	2.78	0.00	–	0.00	4.58	0.00	–	0.00
	95	0.43	0.00	–	0.00	2.42	0.00	–	0.00	3.54	0.00	–	0.00
	90	-0.09	0.00	–	0.00	2.24	0.00	–	0.00	3.16	0.00	–	0.00
LRP + Short put	100	0.98	-0.09	1.08	-27.59	1.07	-1.71	0.83	-35.02	1.17	-3.42	0.57	-42.89
	95	0.58	0.15	1.14	-25.55	0.54	-1.88	0.74	-34.61	0.52	-3.03	0.52	-39.74
	90	0.28	0.37	1.26	-19.53	-0.10	-2.33	0.70	-35.13	-0.24	-3.41	0.47	-41.35
LRP + Synthetic short put	100	0.56	-0.51	0.92	-28.21	0.49	-2.29	0.71	-35.87	0.41	-4.17	0.49	-43.98
	95	-0.30	-0.73	0.82	-26.71	-0.58	-3.00	0.54	-36.07	-0.74	-4.28	0.38	-41.38
	90	-0.51	-0.42	0.80	-20.49	-1.34	-3.57	0.47	-36.76	-1.66	-4.83	0.33	-43.24
LRP + Put spread	100	0.52	-0.55	0.90	-14.46	1.74	-1.04	0.79	-14.95	3.03	-1.55	0.66	-15.47
	95	0.16	-0.26	0.97	-16.49	1.19	-1.23	0.71	-17.56	1.77	-1.77	0.56	-18.17
	90	-0.11	-0.02	1.06	-15.29	0.81	-1.43	0.66	-17.56	1.18	-1.99	0.51	-18.46
Long put (short hedge)	100	-0.88	-1.95	0.17	-5.97	0.61	-2.16	0.14	-6.07	2.19	-2.39	0.11	-6.18
	95	-0.87	-1.29	0.17	-4.09	1.07	-1.34	0.17	-4.35	2.17	-1.37	0.18	-4.49
	90	-0.86	-0.77	0.22	-3.05	1.60	-0.64	0.37	-3.99	2.58	-0.59	0.43	-4.36
Short futures (short hedge)	100	-0.78	-1.85	0.70	-37.37	-0.92	-3.70	0.56	-48.13	-1.07	-5.65	0.41	-59.52
	95	-0.83	-1.26	0.85	-44.24	-1.01	-3.42	0.69	-58.02	-1.10	-4.65	0.61	-65.83
	90	-0.80	-0.71	0.92	-41.78	-1.07	-3.30	0.76	-65.21	-1.17	-4.34	0.70	-74.55

Note: Each row reports equal-weighted averages across endorsement observations, each simulated with 1,000 Monte Carlo price paths. NPVs are in dollars per cwt. ΔNPV is the mean difference relative to LRP-only. Ω is the Omega ratio of the strategy's incremental revenue vs. LRP (values below 1 indicate expected losses exceed gains). ES5(Δπ) is the 5th-percentile expected shortfall of the revenue difference vs. LRP including all trading costs, measuring worst-case tail loss after frictions. Low regime: endorsements purchased when $\xi < 1$. High regime: endorsements with $\xi > 1$. Pooled: all endorsements with valid ξ, weighted by the number of observations within each regime. $\xi = \sigma_{\text{realized}}/\sigma_{\text{implied}}$, reported in parentheses, are the mean empirical volatility ratios within each regime. Each endorsement is simulated at its own ξ.

Table A.4: Live Cattle: Simulation Results by Empirical Volatility Regime ($/cwt)

		Low Regime ($\xi_{\text{low}} = 0.87$)				Pooled ($\xi_{\text{pooled}} = 0.98$)				High Regime ($\xi_{\text{high}} = 1.18$)			
Strategy	**Cov**	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)	**Mean NPV**	**ΔNPV**	Ω	**ES5**(Δπ)
LRP only	100	0.41	0.00	–	0.00	1.16	0.00	–	0.00	2.49	0.00	–	0.00
	95	0.06	0.00	–	0.00	0.83	0.00	–	0.00	2.10	0.00	–	0.00
	90	-0.10	0.00	–	0.00	0.65	0.00	–	0.00	1.86	0.00	–	0.00
LRP + Short put	100	0.58	0.17	1.14	-19.88	0.47	-0.69	0.95	-24.15	0.29	-2.21	0.62	-31.74
	95	0.39	0.32	1.30	-17.40	0.32	-0.51	1.03	-21.94	0.20	-1.89	0.57	-29.51
	90	0.27	0.37	1.51	-14.00	0.21	-0.44	1.12	-19.10	0.10	-1.77	0.48	-27.44
LRP + Synthetic short put	100	0.10	-0.32	0.99	-20.55	-0.17	-1.33	0.81	-25.09	-0.65	-3.14	0.50	-33.16
	95	-0.45	-0.52	0.87	-18.44	-0.76	-1.59	0.67	-23.34	-1.28	-3.37	0.34	-31.50
	90	-0.79	-0.69	0.67	-15.32	-1.21	-1.86	0.48	-20.96	-1.91	-3.77	0.17	-30.18
LRP + Put spread	100	0.06	-0.35	0.90	-12.29	0.45	-0.72	0.81	-12.67	1.13	-1.36	0.65	-13.34
	95	-0.02	-0.08	1.04	-12.78	0.27	-0.56	0.86	-13.58	0.74	-1.36	0.58	-14.91
	90	-0.04	0.06	1.18	-11.71	0.19	-0.45	0.91	-13.01	0.57	-1.29	0.48	-15.14
Long put (short hedge)	100	-0.88	-1.30	0.02	-1.91	-0.18	-1.34	0.02	-1.88	1.08	-1.41	0.02	-1.84
	95	-0.81	-0.88	0.04	-1.42	-0.09	-0.91	0.04	-1.36	1.12	-0.98	0.05	-1.25
	90	-0.74	-0.64	0.08	-1.13	0.00	-0.65	0.09	-1.04	1.21	-0.66	0.10	-0.89
Short futures (short hedge)	100	-0.62	-1.03	0.78	-26.30	-0.82	-1.98	0.67	-32.36	-1.18	-3.67	0.47	-43.14
	95	-0.74	-0.80	0.87	-31.26	-0.92	-1.74	0.77	-37.91	-1.22	-3.32	0.61	-48.98
	90	-0.79	-0.69	0.90	-35.32	-1.04	-1.69	0.82	-43.53	-1.45	-3.32	0.68	-56.96

Note: Each row reports equal-weighted averages across endorsement observations, each simulated with 1,000 Monte Carlo price paths. NPVs are in dollars per cwt. ΔNPV is the mean difference relative to LRP-only. Ω is the Omega ratio of the strategy's incremental revenue vs. LRP (values below 1 indicate expected losses exceed gains). ES5(Δπ) is the 5th-percentile expected shortfall of the revenue difference vs. LRP including all trading costs, measuring worst-case tail loss after frictions. Low regime: endorsements purchased when $\xi < 1$. High regime: endorsements with $\xi > 1$. Pooled: all endorsements with valid ξ, weighted by the number of observations within each regime. $\xi = \sigma_{\text{realized}}/\sigma_{\text{implied}}$, reported in parentheses, are the mean empirical volatility ratios within each regime. Each endorsement is simulated at its own ξ.

Table A.5: Lean Hogs: Simulation Results by Empirical Volatility Regime ($/cwt)

		Low Regime ($\xi_{\text{low}} = 0.86$)				Pooled ($\xi_{\text{pooled}} = 1.19$)				High Regime ($\xi_{\text{high}} = 1.27$)			
Strategy	**Cov**	**Mean NPV**	**ΔNPV**	Ω	**ES5**($\Delta\pi$)	**Mean NPV**	**ΔNPV**	Ω	**ES5**($\Delta\pi$)	**Mean NPV**	**ΔNPV**	Ω	**ES5**($\Delta\pi$)
LRP only	100	0.47	0.00	–	0.00	2.30	0.00	–	0.00	2.81	0.00	–	0.00
	95	0.29	0.00	–	0.00	1.83	0.00	–	0.00	2.34	0.00	–	0.00
	90	0.41	0.00	–	0.00	1.70	0.00	–	0.00	1.93	0.00	–	0.00
LRP + Short put	100	0.90	0.43	1.25	-18.10	0.58	-1.72	0.71	-24.80	0.49	-2.33	0.56	-26.69
	95	0.93	0.64	1.47	-16.29	0.69	-1.14	0.80	-22.33	0.62	-1.72	0.58	-24.29
	90	0.84	0.43	1.45	-14.88	0.55	-1.15	0.70	-21.40	0.50	-1.43	0.57	-22.56
LRP + Synthetic short put	100	0.37	-0.10	1.07	-18.88	-0.21	-2.51	0.58	-26.03	-0.37	-3.19	0.45	-28.05
	95	0.37	0.08	1.18	-16.96	-0.11	-1.95	0.62	-23.41	-0.27	-2.60	0.43	-25.50
	90	0.15	-0.26	1.04	-15.60	-0.36	-2.06	0.47	-22.56	-0.45	-2.38	0.37	-23.80
LRP + Put spread	100	0.20	-0.27	0.87	-6.02	1.57	-0.73	0.69	-5.93	1.96	-0.85	0.64	-5.90
	95	0.18	-0.11	0.96	-6.47	1.15	-0.68	0.68	-6.54	1.47	-0.87	0.59	-6.56
	90	0.31	-0.10	0.96	-6.70	0.98	-0.72	0.60	-6.83	1.10	-0.83	0.53	-6.85
Long put (short hedge)	100	-0.96	-1.43	0.02	-1.63	0.98	-1.32	0.03	-1.53	1.53	-1.29	0.03	-1.50
	95	-0.92	-1.21	0.00	-1.37	0.72	-1.11	0.02	-1.28	1.25	-1.08	0.03	-1.24
	90	-0.61	-1.02	0.00	-1.23	0.87	-0.83	0.02	-1.03	1.14	-0.79	0.03	-0.99
Short futures (short hedge)	100	-0.52	-1.00	0.77	-27.28	-0.75	-3.05	0.50	-39.60	-0.82	-3.63	0.42	-43.08
	95	-0.38	-0.67	0.88	-29.33	-0.56	-2.39	0.64	-40.48	-0.61	-2.95	0.56	-44.10
	90	-0.54	-0.94	0.84	-33.84	-0.64	-2.34	0.69	-45.36	-0.66	-2.59	0.66	-47.42

Note: Each row reports equal-weighted averages across endorsement observations, each simulated with 1,000 Monte Carlo price paths. NPVs are in dollars per cwt. ΔNPV is the mean difference relative to LRP-only. Ω is the Omega ratio of the strategy's incremental revenue vs. LRP (values below 1 indicate expected losses exceed gains). ES5($\Delta\pi$) is the 5th-percentile expected shortfall of the revenue difference vs. LRP including all trading costs, measuring worst-case tail loss after frictions. Low regime: endorsements purchased when $\xi < 1$. High regime: endorsements with $\xi > 1$. Pooled: all endorsements with valid ξ, weighted by the number of observations within each regime. $\xi = \sigma_{\text{realized}}/\sigma_{\text{implied}}$, reported in parentheses, are the mean empirical volatility ratios within each regime. Each endorsement is simulated at its own ξ.