# Optimal Marketing Strategies for Southeastern Cattle Producers

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### Background

It is no secret that commodity prices have become increasingly volatile. The higher level of volatility has led to more interest – at least at the surface – in ways to reduce risk by producers that we interact with. There are a number of tools available to producers which allow for the transfer of price risk, but as previous research has shown few take advantage of these tools (see, Hall et al.; Sartwelle et al.; Schroeder et al.; Goodwin and Schroeder). This body of literature finds that the reasons for a producer's lack of use of price risk management tools include: a general lack of knowledge of the products, the costs associated with using the products, and belief that risk management tools do not effectively reduce overall risk or stabilize income. A unique characteristic to southeastern cow/calf production as mentioned previously is the small operation sizes which do not conform to most price risk minimizing products, most notably feeder cattle futures contracts due to its strict weight specifications. This partially explains why less than 5% of operations forward price[1] feeder cattle (USDA APHIS 2008). Of those producers who are using forward pricing methods, approximately two-thirds of the calf crop is forward priced (USDA APHIS 2008). Further complicating the situation is that significant changes in the cost of production have occurred for cow/calf producers. Changes in the costs of cattle production have partially resulted from the growing importance of biofuel production in the U.S. As a result, the demand for corn, fuel, and fertilizer have increased. These are inputs to cow/calf producers and thus they have largely had to absorb the increased costs of production at the same time as the demand for beef has been declining[2]. Collectively, as a result of these events, producers have had to become more skilled at marketing their calf crops.

Although marketing alternatives available to cattle producers remain limited, the number has increased in recent years (for example, in 2000 USDA released an insurance product for feeder cattle). However, according to the 2007-08 National Animal Health Monitoring Survey (NAHMS) a majority of producers still employ auction barns as their primary marketing outlet (USDA APHIS 2010). This is largely due to the size of the cow/calf operation since this often limits a producer's ability to take advantage of alternative markets. Given the increased volatility in both input and output prices for southeastern US cow/calf producers and the limited marketing options afforded them, the purpose of this study is to determine the optimal time that a southeastern cattle producer should offset price risk.

### Previous Literature

From 1998 to 2001, the Chicago Mercantile Exchange (CME) offered a stocker cattle futures contract for steers weighing 500 to 599 pounds. Although the specifications of this contract fit closely with the type and number of cattle sold by southeastern producers – the contract would require approximately 42 to 50 head of steers to meet the 25,000 pound specification –it is no longer offered by the CME because of lack of trade volume. The lack of volume is another

[1] NAHMS defines forward pricing as a way for cattle sellers and buyers to contract a price in advance of an expected sales date and does include forward cash contracts, futures contracts and options contracts.

[2] Beef demand has declined since 1980 excluding a slight increase in the early 2000s partly as a result of the Atkins Diet and other positive media information (Tonsor, Schroeder and Mintert).

example of producers' unwillingness to utilize risk mitigating products. Now, producers interested in managing price risk are left with using feeder cattle contracts to cross hedge cattle. While cross hedging is a way to minimize risk while still conforming to the contract specifications (Anderson and Danthine; Elam and Davis), cow/calf producers still face residual risk since there is not a 1:1 relationship in the movement of the futures price and the cash price of off-weight cattle. Coffey, Anderson, and Parcell state cross hedging can be an effective price risk management strategy, but differences in the level of hedging risk are present. The location of the spot market impacts the relationship between the futures prices and cash price of off-weight cattle (Schroeder and Mintert; Elam; Elam and Davis). The level of risk that is present also varies by contract month and market location (Coffey, Anderson, and Parcell).

Based on the framework that surrounds hedging, the price received for the cash transaction is of little interest to the individuals hedging feeder cattle (Witt, Schroeder, and Hayenga) while concern with ending basis risk is of greater importance (Buhr). Variability in the basis has been shown to be smaller than variability in price and thus the reason that hedging is effective at reducing price risk. Fluctuations in the basis may result in a lower net price when hedging, but typically will provide a more stable return compared to selling in the local cash market. For risk averse producers, this may be acceptable, especially if the producer raises quality cattle and would generally sell calves in the spot market with a limited number of buyers who are more concerned with assembling a load of cattle regardless of quality (Gillespie, Basarir, and Schupp). Basis for cattle produced in the southeastern U.S. has been highly variable in recent years due to changes in transportation costs, droughts, and regional differences in supply and demand conditions. This has led to a further reduction in the ability of southeastern cow/calf producers to offset price risk in the futures and options markets beyond the reasons listed previously. Another component in determining the final price received for cattle using a forward pricing mechanism is the market timing decision. Muth et al. found that forward contracted prices for fed cattle tended to be lower than direct trade or auction barn prices, likely due to the price being agreed upon in advance of delivery. While a forward cash contract eliminates basis risk, forward fed cattle contract prices were estimated to be lower than with a futures hedge (Elam). Similar relationships are expected with stocker or feeder cattle that are forward cash contracted.

Auction barns are the dominant marketing method in the southeastern U.S. due in part to the size of beef cattle operations in the region. These operations are often tradition oriented in their marketing and management practices and are reluctant to change these practices. Therefore, the majority of operations calve in the spring months. By early to mid spring, producers have formed expectations on the number and weight of calves that will be marketed in the fall. These expectations are a result of information from previous years, current pasture conditions and the future outlook on prices. Producers' price expectations for the fall time period are shaped by feeder cattle futures contract prices from the Chicago Mercantile Exchange which are transparent and efficient. Known, historical basis[3] patterns help refine the price expectations to the area in which the producer markets the annual calf crop. Furthermore, Tonsor, Dhuyvetter, and Mintert found that incorporating current information into feeder cattle basis forecasts improved accuracy up to a 12 week planning horizon. Beyond that time frame, producers did not significantly benefit from including current information into forecasts.

[3] Basis is defined as cash price minus futures price for the month closest to delivery date.

For a producer choosing to market cattle in local auctions, expected returns to the operation may be projected throughout the spring and summer months due to information from the futures market combined with their expected costs of production being known prior to the calf crop being marketed. Other marketing alternatives reduce the amount of price risk a producer is exposed to as prices are determined in advance of delivery date due to the use of forward contracting, hedging, or options. These marketing alternatives result in additional costs to the producer, but provide more certainty regarding the price received for the calf crop. Historical information kept by the operation aid the producer in rationally forming expectations of many of the variables that influence net returns to the cow/calf operation. This information includes the average number of calves to be marketed, expected weight at time of marketing, and expected sales date. For producers that forward price cattle, the slide is known in advance of the sales date should the cattle not conform to the written contract.

## Data and Methods

Prices from the Chicago Mercantile Exchange's feeder cattle futures contract are used as the forward contract price since futures markets are transparent and efficient. Cash prices are from USDA AMS' weekly livestock summary report for the states of Louisiana and Mississippi from January 2006 to August 2010. Cost of production data are from USDA ERS's Commodity Cost and Return Data for Cow/Calf operations in the Mississippi Portal region. Calf death loss and pounds of calf weaned per cow are from USDA NASS's annual Cattle Inventory report.

Futures prices change from time of hedge being placed to the final sale date and ending basis are calculated using the May feeder cattle futures contract. Therefore:

(1) $\Delta f = f_t - f_{t-i}$

and

(2) $EB_i = c_{it} - f_t$

where, $\Delta f$ , is the change in the May futures price from time of hedge placement ($f_{t-i}$) to final sale date ($f_t$) where, *i*, is the number of weeks prior to the sale date that the hedge is placed. The final sale date is assumed to occur in the week closest to May 5, and hedging decisions are made any week from calving to the final sale date. Calf death loss is determined from the annually reported number if calves lost divided by the total number of calves reported in each state. Pounds of calf weaned is the total production divided by the total number of cows reported in each state.

The simulation procedure follows Anderson, Harri and Coble which uses the Phoon, Quek and Huang (PQH) method. The PQH simulation method is a distribution free technique and allows for the correlations of the variable to remain intact. Specifically, the procedure uses the Karhunen-Loeve (KL) expansion technique to simulate correlated standard normal deviates. These deviations are used as probabilities in the desired distribution which can take any form. The PQH procedure is:

(3) $\omega_k = \bar{\omega}_k + \sum_k \sqrt{\lambda_k} \xi_k(\theta) f_k(x)$

where, $\omega_k$, is the KL expansion of a Gaussian process with a mean, $\overline{\omega}_k$. Eigenvalues and eigenvectors of the Pearson correlation matrix are represented by $\lambda_k$ and $f_k(x)$, and $\xi_k(\theta)$ is a matrix of randomly generated standard normal deviates of size *n* x *k*, where *n* is the number of variables in the correlation matrix and *k* is the number of simulated deviates.

The simulated variables are the price and production data previously mentioned to determine the total profit per cow for a 100 cow operation. The profit equation is:

(4) $$\pi = Q_c P_c - C + Q_{fc}^*(f_0 - f_1)$$

where, Qc and Pc are the total quantity of calves sold and Pc is the cash selling price, respectively. Total cost is defined as *C* and the gains or losses from the hedge are represented by $Q^*_{fc}(f_0\text{-}f_1)$ with, $Q_{fc}$ , being the CME specified quantity of 50,000 pounds, $f_0$ is the selling price of the feeder cattle futures contract and, $f_1$, is the purchase price of the feeder cattle futures contract.

A producer is assumed to have the option to market the calf crop under four scenarios: using a cash forward contract, a feeder cattle futures contract, a put option or not hedging and selling through a local auction barn. The percentage of the calf crop that is hedged is variable. Following Harri et al. (2009), the expected utility framework is employed to capture the producers' risk aversion level in modeling the optimal marketing decision. End of period wealth is used to determine ending utility. End of period wealth is defined as:

(5) $$W_E = W_S + Q_c P_c - C + Q_{fc}^*(f_0 - f_1)$$

where $W_E$ is the ending total wealth, $W_S$ is starting wealth, and the remaining variables are defined from equation (4). If a producer chooses to market his cattle through a spot market only, ending wealth collapses to $W_E = W_S + Q_c P_c - C$.

Under this framework, the producer maximizes expected utility according to a von Neumann-Morgenstern utility function defined over ending wealth, $W_E$, which is strictly increasing, concave, and twice differentiable. For the utility maximizing producer who hedges a portion of their cash product across various hedge durations, their objective function is:

(6) $$\max_{m,Q_c^*} EU = W_S + Q_c P_c - \overline{C} + Q_c^*(f_m - f_1 - tc)$$

where $f_m$ replaces $f_0$ as the initial futures price and *m* is the point in time that a hedge is initiated and is allowed to vary across the production process.

An ending wealth value is calculated for each hedging decision across each of the 10,000 price and production outcomes. Ending wealth is then converted into utility values using a constant relative risk aversion (CRRA) utility function. The general form of the CRRA utility function is as follows:

(7) $$E(U)_r = \sum_{i=1}^{n} \frac{1}{n} \frac{W_i^{1-r}}{1-r}, \quad r \neq 1$$

or

(8) $$E(U)_r = \sum_{i=1}^{n} \frac{1}{n} \ln(W_i), \quad r = 1$$

where $W_i$ is ending wealth for period *i*, *r* is a risk aversion coefficient, and *n* is the total number of observations (10,000). Utility values are calculated for risk aversion coefficients of 1, indicating a slightly risk averse producer, and four, indicating a very risk averse producer, with initial wealth set, exogenously, at $10,000.

For a certain level of utility and a given risk aversion coefficient, it is possible to calculate a certainty equivalent (CE) by solving equation (7) or (8) for $W_i$. The CE represents the highest sure payment a decision maker would be willing to take to avoid a risky outcome. For any two alternatives *i* and *j*, if $CE_i > CE_j$, then alternative *i* is preferred to *j*. Therefore, the optimal hedge ratio under any given pricing option can be taken to be that which results in the highest CE. The equations for calculating the CE from the CRRA utility functions used here are:

(9) $$CE_r = [\overline{U}(1-r)]^{\left(\frac{1}{1-r}\right)} - W_0, \quad r \neq 1$$

or

(10) $$CE_r = e^{\overline{U}} - W_0, \quad r = 1$$

where $\overline{U}$ is a value for utility calculated from euation (7) or (8). The process of calculating the CE is repeated for each hedge option. Once the CE's are reported, a search for the highest CE value determines the optimal marketing alternative.

**Results**

Results discussed here a based on a representative cow/calf producer that calves in the Fall (approximately October 15) and sells calves the falling fall. The price and production data based on this scenario are used to simulate 10,000 correlated random outcomes. Table 1 provides the summary statistics for all 17 marketing strategies. The alternative providing the largest expected outcome was hedging calves six weeks prior to the final sale date. The alternative that had the least variability in returns was not placing a hedge. This is understandable given the issue facing most southeastern producers of not being able to fulfill a CME feeder cattle futures contract.

Figure 1 depicts the distribution of returns per cow across four different hedging alternatives. First, it is important to notice from figure 1 – and table 1 – that no marketing strategy provides a sure safety net where returns per cow are always positive. The strategy of not hedging the calf crop results in the lowest chance of observing negative returns. Use of hedging as a marketing strategy provides the highest profits in figure 1, but the downside risk present leads to greater possible losses than an unhedged producer. Finally, from figure 1, under the stochastic dominance framework, no marketing alternative is dominant in either the first- or second order.

Figure 2 and 3 show the certainty equivalents across all hedge timing scenarios. In both cases, the range of the CE's across the 17 marketing alternatives is small indicating only marginal trade-offs from one marketing strategy to another for this representative producer. For a producer with a risk aversion coefficient of one, the optimal time to hedge the calf crop is six weeks prior to the final sell date. Given the results shown in figure 1, this is understandable since a risk aversion coefficient of one indicates a producer that is more risk averse than one who has a coefficient of four. The results depicted in figure 2 indicate that some level of profit protection is desired.

Figure 1 revealed that the chances of negative profits are higher the further out a producer hedges their calf crop. It also indicates that higher profits are possible under this same scenario compared with not hedging. As a result, the optimal hedging time for a less risk averse producer is the furthest out analyzed in this study, 34 weeks prior to the final sale date (figure 3). Hedging that far in advance is not without its own risks due to the possibility of drought, increased feed costs, and greater than expected calf death loss that will result in a lower quantity of cattle sold than initially thought.

**Summary**

Southeastern cow/calf producers have typically been able to rely on the skills in animal production to offset any market risk. Recently, though, producers have had to become increasingly aware of market factors and the impact these have on their livelihood. Input costs and output price variability has forced producers to, at the very least, inquire about multiple marketing opportunities that might mitigate some of the risks they face. Although we find that the current dominant strategy of not hedging – i.e., locking in a price in advance of selling the cash cattle – provides the lowest volatility to returns it appears that strategies exist that also allow for higher expected returns while still being relatively low risk (As compared to not hedging). For the slightly risk averse and very risk averse producer all alternatives retuned roughly the same certainty equivalent.

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**Table 1.** Summary Statistics for Simulated Outcomes of Marketing Alternatives

| Date of Hedge Placement Relative to Final Sale Date | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| No Hedge | $36.89 | **$30.96** | -$109.57 | $129.31 |
| 2 weeks prior | $43.83 | $34.15 | -$114.61 | $146.41 |
| 4 weeks prior | $48.69 | $39.90 | -$108.23 | $183.96 |
| 6 weeks prior | **$52.99** | $44.95 | -$130.21 | $205.01 |
| 8 weeks prior | $52.56 | $49.62 | -$148.87 | $221.24 |
| 10 weeks prior | $47.51 | $50.29 | -$155.79 | $229.29 |
| 12 weeks prior | $47.89 | $48.98 | -$162.19 | $211.61 |
| 14 weeks prior | $39.67 | $53.99 | -$180.69 | $221.42 |
| 16 weeks prior | $28.20 | $49.31 | -$193.83 | $192.55 |
| 18 weeks prior | $33.99 | $58.25 | -$221.32 | $232.91 |
| 20 weeks prior | $32.24 | $58.54 | -$230.71 | $235.50 |
| 22 weeks prior | $21.19 | $57.62 | -$238.60 | $218.49 |
| 24 weeks prior | $16.01 | $67.23 | -$276.36 | $240.05 |
| 26 weeks prior | $6.81 | $62.79 | -$270.42 | $218.11 |
| 28 weeks prior | $7.91 | $69.93 | -$272.41 | $256.97 |
| 30 weeks prior | $5.78 | $67.86 | -$257.79 | $261.14 |
| 32 weeks prior | $1.17 | $72.97 | -$282.11 | $261.14 |
| 34 weeks prior | $1.07 | $76.10 | **-$298.67** | **$266.53** |

Note: The marketing alternative with the highest mean value, the lowest standard deviation, the lowest overall minimum value and the highest overall maximum value are in bold.

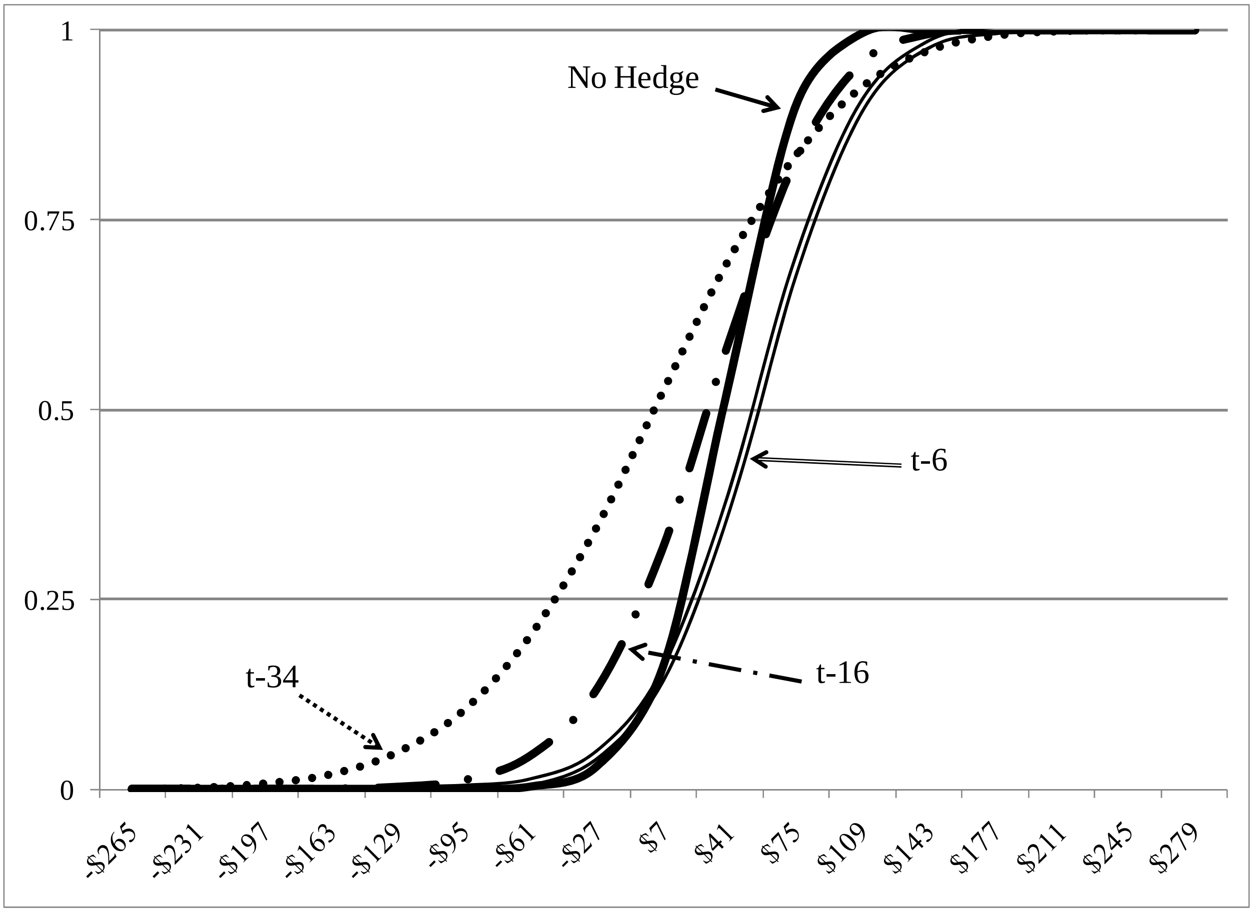


**Figure 1.** CDF of Returns per Cow across 10,000 Simulated Outcomes for Four Various Marketing Alternatives

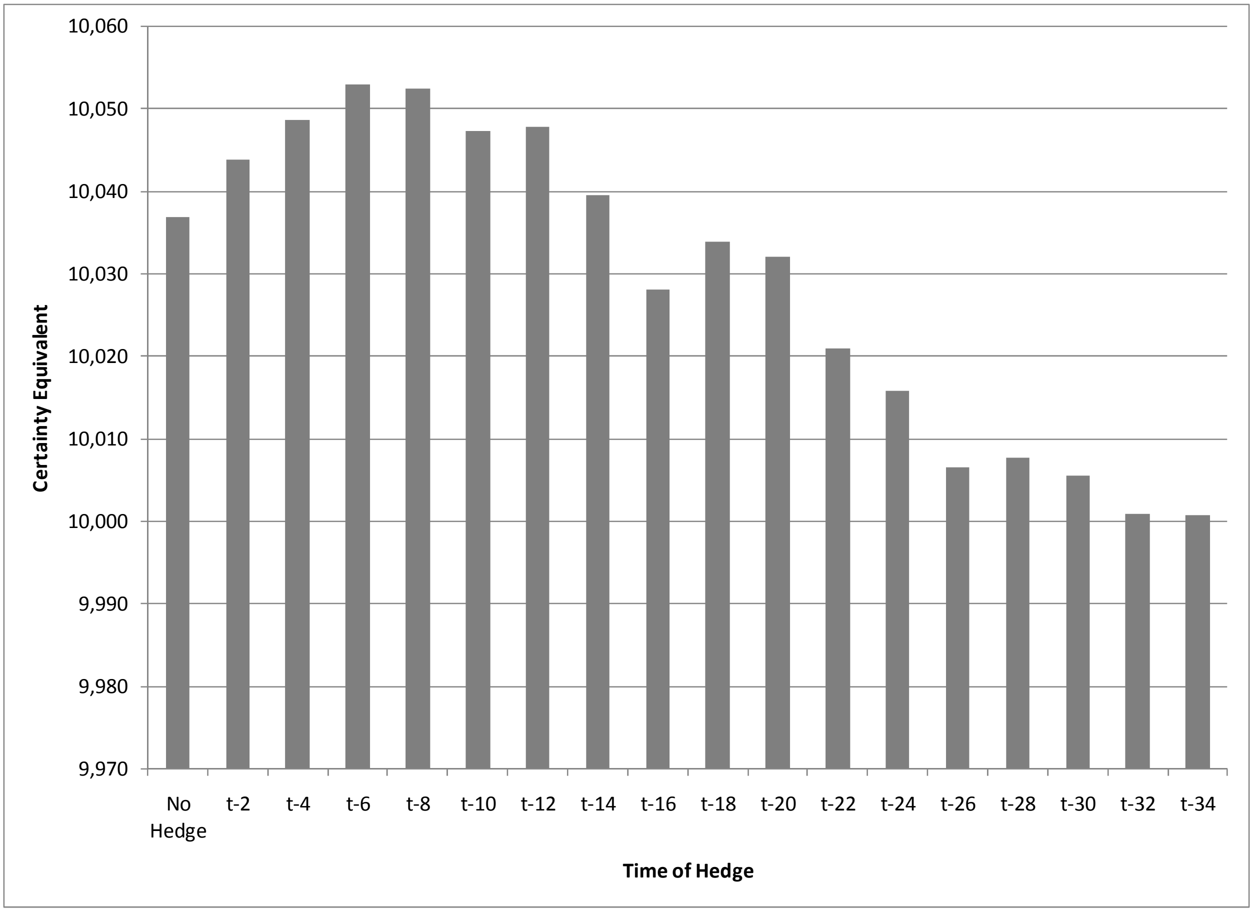


**Figure 2.** Certainty Equivalent for Each Hedging Decision, Risk Aversion = 1

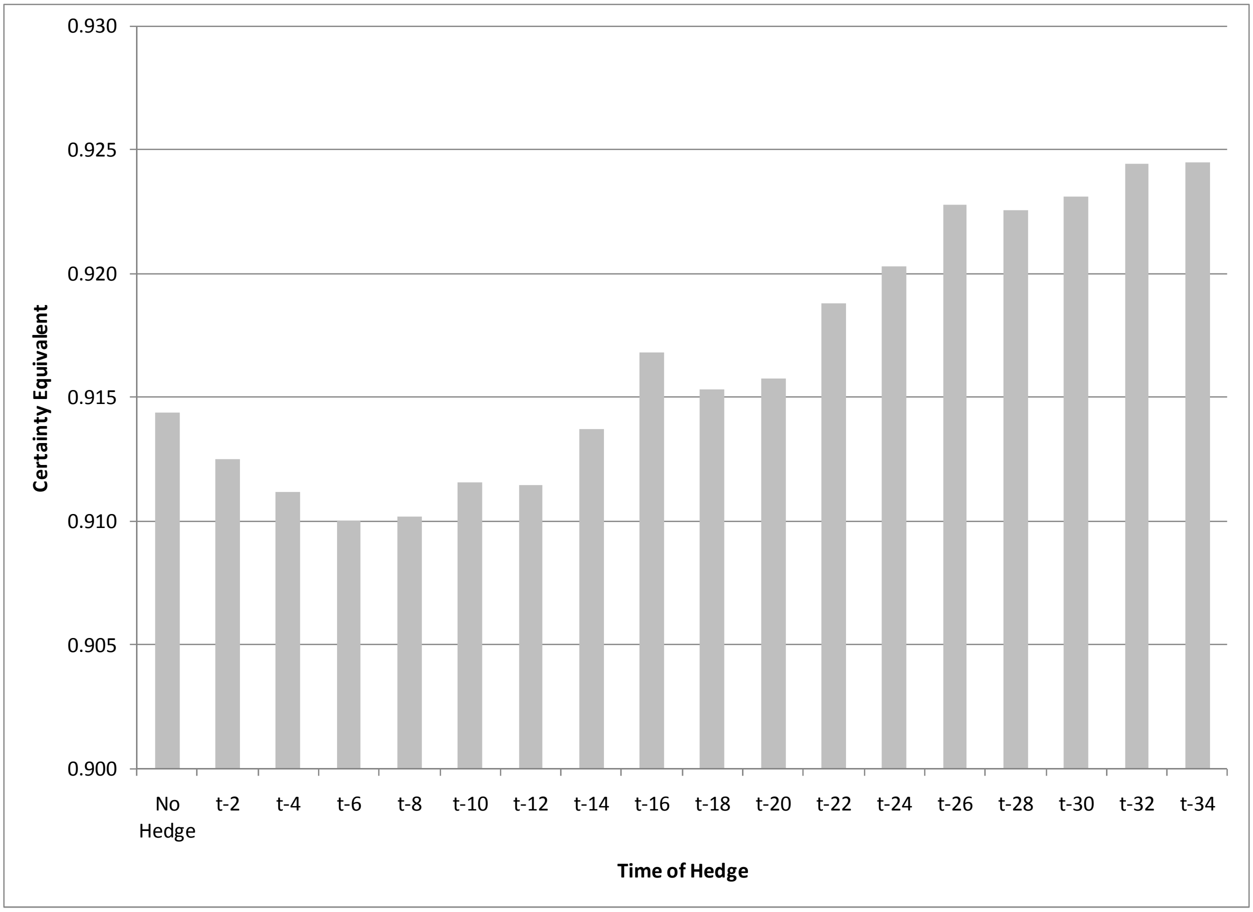


**Figure 3.** Certainty Equivalent for Each Hedging Decision, Risk Aversion = 4