Hedging Carcass Beef to Reduce the Short-Term Price Risk of Meat Packers

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Hedging in the live cattle futures market has largely been viewed as a method of reducing producer's price risk over a rather lengthy production period (three to six months). Meat packers and processors also face price risk. However, packers' and processors' price risk lies on the upside (i.e., risk is due to price increases) and is also relatively short-term (usually a few days). The possibility of reducing packers' and processors' price risk through long-hedging on the live cattle contract for a short period of time (one week) was investigated. The results suggest some potential benefits to meat packers from following a routine hedging strategy.

Meat packers face a different type of price risk than cattle feeders. Feeders are at risk that prices may decline during the production period. The price risk faced by feeders is also relatively long-term, stretching over a period of months between the initial production decision and the ultimate sale of the animals. Conversely, meat packers or processors usually contract to deliver their output at some future date. Thus, their price risk is that prices may increase between the signing of a contract and the purchase of the cattle. The price risk faced by processors is also often short-term since the period between contracting and purchasing cattle is often short. Even small adverse price changes in a large volume business with small margins such as meat packing may mean large losses; in this respect, packers face greater risks than cattle feeders.

These differences between the type of price risk faced by cattle feeders and meat packers are fundamental and raise questions concerning the ability of processors to successfully hedge forward sales for short periods of time. Most meat packers do not long-hedge live cattle as inputs into their operation. This may be due to packers believing that risks will be "evened out" over time since buying and selling is taking place on a daily basis. Also, most packers price their output off some published price list on the day of delivery [Early]. These variable price contracts pass most of the risk faced by meat packers on to the purchaser of the beef. This arrangement may be less desirable for buyers in the Hotel, Restaurant, and Institution (HRI) sector than if some set price were established some days previous to delivery. According to a recent Commodity Futures Trading Commission study, "Livestock processors interviewed predicted an increasing trend toward fixed price forward meat sales to institutions, particularly for beef products" (Commodity Futures Trading Commission, p. 120). Since setting price in advance appears to be favorably received by the HRI sector, strategies should be developed and analyzed to determine if a packer can enter fixed-price contracts with buyers and still manage the price risks involved. If it were possible to set price in advance and still manage price risk, packers using fixed-price contracts may have a "competitive edge" over those who do not.

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Western Journal of Agricultural Economics, 10(2): 330–337

This study seeks to determine the ability of meat packers to hedge live cattle inputs on the live cattle futures contract to reduce the risk associated with short-term fixed price beef sales. Live cattle purchases are assumed to be priced on a carcass basis; thus, this analysis is a study of cross-hedging. Both carcass and futures prices must adjust quickly to new information for a hedging program between carcass beef and live cattle futures to be operative for processors. If carcass and futures prices did not move closely together in the very short-term (less than one week) then successful hedging by processors would be difficult.

Numerous studies have investigated the possibility of cross-hedging carcass beef with the live cattle futures contract. Cross-hedging is defined as the hedging of a cash position in one commodity by using the futures market for a different but related commodity [Miller and Luke]. The cross-hedging studies of carcass beef on the live cattle contract that have been conducted have centered on the ability of the HRI sector to successfully cross-hedge specific cuts of beef [Ginzel; Ginn]. Miller and Luke concluded food service establishments could reduce price risks involved in sirloin butt procurement by cross-hedging with the live cattle contract. Although these past studies suggest cross-hedging in live cattle futures may be possible, none have analyzed the ability of hedging to significantly reduce price risk to meat packers in the very short-term through the use of simulated hedging strategies over past data.

Another relevant issue is the possible existence of downward bias in live cattle futures prices. Helmuth suggested a systematic downward bias exists in cattle futures prices. If this is the case, packers have an opportunity to gain better returns than a cash market only strategy through long-hedging and simultaneously reduce their risks.

The present study analyzes the ability of meat packers to hedge forward fixed-price beef sales during a short time horizon (one week). Although a week is a short period of time, meat packers can be exposed to substantial price risk due to large volumes and variable prices. A one cent per pound price increase within one week after a contract price is established for beef carcasses for a large packer (6,000–10,000 head slaughtered per week) means a loss in revenues of between $36,000 and $60,000. Packers should be interested in reducing this risk and hedging is a possible method of doing so.

Methodology

The study used daily carcass beef prices graded choice with a hot weight of 700 lbs. taken from the *National Provisioner* for January 1981 through April 1984. Daily live cattle futures prices were closing quotes of the Chicago Mercantile Exchange (CME) for the nearby contract for the same period.

The effectiveness of long-hedging for the packer was analyzed by simulating a weekly routine hedging strategy over the study period. The packer was assumed to establish a contract price with a purchaser or group of purchasers for the next week's slaughter on a specified contract day during the current week. Each weekday (Monday, Tuesday, Wednesday, Thursday, and Friday) was simulated as the contract day. Since cattle were purchased two days prior to slaughter, Thursday's and Friday's contracting were assumed to take place at the end of the second week prior to slaughter. Otherwise, purchases of live cattle would have taken place before a contract price was agreed upon with a purchaser. Thus, Monday's slaughter was purchased on the prior Thursday, Tuesday's slaughter was purchased on the prior Friday, etc.[1]

[1] The contracting and purchasing strategy simulated was designed to closely follow practices of a specific intermediate-sized meat packer.

Equal weight was given to each day's purchases, i.e., 20 percent unless the market was closed on any particular weekday due to holidays or some other reason. Purchases were assumed to take place one day earlier if a holiday was encountered. For instance, both Tuesday's and Wednesday's production were purchased on the previous Friday (40 percent of needs for the week) if the markets were closed on Monday of the current week. Pricing of cattle was assumed to be "on-the-rail" with cash price being the *National Provisioner* quoted price for choice beef carcasses on the day the live cattle were purchased.

Two basic strategies were tested for each of the contract days: 1) a cash market only strategy, and 2) a routine hedging strategy. The cash market only strategy relied solely on published choice carcass prices with no position being taken in the futures market.

Hayenga and DiPietre determined that to successfully hedge carcass beef on the live cattle futures contract, the futures position required to hedge a particular volume of carcass beef would vary significantly within a year. Thus, a constant hedge ratio (futures to carcass) was considered inappropriate. "Pound-for-pound" hedging in cattle futures would also not be appropriate for carcass beef since carcass weights and live cattle weights do not correspond on a pound-for-pound basis. Ginn suggests carcass hedging should be undertaken on a physical equivalence base. Thus, if carcass price is \$1/lb. and futures are selling at \$0.65/lb., the basis in terms of value is 1.54, indicating that both cash price and cash value per pound would be equivalent to 1.54 lbs. of live cattle that could be purchased with a futures contract.

Contract price was established as the closing *National Provisioner* price for choice beef carcasses on the contract day. A long-hedge was opened at the closing CME live cattle futures price on the contract day. The hedge requirement was determined by the ratio of current choice carcass and futures price. For example, if current choice price was \$1.02/lb. and live cattle futures were \$0.65/lb., a ratio of \$1.02/\$0.65 = 1.57 is yielded. A hedge, then, required that for each pound of choice carcass, an equivalent 1.57 pounds of live cattle were required to be purchased on the futures market [Ginn]. This method was selected because of its ease of calculation. No evidence suggested that one method was superior to another [Hayenga and DiPietre; Ginn]. Thus, the packer was assumed to select the simpler method rather than calculating regression coefficients as suggested by Hayenga and DiPietre.

As cattle were purchased for slaughter, a portion of the long position in the futures market equal to needs purchased on that particular day was liquidated. For a "normal" day's production, say Thursday, 20 percent of the week's needs would have been purchased in the cash market and 20 percent of the long position established the previous week would have been closed.

The generality of the model was maintained by comparing only price differences between contract day and eventual *National Provisioner* prices and futures prices on contract and purchase days and not volumes. This appeared to be a reasonable approach since most packers price off the *National Provisioner* price or some other published price. Assuming packers price live cattle at a fairly constant margin above or below the published carcass prices, price differences between contract day and purchase day prices offered a good measure of the relative desirability of setting contract price on different days of the week.

An example of how the simulation operated is the following: assume the contract day was Tuesday of last week and carcass and futures prices were \$1.00/lb. and \$0.62/lb., respectively on that day. A contract was written with a buyer at \$1 for each pound of choice carcass beef deliv-

ered the following week. This week's Thursday production was purchased on the current week's Tuesday when carcass price was \$1.02/lb. Futures were sold on the current Tuesday to close 20 percent of the hedged position at \$0.63/lb. The packer foregoes \$0.02 in the cash market while gaining \$0.01 in the futures. Since the packer's hedge ratio was \$1.00/\$0.62 = 1.61, his gain in the futures market was \$0.01 × 1.61 = \$0.016 minus \$0.0007 per pound commissions and interest or \$0.0153.

The commission and interest costs were calculated based on a cut-rate commission fee of \$25 per contract. Interest rates were assumed to be 13 percent on \$800 margin money for each contract. Thus, the overall loss on Thursday's production was \$0.0047 (\$0.0153 − 0.02) per pound. This could be multiplied by any volume, if one desired to do so, say 1,000 carcasses weighing 650 lbs. (1,000 × 650 × \$0.0047 = \$3,055) to determine the overall loss (gain) for that particular day.

Mean returns per hundredweight for the week were calculated as the simple average of returns for the days of the week. Comparisons between contract days were made based upon mean returns per week and also the relative variance of those returns.

An interval approach to stochastic dominance with respect to a function[2] was used to test the relative preference for each of the strategies by alternative risk preference groups [Meyer]. The "efficient sets" were defined to include the strategies preferred by decision makers with preferences corresponding to three specific risk preference categories (i.e., risk neutral, risk averse, and risk loving decision makers) [King and Robinson, pp. 2–6]. More than one strategy could be dominant at each preference level, indicating the processor would be indifferent at that preference level between the strategies specified. The most preferred strategies were listed in the first preference or the efficient set, followed by the next most efficient set, assuming those in the first group are not available, and so on until all of the strategies are ranked.

The following section reports the results for both the cash only and routine hedge strategies. Separate results are reported for both strategies using each day of the week as the day when the contract price was decided upon with a purchaser. This allows comparisons of returns for the separate days of the week used as the contract day. It also provided a method to determine rankings by risk preference among the contract days and separate strategies.

Results

Table 1 presents the results of the simulation for a cash only and routine hedging strategy using the different days of the week as the contract day. On the average, following a cash market only strategy would have yielded a positive average return if the contract price had been set on Monday of the previous week or Thursday or Friday of the second week previous to production. However, none of the contract days yielded a mean return significantly different than zero for the cash market only strategy. The variances of cash market only strategies were larger for each day of the week, as measured by the F-statistic, than the variances for the routine hedging strategy (Table 1). This indicates price risk would be significantly reduced if a routine hedging strategy were followed, regardless of which day of the week was selected as the contract day.

The best day of the week to set contract price (based on the means), if a cash only strategy were followed, was Friday

[2] Inspection of the cumulative density functions (cdf) revealed that there were multiple cross-overs for each day of the week when the routine hedging and cash only cdf's were compared. This necessitated using an interval approach in the stochastic dominance analysis rather than selecting a break-even level of risk aversion.

TABLE 1. Mean Returns and Standard Deviations for Cash Only and Routine Hedging Strategies in Dollars Per Hundredweight.[a]

	Contract Day				
	Monday	Tuesday	Wednesday	Thursday	Friday
Strategy:					
Cash Only					
$\bar{X}$[b]	0.160	−0.053	−0.198	0.049	0.164
	(1.124)	(−0.405)	(−1.468)	(0.185)	(1.011)
σ[c]	2.060	1.723	1.441	2.311	2.268
Routine Hedge					
$\bar{X}$	0.257	0.002	−0.041	0.270	0.249
	(1.863)*	(0.168)	(−0.139)	(1.735)*	(1.649)
σ	1.908	1.570	1.387	2.010	1.961
F-Statistic[d]	1.166**	1.204**	1.079**	1.322**	1.338**

[a] t-values are in parentheses.
[b] Mean.
[c] Standard Deviation.
[d] Test for differences between variances [Steel and Torrie, pp. 82–83].
* Denotes statistically different from zero at ten percent level.
** Statistically different variances at one percent level.

($0.164/cwt). However, Monday ($0.16) yielded virtually the same average return as Friday for the cash only strategy. Friday's mean return was, however, slightly more variable than Monday's. Thursday's mean return for the cash only strategy, although positive, was highly variable as measured by the coefficient of variation. These results are consistent with demand for carcass beef being stronger early and late in the week. Processors may strive to meet contract requirements early in the week and scramble to make up any shortfalls at the end of the week thus increasing demand on Mondays and Fridays [Futrell; Early].

A routine hedging strategy exhibited larger mean returns than the cash market only strategy for each of the respective contract days.[3] The routine hedging strategy increased mean returns by an average of $0.12 per hundredweight. Depending on the day of the week used as the contract day, hedging would have increased returns on a 700 lb. carcass by between $0.39 and $1.54. The largest increase would have been experienced using Thursday as the contract day ($0.22/cwt) while the smallest increase in mean returns using the routine hedging strategy was with Tuesday as the contract day ($0.055/cwt). The means are larger and standard deviations smaller for the routine hedging strategy over the cash only strategy for each respective day of the week. This indicates mean-variance dominance of routine hedging over the cash market only strategy for any particular day of the week. To select across days of the week were mean-variance dominance is not found, the stochastic dominance procedure developed by Meyer was used.

The hedging strategy using Thursday as the contract day (Thursday hedge) would be rated highly (most efficient set) by decision makers in all three risk preference categories (Table 2). Thus, the Thursday hedge strategy appears to be the preferred

[3] These differences were not statistically significant. Also, the mean of the routine hedging strategy being higher than the cash market only strategy is dependent upon the assumptions made about commissions and slippage costs. For example, if full price commissions of $65 per contract were assumed, the mean returns for routine hedging would decrease $0.10/cwt and, thus, mean returns for routine hedging would only be greater on Thursday.

TABLE 2. Preference for Cash and Hedging Marketing Strategies by Risk Preference Group.[a]

Rank of Preference for Sets	Risk Preference Group		
	Risk Averse	Risk Neutral	Risk Lover
Efficient Set	Thursday Hedge[b] Monday Hedge	Thursday Hedge	Thursday Hedge
2nd Most Preferred Set	Friday Hedge	Monday Hedge	Monday Hedge Friday Hedge
3rd Most Preferred Set	Friday Cash Monday Cash	Friday Hedge	Friday Cash
4th Most Preferred Set	Tuesday Hedge Thursday Cash	Friday Cash	Monday Cash
5th Most Preferred Set	Wednesday Hedge	Monday Cash	Thursday Cash
6th Most Preferred Set	Tuesday Cash	Thursday Cash	Tuesday Hedge
7th Most Preferred Set	Wednesday Cash	Tuesday Hedge	Tuesday Cash Wednesday Hedge
8th Most Preferred Set	N/A[c]	Wednesday Hedge	Wednesday Cash
9th Most Preferred Set	N/A	Tuesday Cash	N/A
10th Most Preferred Set	N/A	Wednesday Cash	N/A

[a] The intervals chosen for Pratt's absolute risk aversion coefficient were −0.1 to −0.005 for a risk lover, 0.005 to 0.1 for a risk averse decision maker, and 0.0 for a risk neutral decision maker.
[b] The first word denotes the day the cash contract is signed and the second word denotes the strategy followed, e.g., Thursday Hedge would indicate the cash contract was signed with a buyer on Thursday of two weeks previous to production and that a hedging strategy was followed.
[c] Not applicable.

strategy. A risk averse decision maker would also find the Monday hedge strategy attractive because the Monday hedge return is relatively high and slightly less variable than the Thursday hedge.

In general, the strategies were rated by all three risk preference groups according to mean returns. Risk neutral decision makers would rank the strategies by their expected returns by definition. Risk averse and risk loving decision makers would rank the strategies in a similar fashion indicating the strategies offer clear-cut choices within the range of risk preferences considered.

Hedging was clearly superior to a cash only strategy for all three risk preferences with Thursday, Monday, and Friday hedging all being preferred over any of the cash market strategies. Hedging was preferred above cash only strategies for any particular day of the week (e.g., Wednesday hedge was preferred above Wednesday cash) by all three risk preference groups. This reconfirms the mean-variance dominance of hedging over cash strategies (see Table 1).

Strategies where pricing decisions were placed in the middle of the week (Tuesday and Wednesday) were rated lowly by the three risk preference categories. This may again be explained by increased demand for beef early and late in the week.

These results indicate that packers' short-term price risk could have been reduced by following a routine hedging strategy regardless of risk preference. This may encourage more processors to long-hedge to offset fixed-price forward beef sales. If this were the case, the market would benefit from additional liquidity injected by these "new" traders as cattle producers would find additional traders willing to offset their short positions. Hedging should work well in a market with variable price levels and where cash and futures prices are highly positively correlated. This appears to have been the

case over the study period between live cattle futures and choice carcass beef prices. Of course, different strategies or alternative time periods may yield different results.

Summary and Conclusions

Price risks faced by meat packers differ from those faced by producers in that packers' price risk is often short-term while producers' risk stretches over a relatively long production period. This paper sought to determine the ability of packers to reduce price risk by following a routine long-hedging strategy with a short contract period (one week). Most packers do not hedge since they are able to transfer most of the price risk to their buyers and/or believe their price risk is spread over time because of daily trading. This paper provides some evidence that packers could sign short-term contracts with buyers and still have some protection from price risk if a routine long-hedging strategy were followed.

The study period stretched from January 1981 to April 1984. Each day of the week was simulated as the day when a weekly contract was signed to set the price for the entire production of the following week. A long position was also opened in the futures market on this day. Routine hedging was found not only to increase mean returns by a small amount but, more importantly, to significantly reduce price risk to packers no matter which day was selected as the contract day.

Monday of the week preceding slaughter and Thursday of the second week preceding slaughter yielded the highest mean returns as contract days (day carcass price was set with purchasers). This was probably due to increased demand for carcass beef early and late in the week. This implies packers should attempt to set price either early or late in the week rather than in the middle of the week.

Stochastic dominance analysis showed hedging would be preferred over simple cash market strategies by all three risk preference categories (i.e., risk neutral, risk loving, and risk averse) regardless of the day of the week used as the contract day. A hedging strategy using Thursday, Friday or Monday as the contract day would be highly preferred by all three risk preference groups.

Hedging in the live cattle futures market has largely been viewed as a method of reducing producers' price risk over a rather lengthy production period (three to six months). This paper indicates hedging may also be a very useful tool to reduce short-term price risks of meat packers.

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