EFFICIENT CASH AND HEDGED ENTERPRISE COMBINATIONS IN FEEDER CALF BACKGROUNDING OPERATIONS

Barry W. Bobst, Orlen C. Grunewald, and J. T. Davis

Backgrounding of feeder cattle is a growing specialty operation in the so-called "Fescue Belt" grasslands of the South (Bradford et al.). Backgrounding is largely a seasonal enterprise, consisting of the purchase of weaned calves that are placed on pasture and supplemental feed for several months and then resold for placement in feedlots. Since feeder calf and feeder cattle prices are among the most volatile of all classes of cattle, backgrounders face considerable price risk (Russell and Franzmann). In principle, hedging could shift this risk, but there has been a question whether hedging can be worthwhile, given the additional costs and financial obligations involved. Size of operation is also a factor, because the feeder cattle futures contract is indivisible. Profitable application of hedging requires a balancing of risks and rewards from alternative combinations of hedged and cash backgrounding operations to find the one best suited to the individual manager's needs, given his price expectations. Since individuals differ greatly in their responses to risk and also differ in their price expectations, research on hedging application will be most useful if it provides arrays of alternatives from which to choose. This article demonstrates how this can be done and assesses the potential demand for such information. That is, is it applicable only to a few large farmers capable of absorbing a contract, or can more substantial numbers be involved?

Previous research on feeder cattle hedging in the South has included work on location basis variability (O'Bryan et al.) and the development of decision rules for selective hedging programs (Franzmann; Russell and Franzmann). Selective hedging research has been concerned with returns and variances of alternative trading strategies, but has ignored the problem of choice among equivocal strategies. These strategies indicate that returns can be increased, however, only at some increased level of risk, or vice versa. Choice among equivocal alternatives, or more accurately, the analysis of them so that farmers can make choices, is the object of this research.

METHOD OF ANALYSIS

Portfolio analysis techniques are used to evaluate the hedging of backgrounding operations. As its name implies, portfolio analysis originated in financial security analysis for the purposes of determining the combination of securities that would maximize returns for a given amount of risk, or alternatively, minimize risk for a given level of return (Markowitz). Markowitz developed the concept of the efficient frontier, which consists of combinations of securities that meet these criteria. Portfolios that do not lie on the efficient frontier can be reorganized to increase returns or decrease risk without change in the other measure. The efficient frontier consists of a series of portfolios rather than a single one, because the choice of a particular combination along the efficient frontier depends upon the individual investor's utility function with respect to risk versus reward. By providing information about the makeup of the efficient frontier, the analyst can facilitate decision making for many investors without having to know their utility functions.

Portfolio analysis techniques are applied to backgrounding operations by budgeting alternative production and marketing enterprises, and by determining the expected value and variability of their rates of return (Musser et al.). Covariances among all alternatives are also required. Delimiting the number of alternatives is crucial, because if the problem is approached as an investment decision in its largest sense, the number of possible alternatives is virtually without limit. The problem is made tractable by restricting its focus to backgrounding operations only. Efficient frontiers composed of backgrounding enterprise combinations can then be computed by means of quadratic programming, using annualized rates of return and variances and covariances of rates of return as input variables (Grunewald).

A number of different feeding systems can be used in a backgrounding operation, ranging from confinement drylot to straight pasturage. Analy-

Barry W. Bobst is Associate Professor of Agricultural Economics, University of Kentucky. Orlen C. Grunewald is Assistant Professor of Economics, Kansas State University. J. T. Davis is Associate Professor of Agricultural Economics, University of Kentucky.

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sis of alternative systems by Rutledge et al. indicated that a combination of pasture and winter drylot feeding was most profitable. This system was adopted for the present study. Feed rations, pasture costs, death losses, labor, and other cost items were adopted from Rutledge et al., with updated feed prices and input prices for labor, transportation, and marketing updated from Cornbelt cattle feeding budgets (USDA, *Livestock and Meat Situation*).

While various classes and grades of feeders can be backgrounded, this report concentrates on the most common, Medium No. 1 (formerly Choice) steers. Two weaned calf purchase weights are considered, (a) light (*circa* 300 pounds), and (b) heavier (*circa* 400 pounds). Holding periods are budgeted for 28 to 44 weeks, with 4-week intermediate periods, for the light calves and 28, 32, and 36 weeks for the heavier ones. These budgets provide an array of market weights ranging from approximately 550 pounds to 800 pounds and sales dates ranging from late winter to mid-summer. Feed and other resources are assumed to be available so that all feeding periods are attainable.

Annual rates of return to the working capital invested in backgrounding enterprises are computed according to the formula

$$(1)\quad R = \frac{P_{t+k}X_{t+k} + (F_t - F_{t+k})X_f + Q}{P_tX_t + C_k(X_{t-k} - X_t) + C_fX_f} - 1$$

where R = annual rate of return,
P_t, P_{t+k} = Medium No. 1 steer prices at periods t and t+k weeks,
X_t, X_{t+k} = initial and ending weights, in hundredweight,
X_f = quantity hedged, in hundredweight,
F_t, F_{t+k} = feeder cattle futures prices in periods t and t+k weeks for contracts maturing in period m, $m \geq t+k$,
C_k = cost per hundredweight of feeding and cash marketing over the k week period,
C_f = hedging cost per hundredweight, and
Q = earnings from investment of proceeds for 52 − k weeks at the current U.S. Treasury bill rate.

Both hedged and unhedged enterprises are accommodated by setting $X_f = X_{t+k}$ for hedged activities and $X_f = 0$ for unhedged ones. Comparability between periods is achieved through allowing subsequent investment in Treasury bills.

Purchase and sale prices of feeders are obtained from market news reports for Kentucky auctions (USDA, *Livestock, Meat, Wool Market News*). Hedged enterprises involve simple hedge-and-hold actions. No intraperiod contract trades are considered. Such trades are open to backgrounders, of course, but the complexities that active trading programs add to the analysis of efficient frontiers are beyond the scope of this particular study.

Hedging costs include $50 per contract brokerage fees for one round-turn trade plus $1,000 margin at the interest rate given for Cornbelt feeding. Origins of production and cash marketing cost information were described previously.

Grade and location basis differentials between local cash prices and the Chicago-based futures market prices can affect rates of return for hedged enterprises. Conceivably, basis effects can greatly reduce the risk-shifting capability of hedging. However, O'Bryan et al. indicated that basis does not distort the spatial price surface for the study area; therefore, no appreciable effects on means and variances of hedged enterprise revenues are incurred.

Rates of return are computed weekly and then averaged by months to provide annual rates of return for all enterprises commencing in August and September for the years 1973–80 and ending in various periods from March to July for the years 1974–81. Means, variances, and covariances are computed from these monthly data. Since August and September results are essentially similar, only September data and results are used in this paper.

Table 1 presents means and standard deviations of rates of return for backgrounding enterprises commencing in September, 1973–1980. Covariances are presented in Appendix Table 1. Reward versus risk trade-offs are exhibited in Table 1. Both means and standard deviations of rates of returns for unhedged enterprises are larger than their hedged counterparts. Despite consistently higher purchase prices and budgeted death losses (4 percent versus 3 percent), enterprises using the lighter weight calves tended to out-perform those using the heavier weight calves. Table 2 illustrates the distribution of hedged and unhedged returns for one enterprise. Routine hedging over the 8-year period would have reduced the number and magnitude of losses, but it would also have curtailed the large gains accruing to unhedged operations in some years.

In general, the information presented in Tables 1 and 2 (assuming Table 2 to be expanded to all enterprises) is not sufficient for decision making. Only in the special case of backgrounders who base their expectations of future returns on past averages and who have singular risk-reward utility functions (either maximizing returns without regard for risk, or vice versa) can optimum decisions be made. Many backgrounders will use other expectations models and virtually all will be concerned both with returns and risks in their decision making. They need to know the efficient

TABLE 1. Feeder Cattle Enterprise Rates of Return, September 1973–80

			Rates of Return					
			Unhedged			Hedged		
Purchase Weight	Sale Weight	Holding Period	Enterprise Code[1]	Mean	Std. Dev.[2]	Enterprise Code[1]	Mean	Std. Dev.[2]
lbs.	lbs.	weeks		..Percentage..			..Percentage..	
300	570	28	U3/28	18.99	25.85	H3/28	11.65	13.20
300	615	32	U3/32	17.02	23.06	H3/32	6.39	10.04
300	660	36	U3/36	22.49	27.76	H3/36	11.63	11.55
300	705	40	U3/40	19.69	29.96	H3/40	12.34	9.83
300	755	44	U3/44	19.20	22.65	H3/44	14.35	10.33
400	695	28	U4/28	10.40	22.60	H4/28	3.83	11.39
400	740	32	U4/32	10.74	19.76	H4/32	1.01	11.29
400	795	36	U4/36	17.43	27.79	H4/36	8.00	12.80

[1] Enterprise codes: U3/28, for instance, means unhedged, purchased at 300 pounds and marketed after 28 weeks.
[2] Hedged enterprise variances are significantly ($\alpha = .05$) smaller than unhedged variances, indicating substantial risk-shifting potential.

frontier that is associated with their expectations and with all possible combinations of enterprises. Efficient frontiers are calculated with the historical variances and covariances of the enterprises considered.[1] They reflect the distribution of outcomes of all combinations of enterprises, and provide a common measure of risk for comparison of plans based on different expectations.

Expectations about returns from backgrounding are usually formulated first as price expectations based on information available at the time calf purchase decisions are being made. These price expectations are entered into equation (1), and rates of return are estimated. Two price expectations functions are used in this paper, together with mean returns as comparison. These functions were chosen from the many possibilities because of their simplicity and because they seem to be in some use among backgrounders. Both simply project from current price levels, but in different ways. In model A, current cash prices for different weight classes are taken as estimates of cash prices to be received at future dates. Thus

$$(2) \qquad \hat{P}_{i,t+k} = P_{it}$$

where the i subscript refers to weight class. Prices to be paid for re-purchase of futures contracts on sales dates are also estimated from current cash prices as

$$(3) \qquad \hat{F}_{t+k} = P_i + Basis_i$$

where $Basis_i$ is the localized basis by weight class. Using current prices facilitates the rough budgeting on costs and weight class price differentials that backgrounders estimate before committing themselves to a calf purchase. With these prices, computation by equation (1) is a more sophisticated version of the budgeting process that backgrounders (and their bankers) now use. This expectation model assumes that current cash prices are at least as good as current futures prices as forecasters. This assumption is supported by the work of Martin and Garcia.

Expectations model B, on the other hand, assumes that current futures prices may provide a

TABLE 2. Annual Rates of Return for 300 Pound Medium No. 1 Steers, Fed for 36 Weeks, September 1973–80

	Enterprise Code	
Year	U3/36	H3/36
	.....Percentage.....	
1973	-8.50	27.92
1974	7.74	-5.35
1975	46.69	7.07
1976	18.98	13.52
1977	51.59	-5.48
1978	69.50	24.57
1979	-5.28	15.10
1980	-0.60	15.70

[1] Portfolio analysis can be extended to trading strategies, i.e., the active buying and selling of futures contracts during the backgrounding period, by appropriate extension of the variance-covariance matrix.

better forecast of cash price at the time the animals are sold. This follows the work conducted by Leuthold (live cattle) and more recently by Blank (live cattle and feeder cattle) in which futures prices were found to perform the forecasting function with at least some degree of accuracy. The formulation of expectations model B is contained in equations (4) and (5).

$$(4) \quad P_{i,t+k} = F_t - \text{Basis}_i$$

$$(5) \quad \hat{F}_{t+k} = F_t$$

These price expectations and mean returns are applied to the 1980–81 backgrounding season. Expected rate of returns, based on September, 1980, prices are given in Table 3. Backgrounders who base decisions only on expected returns could plan their operations from Table 3, providing they concur with one or the other of the expectations. A simple maximizer who used price model A, for example, would purchase 300-pound calves, intending to hold them for 28 weeks and "selectively" hedge the entire lot in the appropriate contract (March to April, 1981, delivery). Another simple maximizer, using price model B, would decide upon the same production enterprise, but would choose to leave it unhedged.

Backgrounders concerned with both risks and rewards need to know the efficient frontier associated with their price expectations. Given the information that the efficient frontier provides, that is, the enterprise combinations that maximize expected returns for given levels of risk, the backgrounder can choose the combination that maximizes his utility with respect to risk and reward. Since risk/reward utility functions are unique to individuals, provision of the entire efficient frontier allows each to choose the enterprise combination that is optimal for him. This information needs to be updated annually, thus, the results given here for 1980–81 are applicable for that year only. Comparisons of efficient frontiers with actual outcomes over time serve to determine the effectiveness of expectations models, but do not help to guide decisions along a given frontier within a given year.

TABLE 3. Expected Returns from Selected Expectations Models, 1980–81

	Expectations Model					
	Price Model A		Price Model B		Mean Return	
Enterprise	Unhedged	Hedged	Unhedged	Hedged	Unhedged	Hedged
	.....Percentage.....					
300 lbs./28 wks.	10.3	21.1	21.6	21.1	19.10	11.6
300 lbs./32 wks.	1.8	15.9	16.4	15.9	17.0	6.4
300 lbs./36 wks.	3.4	18.2	19.0	18.2	22.5	11.6
300 lbs./40 wks.	8.1	-2.9	17.7	16.8	19.7	12.3
300 lbs./44 wks.	14.4	-8.1	19.6	18.7	19.2	14.4
400 lbs./28 wks.	2.1	13.6	14.1	13.6	10.4	3.8
400 lbs./32 wks.	-2.2	12.4	12.9	12.4	10.7	1.0
400 lbs./36 wks.	-1.2	14.4	15.1	14.4	17.4	8.0

PORTFOLIO ANALYSIS RESULTS

Table 4 and Figure 1 present the enterprise combinations and their weights comprising the efficient frontiers for the expectations models in 1980–81. Efficient frontiers are specific to expectations models, thus, backgrounders' decisions or possibly their banker's, if hedging is made a condition for a cattle loan, are made along a given frontier rather than choices between them. Adjustments along frontiers are made by reweighting enterprise mixes or by changing enterprises.

Examination of adjacent combinations in Table 4 indicates the nature of these changes. For example, one mix for price model A consists of enterprises U3/44 at 24 percent and H3/28 at 76 percent. Ignoring Treasury bill yield effects on conversion to cattle numbers, this combination indicates that, of 100 head of 300-pound calves purchased, 76 head are hedged and held for 28 weeks, and the remaining 24 head are held unhedged for 44 weeks. Backgrounders can adjust toward either of the adjacent combinations and still be on their efficient frontier. Reweighting in favor of the H3/28 enterprise would move them

TABLE 4. Efficient Frontiers for Alternative Expectations Models, 1980–81

Enterprises[a/]	Weights	Expected Return	Standard Deviation
		.....Percentage.....	
Mean Return Model			
U3/40, U3/44, H3/44, H4/32	11, 18, 3, 68	6.7	4.8
U3/40, H3/44, H4/32	24, 30, 45	9.8	5.1
U3/40, H3/44, H4/32	23, 69, 8	15.0	6.4
U3/40, H3/32, H3/44	23, 4, 73	15.7	6.6
U3/44, H3/44	23, 77	16.1	6.8
U3/36, H3/44	39, 61	17.8	10.4
U3/36	100	22.5	27.7
Price Model A			
U3/40, U3/44, H3/44, H4/32	11, 18, 3, 68	11.6	4.8
U3/40, U3/44, U4/32	7, 23, 70	12.5	4.8
U3/44, U4/32	31, 69	12.9	4.9
U3/44, H3/32	27, 73	15.4	5.5
U3/44, H3/32, H3/36	26, 66, 8	15.6	5.7
U3/44, H3/28, H3/32	26, 15, 59	16.2	6.2
U3/44, H3/28	24, 76	19.4	9.2
H3/28	100	21.1	13.2
Price Model B			
U3/40, U3/44, H3/44, H4/32	11, 18, 3, 68	14.5	4.8
U3/44, H3/32, H3/44, H4/32	29, 26, 15, 30	16.3	5.0
U3/44, H3/32, H3/44	28, 54, 18	17.4	5.7
U3/44, H3/28, H3/44	28, 23, 49	18.5	7.6
U3/44, H3/28	30, 70	20.7	9.0
U3/28, H3/28	23, 77	21.2	12.5
U3/28	100	21.6	25.8

[a] Enterprise codes: U,H = unhedged, hedged; 3,4 = 300, 400 pound initial weights, 28–44 = weeks duration of enterprise. See Table 1.

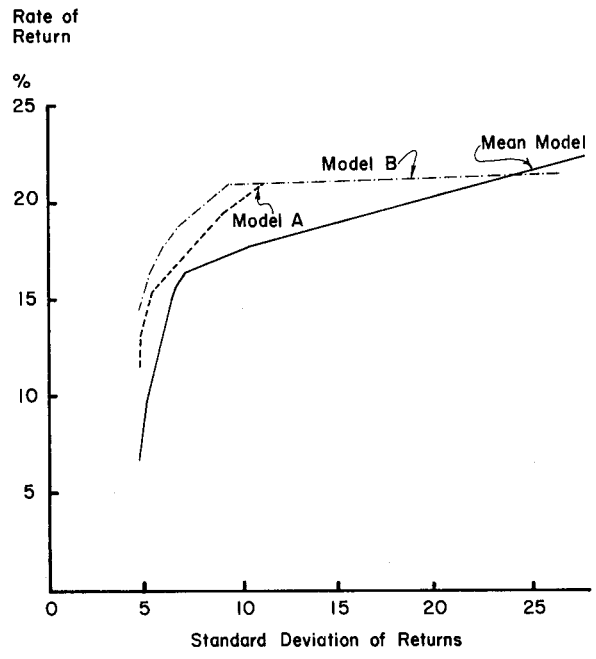

FIGURE 1. Efficient Frontiers for Selected Price Expectations, 1980–81 Backgrounding Season

toward the maximum return, maximum-risk enterprise for this expectation, which is 100 percent weighting of the H3/28 enterprise. Adjustment in the other direction would reduce expected returns and risks. Similar adjustments can be made along the other frontiers, and more frontiers can be computed for any other price expectations that backgrounders might be able to articulate.

Most notable, in the efficient frontiers presented in Table 4, is the predominance of mixes of hedged and cash enterprises. Except for the maximum-return endpoint for price model A, completely hedged operations do not appear on the efficient frontiers. Thus, mixed hedged and cash enterprises minimize risks for a given level of return at all levels except the one endpoint. These results indicate that complete hedging is not a risk-averting strategy, but rather a profit-maximizing one under given conditions, such as the expectation under price model A. However, hedging some of the backgrounding enterprise is integral to risk reduction for all three expectation models examined. Since these results stem from enterprise variances and covariances, which are historic rather than expectational in nature, and from the general consistency of cost and price differentials, they will hold for other expectations and for other years. Although maximum-return endpoints will vary, the general similarity of slopes of efficient frontiers, especially in their interiors, is ensured by the above-mentioned factors. Partial hedging, then, will be the optimum decision for many backgrounders, unless they are barred by the indivisibility of futures contracts.

POTENTIAL FOR APPLICATION

Divisibility of enterprises is assumed in the analysis, but actual attainment of these efficient frontiers will be impeded by the indivisibility of futures contracts. A feeder cattle contract (44,000 pounds) represents a truckload of cattle containing approximately 60–70 head. Operators handling less than truckload lots may not be able to achieve the efficient frontier, or at least have limited access to it. For example, a small backgrounder holding price expectations corresponding to model A in 1980 could have reached the efficient frontier only in the low return-low risk zone where straight cash enterprises are to be found; higher return combinations involving hedging were closed to him. Pooling of small backgrounders is conceivable but difficult to implement because of the large number of possible combinations of price expectations and enterprise weights.

Backgrounders probably need to be handling multiple truckloads before they can approximate the hedging proportions indicated by the efficient frontiers, but they need not be gigantic. A total of 90–110 head would be required to match the 70–77 percent-hedged enterprise (H3/28) weights for the simpler enterprise combinations—those containing only one hedged activity, for price models A and B and 75–95 head of comparable activities and weights in the mean return model. Such portfolios are attainable by a substantial number of producers and for an even more substantial number of feeder cattle. The 1978 Census of Agriculture cattle marketing data for Arkansas, Kentucky, and Tennessee show that an average of 3.5 percent of all farms reporting sales of cattle had annual sales of 100 head or more. After adjusting for fed cattle marketings, this size group accounted for 32.9 percent of nonfed cattle marketed. While these numbers include cows and other nonfed classes of cattle (but they exclude calves), they indicate that a sizable clientele group exists in these states that could benefit from portfolio analyses of backgrounding operations.

IMPLICATIONS

Factors considered in this study indicate some of the problems associated with hedging that can greatly inhibit its use. The problem of contract indivisibility impedes hedging by small producers, but substantial numbers seem to be in a position to use it, far more than have actually done so. However, perceptions of the use of hedging and producers' attitudes towards risk may be important reasons for the reluctance to hedge. Brokers' examples usually show a "perfect" hedge and, by implication, apply it to the entire backgrounding operation. Selective hedging studies attempt to show backgrounders how to recognize favorable hedging opportunities, but they too imply application to the entire operation. The results here suggest that all-or-nothing hedging de-

cisions apply only to producers willing to try to maximize profits without regard to risk. Single enterprise decisions will always result from such preferences, some of which may involve hedging, as was the case in the 1980–81 season for backgrounders basing expectations on cash market prices (model A). Backgrounders as a group are willing to accept some risk, or they would be in another business, but it does not follow that they are insensitive to it. Backgrounders who consider risks and rewards in making decisions may be inhibited from the use of hedging because they do not know how to incorporate it in the mixed enterprise sense found along the efficient frontiers. Backgrounders may be articulating this uncertainty when they state that they do not know how hedging can "fit into" their operations. Information to assist them can be provided by portfolio analysis of backgrounding operations, updated to include current price information and current expectations. Further research to refine these analyses and extension efforts to keep them updated should be of substantial benefit.

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APPENDIX TABLE 1. Variances and Covariances of Feeder Cattle Enterprise Annual Percentage Rates of Return, 1973–80

	Backgrounding Enterprises															
	U3/28	U3/32	U3/36	U3/40	U3/44	U4/28	U4/32	U4/36	H3/28	H3/32	H3/36	H3/40	H3/44	H4/28	H4/32	H4/36
U3/28	668															
U3/32	559	532														
U3/36	659	626	766													
U3/40	577	611	754	903												
U3/44	486	481	600	676	525											
U4/28	580	488	585	529	439	511										
U4/32	483	450	541	528	417	429	390									
U4/36	650	604	758	721	586	581	530	772								
H3/28	51	-41	-85	-197	-123	25	-40	-83	174							
H3/32	-61	-111	-161	-216	-156	-65	-99	-162	120	101						
H3/36	44	-43	-72	-197	-120	24	-35	-61	150	99	142					
H3/40	53	-26	-45	-114	-66	41	-14	-43	112	75	106	104				
H3/44	16	-53	-87	-194	-124	-1	-48	-80	135	91	124	85	113			
H4/28	-26	-96	-145	-228	-158	-36	-83	-142	144	111	125	95	114	130		
H4/32	-125	-175	-229	-277	-205	-116	-146	-222	117	108	100	80	92	118	128	
H4/36	46	-48	-63	-207	-119	28	-34	-35	145	92	146	101	125	120	96	164