ANALISYS OF FEEDER CATTLE CROSS HEDGE AND LIVE CATTLE HEDGE AT BM&F FUTURES MARKET

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Summary – The aim of the study is to analyze the feeder cattle cross hedge at BM&F Futures Market verifying the real need of the existence of futures contract for this commodity. Basis risk of these operations was calculated, as well as the optimal hedge ratios and the respective effectiveness in the main commercialization regions of bovine cattle in Brazil, for the period comprised between September of 1995 and February of 2001. The same analyzes were carried for the live cattle hedge. The optimum hedge ratio appeared high in the cross hedge (between 37% and 49%) and in the own hedge (between 58% and 63%). The own hedge figures mean a 50% reduction in price risk when hedging at the optimal ratio, a value that drops consistently to about 1,5% for all regions when the cross hedge is considered. The main conclusion of the study is that the BM&F live cattle future markets are quite effective as a price risk reduction strategy for the own hedge operations, but lack effectiveness in this sense for the feeder cattle cross hedge. That is caused by the high basis risk of these operations, around 80% higher than the risk associated to the live cattle hedge during the contract maturity week considered in this period. This way, the results show the BM&F's hit for the recent introduction of the feeder cattle futures contract.

Key-words: futures market, feeder cattle, cross hedge.

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1. Introduction

The agricultural futures contracts are negotiated, in Brazil, at the Brazilian Mercantile & Futures Exchange (BM&F). Beyond having the function of discovering prices when they provide a future signal of the price and, then, allowing an effective planning of the activity, futures market help to minimize price risks and the problematic that involves activity funding (Schouchana and Perobelli, 2000).

Brazilian livestock production is exposed to a high price risk. It happens mainly because most of the production system is horizontal (not integrated with industry). According to data of the Farming Census (1996), elaborated by IBGE (Brazilian Institute of Geography and Statistic), around 86.75% of the national slaughter bovine cattle, that corresponds to 98.9 million heads of cattle do not come from vertical production. The specialization in one or two steps is commoner. Added to the cultural factors and to matters related to the localization and land prices, economic aspects lead producers to the specialization of the production process (Oliveira, 1991).

In such case, the feeder cattle price is a key variable for cattle farmer who are specialized in animal breeding and for agents involved in breeding/fattening, rebreeding/fattening and fattening. For the last ones, the live cattle price is not analyzed isolated from the decision of selling it or not. The evaluation of feeder cattle price is essential since cattle reposition is a main factor for the activity's continuity. So, the price risk, for these cattle farmers, involves the exchange between live cattle and feeder cattle. (Schouchana and Caffagni, 2001).

The possibility of hedging against adverse price movements of both the feeder and the exchange relations mentioned above become a reality after October 2002, when the BM&F first launched the feeder futures contracts. Before that, cross-hedge operations in the live cattle futures market ought to be done for those seeking protection in the feeder market. The cross hedge risk is related to the unexpected movements that occur in the difference between: i) future and spot prices of the product mentioned in the contract; ii) spot prices of the hedged product and of the product specified in the contract (Hull, 1996). The strategies, that involve this type of operation, should be analyzed with extreme care, because it should be considered the additional price risk associated to the differences in the product's quality (Rochelle, 2000).

2. Objectives

The aim of this study is to analyze the feeder cattle cross hedge at BM&F's live cattle futures market for the following regions: Araçatuba (SP), Bauru/Marília (SP), São José do Rio Preto (SP), Presidente Prudente (SP), Três Lagoas (MG), Triângulo Mineiro (MG), Campo Grande (MS) and Northwest of Paraná.

With that purpose, many different aspects will be analized: a) the basis risk of feeder cattle cross hedge during the live cattle contract maturity week; b) the optimal cross hedge ratio and the effectiveness of this operation, in each region, taking into account the activity's seasonality. Additionally, the analysis of live cattle basis risk will be updated and the optimal hedge ratio of these operations and the respective effectiveness will be calculated. Herewith, the study will verify the differences of the basis variance between live cattle and feeder cattle and between the regions, according to a regression model and tests of hypothesis. With the abovementioned results the study will highlight some important aspects relating the launch of the feeder cattle contract by BM&F.

3. Data

The present study utilized the live and feeder cattle spot prices from the Center for Advanced Studies on Applied Economics/Luiz de Queiroz Foundation for Agrarian Studies (CEPEA/ FEALQ). These values were converted to nominal dollars using the exchange rate of Brazilian Real (R$) per US Dollar (US$) for cash delivery. The futures prices were obtained at the Brazilian Mercantile & Futures Exchange (BM&F) and they correspond to the prices of the first delivery month of live cattle's futures dollar contract. The sample used in this study ranges from September of 1995 (when the contract changed to price index settlement) to February of 2001, when the contract specification changed again. Prices used in the optimal hedge ratio estimation were transformed into weekly arithmetic averages of the future and spot prices, due to serial autocorrelation problem.

4. Methodology

4.1. Basis Risk Analysis

The basis risk analysis is extremely important, since it represents the risk of hedging both live cattle and feeder cattle cross hedge at BM&F's live cattle futures market, and will allow a comparison between the two operations.

First of all, live cattle and feed cattle week basis will be calculated, in each region. The week basis will be obtained through the average of the daily basis observed in the contract maturity week, using the difference between the spot and future prices. It is important to note that the live cattle spot and future prices is measured in US$ per net arroba (15 kg), a different measurement unity when compared to the feed cattle prices (US$/head). Aiming to equalize the price quotation of these animals, the live cattle's spot and future prices will be multiplied by 16.5, since the average weight of a live cattle, which age is more than 36 months, is 16.5 net arrobas.

So, the calculation of feeder cattle basis follows the equation (1):

$$B_{FEED} = (16.5 * p_{LC} - 16.5 * f_{LC}) + \left(p_{FEED} - 16.5 * p_{LC}\right) \qquad (1)$$

B_{FEED} is the feed cattle basis during the live cattle contract maturity week; p_{LC} is the live cattle spot price in this period;

is the live cattle futures price and;

is the feed cattle spot prices.

The calculations of live cattle basis are done using equation (2) that corresponds to the first component of feed cattle basis.

$$B_{LC} = (16.5 * p_{LC} - 16.5 * f_{LC}) \qquad (2)$$

Since the basis that will be considered only takes into account the week that includes the contract maturity date, it is admitted that the spot and future prices already converged to a historic basis. So, the basis, in these periods is composed only by its random component. To obtain the basis risk, then, it is enough to calculate the variance of this series.

Besides that, to verify how the basis risk is different between live cattle and feeder cattle and across the considered regions, it will be estimated a regression model by the Ordinary Least Squares (OLS), in which the basis standard deviation[3], during the contract maturity week, will be expressed in function of binary variables (Equation 3).

$$\ln(s_{BASISij}) = \alpha Type_i + \sum_{j=1}^{8} \beta_j L_j + u_{ij} \qquad (3)$$

Considering,

$\ln(s_{BASIS})$ = neperian logarithm of the basis standard deviation during the live cattle contract maturity week;

$Type_i$ = binary variable to represent if the animal is a live cattle or a feeder cattle. It will assume the value 0, when *i* is related to the basis standard deviation for feeder cattle and value 1, when *i* is related to the basis's standard deviation for live cattle;

L_j = binary variable that indicates the localization. The value will be 1 for a region *j* in which one the basis standard deviation is related and 0 for other regions;

u_{ij}= random error assumed to be normally distributed with zero mean and constant variance.

4.2. Optimal hedge ratio estimation and effectiveness

The study of Myers and Thompson (1989) develops a general procedure to obtain the optimal hedge ratio (δ), through the estimation of the equation (4) using the Ordinary Least Squares (OLS).

[3] The use of the basis standard deviation, as opposite to the variance, is explained by the fact that this last one has the values elevated to the square. To obtain a higher stability of data, the standard deviation was used in form of neperian logarithms.

$$p_t = \delta f_t + \alpha X_{t-1} + \varepsilon_t \quad (4)$$

In the above equation, ε_t corresponds to a random error with normally distribution.

The matrix X_{t-1} will be composed by the following elements: constant term, lagged spot and futures prices. Two presuppositions are made regarding these two last variables: i) they correspond to an auto-regressive process; ii) they reflect other explicative variables that could be present.

Before proceeding to estimations, it is essential to verify the stability of the future and spot prices series. In order to estimate equation (4) using OLS, it is necessary that: i) the future price series is stationary in its first differences (factor that determines the future market efficiency); ii) in case of the spot price series stay stationary only in its first difference, the equation should be specified again, in order to present the spot price in the first difference. Due to that unit root tests will be performed to verify the stationarity of the series, according to the procedure of Enders (1995). For that purpose Dickey & Fuller tests were applied (Dickey and Fuller, 1981).

Aiming to verify the effect of the season's variation in hedge ratio, it will be inserted a *dummy* variable to the models. In other words, the analysis will try to catch the differences that the slope, which correspond to the hedge ratio, can show in different periods of the year. For the models related to the live cattle hedge, it will be considered a *dummy* variable with value one in the rainy season (1st semester) and value zero in the dry season (2nd semester). In the case of feeder cattle cross hedge, the *dummy* will have value one in the months between April to July and value zero for the other months.

The lag length determination of the spot price, which will be contained in matrix X_{t-1}, will follow the results of the Akaike's Information Criterion (AIC) and the Schwarz's Information Criterion (SIC) - equations (5) and (6). The preference will be based on models that have the lowest values of the criterion mentioned above. In other words, the models that present the lowest residues variances and the lowest quantity of parameters will be chosen.

$$AIC = ln\ s^2 \left(\frac{2}{T}\right) (number\ of\ parameters) \quad (5)$$

$$SIC = ln\ s^2 + \left(\frac{\ln T}{T}\right) SIC = ln\ s^2 + \quad (6)$$

In the above equations, s^2 is the residual sum of squares and T is the sample size.

The procedure involves the estimation of a multiple regression. To obtain the hedge effectiveness (*E*), it is necessary to utilize the equation (7).

$$E = 1 - \frac{Var(h)}{Var(p)} \quad (7)$$

Var(h) is the portfolio profit variance with hedge in its optimal ratio, and *Var(p)* is related to the portfolio profit variance not involving hedge operation.

4.2.1. Methodology for the analysis of live cattle futures market efficiency

Since one of the hypothesis used by the methodology to estimate the optimal hedge ratio, defined by Myers and Thompson (1989), consists in the efficiency of future prices, this must be checked for the live cattle's future prices. It will be done according to the study of Saboya and Bacchi (1999).

A future market is considered efficient when there is no relation between the price variations of one day and the variations occurred in previous days. So, the prices come to reflect all the available information until that moment. For this reason, the process that generates the series should have a random behavior and when it is transformed for its first difference, stationary series should be obtained. To verify this, the unit root test is used.

Moreover, it should be emphasized that before doing the unit root test it is necessary to identify the autoregressive process order p denoted by [AR(p)] according to the criterion of information, mentioned before. For the existence of an efficient market, this process should be an AR(1). So, it will be possible to estimate the equation (8) and to analyze if the hypothesis of the unitary root's existence ($\alpha = \beta = \theta = O$) is verified.

$$\Delta f_t = \alpha + \beta t + \theta f_{t-1} + e_t$$

Where $\Delta f_t = f_t - f_{t-1}$ and $\theta = \rho - 1$

5. Empirical Results

5.1. Basis Risk

The Table 1 shows the results of the basis average value and the live cattle and feeder cattle basis risk. The feeder cattle basis was higher than live cattle basis in all regions. Besides that, the cross hedge basis risk was much higher when compared to the results of the own hedge risk.

Table 1. Basis average and basis risk during the live cattle contract maturity week for live cattle and feeder cattle in the period from September of 1995 and February of 2001

Region	Basis Average Value (US$)		Basis Risk (US$²)	
	Feed Cattle	Live Cattle	Feed Cattle	Live Cattle
Araçatuba	-211.19	-2.98	947.01	20.60
Bauru	-210.52	-3.93	1.094.35	23.60
S.J. do Rio Preto	-212.02	-2.67	934.50	23.63
Presidente Prudente	-209.54	-4.51	896.33	25.45
Triângulo Mineiro	-216.46	-21.03	902.69	42.09
Campo Grande	-220.16	-32.74	998.09	76.42
Northwest of Paraná	-215.93	-20.32	1.182.85	63.44
Três Lagoas	-222.12	-27.47	964.82	79.64

To do a comparative analysis of the basis risk between live cattle and feeder cattle and between the regions, the model presented by the equation (3) was estimated.

The Table 2 shows the results of this procedure. The *F* statistic equals 35.65 (greater than the corresponding 1% critical value). More than that, the model explains 97.60% of the variability in the basis standard deviation (R^2= 0. 9760).

Table 2. Regression results of the basis standard deviation during the live cattle contract maturity week in function of binary variables for the type of animal and region

Variables	Estimative of Parameters	t
Type	-1.6224	-16.63*
L1 (Araçatuba)	3.2808	22.42*
L2 (Bauru/Marília)	3.351	22.90*
L3 (São José do Rio Preto)	3.3119	22.64*
L4 (Presidente Prudente)	3.3199	22.69*
L5 (Triângulo Mineiro)	3.4475	23.56*
L6 (Campo Grande)	3.6217	24.75*
L7 (Northwest of Paraná)	3.6177	24.73*
L8 (Três Lagoas)	3.6236	24.77*

Note: *coefficients significantly from zero at the 1% level; ** coefficients significantly from zero at the 2% level

To obtain the effect of the binary variables related to the type of animal and region (*Type e Lj*) on the dependent variable (basis standard deviation), the transformation described by the equation (9) was performed. This is necessary due to the log transformation previously done.

$$Effect = exp(coefficient) - 1 \qquad (9)$$

The observed value for the binary variable *Type* shows that the basis risk differs between live cattle and feeder cattle. Since the coefficient of this variable is negative, after applying the transformations cited above, it can be verified that the basis standard deviation for live cattle was 80.25% lower than the number obtained for the feeder cattle.

Another important result is related to the coefficients values of the binary variables for regions. These values are positive and statistically significant. More than that, when the coefficients related to the regions participating in the Live Cattle Index (IBG), calculated by CEPEA-ESALQ/BM&F (Araçatuba, São José do Rio Preto, Presidente Prudente and Bauru/Marília) are compared to the others, it can be seen that the basis risk was inferior for this first group, what is in agreement with the results obtained by Rochelle (1997).

To analyze if the basis risk differs statistically from one region to the other, hypothesis tests about the fed cattle and feeder cattle variances basis during the live cattle contract maturity week were performed. It was considered as null hypothesis the equality of the basis variance between two regions, against the alternative hypothesis that these variances would be different. 28 combinations of values correspondent to the basis risk were tested with the aid of the F statistic. The results can be observed in the Table 3.

The live cattle basis risk in the regions of IBG was lower than the other ones. Among the regions that participate in the index composition the basis variance doesn't differs statistically. This last result is explained by the fact that IBG is calculated based on price quotations of the main centers of live cattle commercialization in São Paulo State. Moreover, there are no statistically significant observed differences between the regions that present the higher basis risks (Campo Grande, Três Lagoas and Northwest of Paraná).

No basis risk differences across regions were found for the feeder cattle.

Table 3. Results of "*F*" tests about the equality of the live cattle and feeder cattle variances basis during the live cattle contract maturity week at BM&F

Null Hypothesys	**Live Cattle *F* test**		**Feeder Cattle *F* test**
H_0: Araçatuba = Bauru/Marília	1.1457		1.1556
H_0: Araçatuba = Campo Grande	3.7101	*	1.0539
H_0: Araçatuba = Três Lagoas	3.8663	*	1.0188
H_0: Araçatuba = Triângulo Mineiro	2.0435	*	1.0491
H_0: Araçatuba = Presidente Prudente	1.2355		1.0565
H_0: Araçatuba = Northwest of Paraná	3.0798	*	1.249
H_0: Araçatuba = São José do Rio Preto	1.1473		1.0134
H_0: Bauru/Marília = Campo Grande	3.2383	*	1.0964
H_0: Bauru/Marília = Três Lagoas	3.3746	*	1.1342
H_0: Bauru/Marília = Triângulo Mineiro	1.7836	**	1.2123
H_0: Bauru/Marília = Presidente Prudente	1.0783		1.2209
H_0: Bauru/Marília = Northwest of Paraná	2.6882	*	1.0809
H_0: Bauru/Marília = São José do Rio Preto	1.0014		1.171
H_0: Campo Grande = Três Lagoas	1.042		1.0345
H_0: Campo Grande = Triângulo Mineiro	1.8156	**	1.1057
H_0: Campo Grande = Presidente Prudente	3.003	*	1.1135
H_0: Campo Grande = Northwest of Paraná	1.2046		1.1851
H_0: Campo Grande =São José do Rio Preto	3.2336	*	1.0681
H_0: Três Lagoas = Triângulo Mineiro	1.8919	**	1.0325
H_0: Três Lagoas = Presidente Prudente	3.1294	*	1.0764
H_0: Três Lagoas = Northwest of Paraná	1.2553		1.4512
H_0: Três Lagoas = São José do Rio Preto	3.3698	*	1.0688
H_0: Triângulo Mineiro = Presidente Prudente	1.7811	**	1.0071
H_0: Triângulo Mineiro = Northwest of Paraná	1.5071		1.3104
H_0: Triângulo Mineiro = São José do Rio Preto	1.7811	**	1.0352
H_0: Presidente Prudente = Northwest of Paraná	2.4929	*	1.3197
H_0: Presidente Prudente =São José do Rio Preto	1.0767		1.0426
H_0: Noroeste do Paraná =São José do Rio Preto	2.6843	*	1.2658

Notes: *coefficients significantly from zero at the 1% level; ** coefficients significantly from zero at the 5% level; ***coefficients significantly from zero at the 10% level

5.2. Optimal hedge ratio estimation and hedge effectiveness

5.2.1. Autoregressive process identification

The first step to estimate the optimal hedge ratio and to obtain the hedge effectiveness consists in identifying the autoregressive process generators of the series.

Table 4 shows the autoregressive process order of the feeder cattle and live cattle spot prices, by region, and the live cattle future prices. These results were obtained according to the Akaike and Schwarz Information Criterion (AIC and SIC). In some cases, the lowest values of AIC and SIC for these series differ in relation to the criterion utilized. In these cases the lowest lag indicated by one of the criterions were used. During the unit root tests the residues were tested for autocorrelation. When the autocorrelation of the residues was presented, the model was re-specified, considering the lag indicated by the other criterion.

Table 4. Autoregressive process order of the feeder cattle and live cattle prices series indicated by AIC e SIC

	Live Cattle Price Series		**Feeder Cattle Price Series**	
	AR(p) indicated by:		**AR(p) indicated by:**	
Live Cattle Price	**AIC**	**SIC**	**AIC**	**SIC**
Spot				
Araçatuba	p = 8	p = 2	p = 3	P = 2
Bauru/Marília	p = 8	p = 2	p = 3	P = 2
S. José do Rio Preto	p = 7	p = 2	p = 2	P = 1
Presidente Prudente	p = 7	p = 2	p = 8	P = 1
Triângulo Mineiro	p = 7	p = 2	p = 3	P = 3
Campo Grande	p = 11	p = 2	p = 3	P = 3
Northwest of Paraná	p = 2	p = 2	p = 4	P = 2
Três Lagoas	p = 7	p = 2	p = 11	p = 4
Future (BM&F)	p = 2	p = 2	-	-

5.2.2. Unit root test

After defining the auto-regressive process order, the unit root tests was performed, according to the Dickey & Fuller (DF) and Augmented Dickey & Fuller (ADF) Tests. The steps for this analysis follow the procedure described by Enders (1985).

Since the unit root tests are not valid in the presence of residue autocorrelation, the Q statistics of Ljung Box were checked. For the models that presented autocorrelation in residues, lags indicated by the alternative criterion were successfully used, as it was described previously. The results showed that the feeder cattle and live cattle prices series become stationary in the first differences.

5.2.3. Hypothesis of efficient future market

After identifying the autoregressive process order and the series stationarity, the hypothesis of efficient future market for the live cattle future price was analyzed. For that, as it was cited previously, the procedure created by Saboya e Bacchi (1999) was adopted.

It was evidenced, previously, that the autoregressive process of live cattle future prices has order two [AR(2)]. In other words, the average price observed in one week is related to the price of the two previous weeks. This result indicates that the formation of these prices should have tendencies. However, it is not possible to conclude definitely that the market is inefficient because the autoregressive process order is low. It's important to point out that Saboya & Bacchi (1999), utilizing the daily data of live cattle future prices at BM&F in the period between October of 1994 to February of 1999 and excluding the live cattle contracts that present low liquidity, concluded that in all the 39 contracts analyzed, the auto-regressive process of the price series was an [AR(1)], showing efficiency in this future market.

Since it is not possible to take an exact conclusion about the efficiency of live cattle futures market, the optimal hedge ratio estimation will be done according to the methodology considered by Myers & Thompson (1989), recognizing the limits of the procedures.

5.2.4. Effectiveness and optimal hedge ratio

The optimal hedge ratios were obtained using the estimation of the equation (10). Since the live cattle and feeder cattle prices series became stationary only in the first difference, the regressions occurred in the variations of spot and future prices. More than this, to differentiate the hedge ratios across different periods equation (11) was estimated for the different regions studied.

$$\Delta P_t = \alpha + \delta \Delta F_t + \sum_{i=1}^{p} \beta_i \Delta P_{t-i} + \gamma \Delta F_{t-1} + u_t \qquad (10)$$

$$\Delta P_t = \alpha + \delta \Delta F_t + \sum_{i=1}^{p} \beta_i \Delta P_{t-i} + \gamma \Delta F_{t-1} + \gamma D_i \Delta F_t + u_t \qquad (11)$$

Where,

ΔP_t = live cattle (feeder cattle) spot price in the first difference at the moment t;
δ = optimal hedge ratio;
ΔF_t = live cattle future price at BM&F in the first difference;
ΔP_{t-i} = live cattle (feeder cattle) spot price in the first difference at the moment $t-i$;
ΔF_{t-1} = live cattle future price at BM&F at the moment $t-1$;
D_i = slope dummy variable to capture the differences of the hedge ratios between different periods;
u_t = random error.

The results of the operation effectiveness and the live cattle and feeder cattle optimal hedge ratios can be observed in the Tables 5 and 6. Despite high cross hedge ratios were evidenced (between 38% and 48%), the effectiveness of these operations turned out to be very low – around 1.5%. The main reason for this fact consists in the high basis risk that involves these operations when compared to the live cattle basis risk. It's observed that the higher effectiveness occurred at Presidente Prudente – maintaining 43.81% of the position hedged would reduce price risk by 3.13%. The lower effectiveness was verified at Triângulo Mineiro, where maintaining 47.84% of the feeder cattle hedge would reduce price risk by only 0.66%. It's worth to mention that the effectiveness of these operations didn't differ significantly between the periods analyzed.

In relation to the live cattle hedge, it is noticed that the effectiveness, in regions considered in the study, were close one to each other. The highest values occurred in Araçatuba and Três Lagoas, indicating that the position in live cattle future contracts in the proportion of optimal hedge ratio (58.35% and 62.22%, respectively) would reduce the price risk in 51.50% and 50.15%, respectively. The lowest values of effectiveness where verified in the models relative to Campo Grande (41.83%) and Northwest of Paraná (41.14%). More than this, it was observed that, in all regions, the operations had a higher effectiveness during the rainy season. This can be explained by the higher amount of information that the market owns in this period, what contributes to the existence of a lower basis risk. This fact occurred with more intensity in the models of Triângulo Mineiro and Bauru/Marília.

Table 5. Effectiveness and feeder cattle cross hedge ratio in the period between September of 1995 and February of 2001

	Optimal cross hedge ratio (%)			**Cross hedge effectiveness (%)**		
Regions	**General**	**Harvest**	**Between Harvests**	**General**	**Harvest**	**Between Harvests**
Araçatuba	40.55	11.07	50.32	1.89	0.77	2.52
S. J. Rio Preto	41.23	25.34	46.63	2.05	1.28	2.49
Bauru/Marília	41.12	34.18	43.46	1.33	0.53	2
P. Prudente	43.81	13.05	53.93	3.13	0.94	4.52
Nor. Paraná	38.69	32.22	37.39	1	1.08	0.89
Três Lagoas	48.27	23.93	56.56	1.13	0.87	1.29
C. Grande	37.41	1360	45.38	1.47	0.46	2.72
T. Mineiro	47.84	6.71	61.25	0.66	-0.3	1.84

Table 6. Effectiveness and live cattle hedge ratio in the period between September of 1995 and February of 2001

	Optimal hedge ratio (%)			Hedge effectiveness (%)		
Regions	General	Harvest	Between Harvests	General	Harvest	Between Harvests
Araçatuba	58.35	62.82	56.47	51.5	55.42	49.09
S. J. Rio Preto	59.97	64.48	52.47	48.55	50.98	47.53
Bauru/Marília	58.36	64.24	48.54	48.87	53.41	45.05
P. Prudente	59.51	64.95	50.49	49.55	53.72	46.4
Nor. Paraná	61.47	66.36	53.48	42.85	46.06	41.14
Três Lagoas	62.22	65.66	56.47	50.15	51.8	49.82
C. Grande	60.19	62.85	55.68	41.83	43.27	41.77
T. Mineiro	55.84	61.99	45.52	47.12	52.69	42.18

The F statistics are significantly greater than the respective 1% critical value in all models. Moreover, the optimal hedge ratio, indicated by the coefficient δ, was significant in all cases.

6. Conclusions

Before the introduction of feeder cattle future contract at BM&F in October of 2002, the cattle farmers specialized in the steps of breeding, breeding/fattening, rebreeding/fattening and fattening had as alternative the realization of operations known as cross hedge in the live cattle futures market, with the target of protecting themselves from the adverse variations in feeder cattle prices.

In this study, the risk of this operation was evaluated and compared to the own hedge risk. It was verified that the cross hedge presented a basis risk approximately 80% higher than the one seen in the own hedge during the live cattle contract maturity week in the period between September of 1995 and February of 2001.

Moreover the optimal hedge ratios and the effectiveness of feeder cattle cross hedge were calculated. As a way of comparison, the same analyses were done for live cattle hedge. In the cross hedge and in own hedge, the ratios were elevated – in the first case they were between 37% and 49%, and in the second they varied between 58% and 63%.

In relation to the effectiveness, it was noticed that, in the own hedge's case, the price risk can be reduced by around 50% (considering the optimal hedge ratio). However, for the cross hedge, the effectiveness was very low for all the regions. BM&F's live cattle futures prices changes do not explain enough of the variances in feeder cattle cash prices to allow feedlot operators to reduce risk through hedging. In other words, these operations involve a high basis risk. In addition, it was noticed that the own hedge effectiveness was superior in the rainy seadon in relation to the dry season. The same aspect was analyzed in cross hedge, but there were no significant differences presented.

The results found lead to the conclusion that the feeder cattle could not be efficiently hedged through a cross-hedge in the cattle futures market. The launch of the feeder cattle futures contracts by BM&F creates new hedging opportunities for producers, both for those specialized in the feeder production and for those seeking stocks replenishing. The results, then, point out for the correctness, from a producer risk management standpoint, of the BM&F decision in creating this new futures contract.

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