Robustness Results for Regression Hedge Ratios: Futures Contracts with Multiple Deliverable Grades

P.V. Viswanath
Sris Chatterjee

INTRODUCTION

A standard technique in computing the minimum-variance hedge ratio is to run a regression where the past price changes of the commodity being hedged constitute the dependent variable, and where the independent variable is the set of past price changes of the futures contract [Ederington (1979)]. This is referred to as the time-series regression. This regression approach assumes that the distribution of spot and futures price changes is independent of the time that the hedge is put in place and the duration of the hedge. In most situations, this is a reasonable assumption. Recently, however, Kamara and Siegel (1987) show that this assumption is inappropriate for futures contracts where the short trader can choose to deliver from a variety of deliverable grades. This is due to the information content of the relative price levels of the deliverable grades at the time the hedge is implemented. Depending on the price dynamics, the relative price levels have some bearing on which grade is the cheapest to deliver at maturity.

Various aspects of the existence of multiple deliverable grades are examined in the literature. For example, the valuation of the delivery option that it gives rise to is the subject of overwhelming theoretical and empirical research [see Boyle (1989) and Hemler (1990) for a review of the literature]. Lien (1988) looks at the welfare aspects of multiple-delivery contracts and analyzes broad-based versus narrow-based contracts. Lien (1989b) examines the optimality characteristics of conven-

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[1] Lien (1989a) extends Kamara and Siegel's findings to the case of optimal hedging in several wheat futures markets. The markets he considers are the CBT, which has multiple deliverable grades and the KCBT, which has only one deliverable grade. However, for the purposes of this discussion, it is sufficient to refer to Kamara and Siegel's analytic results only, because Lien's theoretical results are based on Kamara and Siegel's analysis.

P.V. Viswanath is an Assistant Professor, Graduate School of Management, Rutgers University.

Sris Chatterjee is an Assistant Professor, Graduate School of Business Administration, Fordham University.

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tional delivery contracts with multiple deliverable grades compared to cash settlement based on the spot prices of multiple grades. The question of estimating the optimal hedge ratio in the presence of multiple deliverable grades, however, has received scant attention. Castelino and Chatterjee (1988) provide some evidence that a hedge ratio based on an index of deliverable bonds outperforms the hedge based on the cheapest-to-deliver. Kamara and Siegel, however, are the only researchers to investigate this question rigorously, albeit only for the special case where the futures contract allows only two deliverable grades and the hedge is lifted at maturity.[1]

In this case, they provide a method for computing the theoretically correct hedge ratio. They apply their model to a sample of wheat futures and show that the hedging effectiveness of their hedge ratio is superior to that of a full hedge, but they do not compare it to the regression hedge. This study makes that comparison. It is found that although the regression hedge ratio may be wrong "in theory," it works very well "in practice." A modified version of the time-series regression hedge ratio using "cross-contract" data is suggested that resolves some of the theoretical difficulties of the regression method. This modified "cross-contract" regression hedge ratio is found likely to work best for futures contracts with no timing options or any options other than the quality option.

This investigation is in the spirit of Grant and Eaker (1989) who show that simple hedges based on time-series regression hedge ratios perform extremely well even in situations where theory suggests the construction of more complex hedges. They look at the case of an elevator operator who wants to sell part of his position in March and part in May. Theoretically, he should construct a complex hedge with both March and May futures. In practice, they find that he does quite well using May futures alone, using hedge ratios for a simple time-series regression. The time-series regression and the Kamara–Siegel estimation methods are presented first and the hedging effectiveness of the two in the wheat futures market are compared.

THE THEORETICAL HEDGE RATIO WITH TWO DELIVERABLE GRADES

Following the notational style in Kamara and Siegel, let X and Y be two grades of the spot asset, and let P_{xt} and P_{yt} represent their prices at time t, $t = 0,1$. A futures contract is traded at time 0 with a price of f_0, calling for delivery of one unit of either X or Y at time 1. Assuming that the trader wishes to hedge the X variety at time 0, the dollar return at time 1 on a hedge portfolio long one unit of X and short h units of the futures contract is given by

$$R = P_{x1} - P_{x0} - h(f_1 - f_0)$$

The portfolio's expected return and variance of return are given by:

$$E(R) = E(P_{x1}) - P_{x0} - h[E(f_1) - f_0]$$

and

$$\text{Var}(R) = \text{Var}(P_{x1}) + h^2\text{Var}(f_1) - 2h\text{Cov}(P_{x1}, f_1)$$

The minimum-variance hedge ratio h* is then given by:

$$h^* = \frac{\text{Cov}(P_{x1}, f_1)}{\text{Var}(f_1)} \tag{1}$$

Eq. (1) provides the rationale for the traditional regression hedge ratio. In this approach the hedge ratio is determined by the slope coefficient of the regression of spot prices on futures prices using historical data.[2] But the presence of delivery options complicates this situation, because the short trader has the option to deliver the cheapest quality. If spot-futures convergence is guaranteed, and the hedge is lifted at time 1, the futures price will converge to the minimum of the two spot prices.[3] In this case, the futures price and the optimal hedge ratio are given by:

$$f_1 = \mathrm{Min}(P_{x1}, P_{y1})$$

and

$$h^* = \frac{\mathrm{Cov}[P_{x1}, \mathrm{Min}(P_{x1}, P_{y1})]}{\mathrm{Var}[\mathrm{Min}(P_{x1}, P_{y1})]} \tag{2}$$

Kamara and Siegel derive an analytical expression for h* in eq. (2) by assuming that P_{x1} and P_{y1} follow a bivariate normal distribution. Their hedge ratio is a nonlinear function of the mean and standard deviation of $P_{x1} - P_{y1}$, and the probability that X will be the cheaper variety to deliver at contract maturity.[4]

In the next section, the performance of the two hedge ratio estimation methods—the time-series regression and the Kamara–Siegel method—are evaluated. For the sake of completeness, results for the full hedge are presented also.

DATA AND ESTIMATION METHOD

Tests are conducted on the same sample studied by Kamara and Siegel who graciously supplied their data on the spot prices on #2 hard and #2 soft red winter wheat in Chicago. These data cover a period from January 1970 through March 1981. Futures price data on the Chicago Board of Trade wheat contract are from Data Resources Inc. (DRI). DRI reports futures prices until the last trading day of the month prior to delivery. The futures prices on the first delivery day are from the Dow Jones News Retrieval system. Following Kamara and Siegel, two contracts are dropped and 54 contracts are retained.

The time-series regression and Kamara–Siegel hedge ratios[5] are computed as follows. For the estimation of the time-series regression hedge ratio, the daily spot

[2]In practice, a regression of spot price *changes* on futures price *changes* is usually run. This does not affect the conceptual argument made here. [see Witt, Schroeder, and Hayenga (1987) for a comparison of regression in the price levels, in the price changes and in the percent price change.]

[3]Spot-futures convergence, in the context of this article, refers to convergence of the futures price to the minimum of the spot prices of the deliverable grades.

[4]The optimal hedge ratio is given by:

$$h^* = \frac{\sigma_x^2 - (\sigma_x^2 - \sigma_{xy})N(-\delta)}{\sigma_x^2 + (\sigma_y^2 - \sigma_x^2)N(-\delta) + \mu^2/4 - \beta^2}$$

where:

$$\beta = \mu/2 - \mu N(-\delta) + \mu\Phi(\delta)/\delta$$
$$\delta = \mu/\sigma_{(y-x)} = \mu/(\sigma_x^2 + \sigma_y^2 - 2\sigma_{xy})^{1/2}$$
$$\mu = \mu_x - \mu_y \quad N(t) = \int_{-\infty}^{+}\Phi(\tau)d\tau$$
$$\Phi(t) = \exp(-t^2/2)/(2\pi)^{1/2}$$

[5]Kamara and Siegel evaluate the effectiveness of their optimal hedge ratio against a full hedge both under the assumption that the variances of the two spot prices P_{x1} and P_{y1} are different, and under the assumption that they are equal. They find, however, that their estimation method produces the best results when the two variances are assumed to be the same. This study is restricted also to the case where the two variances are assumed to be equal.

price changes are regressed against futures price changes[6] for 20 trading days prior to the day the hedge is implemented. Similarly, for the Kamara–Siegel hedge ratio, the variance and covariance of spot price changes are estimated using the same 20 trading days. The resultant estimates are then used in the Kamara–Siegel formula to compute the hedge ratio. The computed ratios are then used to implement the hedges for four different hedge durations (specifically, 1, 2, 3, and 4 weeks), with all hedges being lifted on the first day of the delivery month.

In comparing different hedging strategies for hard and soft wheat, Kamara and Siegel compute the rate of return according to the following formula:

$$\mathrm{ROR} = \frac{(P_{x1} - P_{x0}) - h[\mathrm{Min}(P_{x1}, P_{y1}) - f_0]}{P_{x0}} \tag{3}$$

In their empirical tests, Kamara and Siegel lift the hedge on the first trading day of the delivery month. If there were convergence of the futures price to the minimum of the two spot prices on the first trading day of the delivery month, this procedure would be correct. However, because of the presence of the delivery-day timing option,[7] such a convergence does not, in general, hold. The closing futures price on the first trading day of the delivery month may be very different from the minimum of the two spot prices, which is the case here.[8] Since the open futures position would normally be closed by an offsetting transaction in the futures market, using $\mathrm{Min}(P_{x1}, P_{y1})$ in computing the ROR introduces an error of unknown magnitude. This problem is rectified by using the futures price on the hedging-lifting day, and the following equation is used to compute ROR:

$$\mathrm{ROR} = \frac{(P_{x1} - P_{x0}) - h(f_1 - f_0)}{P_{x0}} \tag{4}$$

RESULTS

Table I reports the estimated time-series regression and Kamara–Siegel hedge ratios. At a 5% level of significance, all the Kamara–Siegel hedge ratios are significantly different from 1.00, but none of the regression hedge ratios is significantly different from 1.00. Table II presents the mean and the standard deviation of the portfolio RORs for (1) the unhedged portfolio; (2) the fully hedged portfolio; (3) the Kamara–Siegel-hedged portfolio; and (4) the time-series regression-hedged portfolio. Results are presented for both definitions of ROR—eq. (3) (assuming convergence) and eq. (4) (not assuming convergence). If the hedges are assumed to be lifted at the minimum of the two spot prices (in practice, this is not feasible for a trader, unless spot-futures convergence occurs), the Kamara–Siegel-hedged portfolio performs the best with the fully hedged portfolio not far behind. However, if the hedges

[6]For this study, the spot and futures prices have very little serial correlation. Consequently, it is appropriate to use spot and futures price changes instead of price levels.

[7]That is, the option that the short has to deliver on any business day in the delivery month. On average, only 25% of the deliveries on the CBT wheat contract in 1982 are made on the first day. For 1983, the figure is 17.5% and for 1984, it is 29%. This indicates the importance of the delivery-day timing option.

[8]In this sample of 54 contracts, the futures price on the first day of the delivery month is, on average, 6.5¢ greater than the minimum of the spot prices of the two main deliverable grades on that day. The standard error of the mean was 1.89¢, thus allowing one to statistically reject the hypothesis that the difference is zero. The actual difference ranges from −30¢ to +60¢.

Table I
KAMARA–SIEGEL AND TIME-SERIES REGRESSION HEDGE RATIO ESTIMATES

	Hedge Duration							
	1 week		2 weeks		3 weeks		4 weeks	
	Soft[a]	Hard[a]	Soft	Hard	Soft	Hard	Soft	Hard
Time-series regression:								
Mean	1.004	1.004	0.977	0.976	0.998	0.971	0.984	0.970
SD	0.158	0.138	0.132	0.140	0.156	0.146	0.188	0.168
SE of Mean	0.022	0.019	0.018	0.019	0.021	0.020	0.026	0.023
Minimum	0.612	0.698	0.627	0.379	0.442	0.442	0.102	0.346
Maximum	1.545	1.525	1.253	1.366	1.346	1.271	1.507	1.566
Kamara–Siegel								
Mean	0.927	0.936	0.922	0.933	0.902	0.949	0.917	0.928
SD	0.109	0.132	0.121	0.135	0.156	0.118	0.155	0.157
SE of Mean	0.015	0.018	0.017	0.018	0.021	0.016	0.021	0.021
Minimum	0.575	0.315	0.480	0.179	0.262	0.216	0.086	0.194
Maximum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[a]Wheat quality.

are assumed to be lifted by an offsetting futures market transaction (which is the more realistic assumption), the three hedged portfolios perform fairly similarly.

To better compare the performance of the Kamara–Siegel hedge ratio relative to the other portfolios, relative hedging effectiveness values are computed: the percentage improvement obtained by the Kamara–Siegel portfolios over the other three portfolios, in terms of standard deviation of ROR. These are shown in Table III. If spot-futures convergence is assumed (the hedges are lifted at the minimum of the spot prices of the deliverable grades), the superiority of the Kamara–Siegel hedge compared to the full hedge and the time-series regression hedge is evident (see panel A). However, the situation is very different if it is not assumed that spot-futures converge (i.e., the hedges are lifted at the futures price). In this case (panel B), it is shown that the hypothesis of no difference between the variances of the returns to the Kamara–Siegel and the time-series regression-hedged portfolios can be rejected in only one case,[9] that of the four-week hedge for hard wheat. If the Kamara–Siegel hedge ratio is compared to the full hedge, it is found that the full hedge is significantly better for the one-week hard wheat hedge, while the Kamara–Siegel hedge ratio is better for the four-week hard wheat hedge.[10] Therefore, there is no particular advantage to using the more complicated Kamara–Siegel hedge ratio computation if, in fact, there are timing options available to the

[9]Morgan's test of differences in variances (1939) is used. This is the same test used by Kamara and Siegel (1987).

[10]The reader should keep in mind that the regression hedge ratio estimate could not, in any case, be distinguished from unity, i.e., a full hedge. The good showing of the full hedge, therefore, can be used as indirect evidence supporting the regression hedge ratio. It is important, nevertheless, to look at the hedging effectiveness of the portfolios using the actual regression hedge ratio estimate, because for hedges lifted away from maturity, there would no longer be a presumption of an optimal hedge ratio of unity, even with a single deliverable grade.

Table II
STANDARD DEVIATIONS OF RATE OF RETURN ON HEDGED PORTFOLIOS (IN %)

Hedge Duration	Unhedged	Full Hedge	Kamara–Siegel	Time-Series
(A) Assuming spot-futures convergence—hedge lifted at minimum of soft and hard spot prices.				
Soft wheat				
1 week	4.07	3.91	3.56	4.26
2 weeks	5.05	3.99	3.28	4.10
3 weeks	6.57	4.39	3.67	5.09
4 weeks	7.83	4.31	3.55	5.06
Hard wheat				
1 week	4.13	3.88	3.84	4.13
2 weeks	5.00	4.31	4.30	4.54
3 weeks	6.37	4.31	4.19	4.72
4 weeks	7.50	4.57	4.27	5.31
(B) Not assuming spot-futures convergence—hedge lifted at futures price.				
Soft wheat				
1 week	4.07	1.28	1.28	1.42
2 week	5.05	1.39	1.42	1.45
3 week	6.57	2.11	2.26	2.23
4 week	7.83	2.56	2.52	2.92
Hard wheat				
1 week	4.13	0.90	1.07	1.06
2 week	5.00	1.80	1.89	1.89
3 week	6.37	2.03	1.96	2.07
4 week	7.50	2.39	2.21	2.85

short, so that convergence of the futures price to the minimum of the spot prices is no longer guaranteed.[11]

THE CROSS-CONTRACT REGRESSION HEDGE RATIO

If there is a quality delivery option, the distribution of the change in futures prices between two points in time, t_0 and t_1 ($t_0 < t_1$) depends on the relative levels of the spot prices at t_0. In fact, this distribution is related also to the difference $t_1 - t_0$ and to the distance from contract maturity. The actual form of this relationship is quite nonlinear, and depends crucially on the distributional assumption that is made.[12] In principle, the hedge ratio formula has to take this relationship into account: the Kamara–Siegel formula does this by making the specific assumptions of joint normality and spot-futures convergence.

[11]It must also be kept in mind that the performance of the Kamara–Siegel hedge ratio is substantially worse if the variances of the spot prices P_{x1} and P_{y1} are assumed to be different. In this case, if the hedge is lifted at the futures price, the full hedge is significantly better than the Kamara–Siegel hedge ratio in three cases out of eight (four hedge durations for hard wheat and four for soft wheat), while the latter is never significantly better. None of the other results is altered.

[12]Some idea of this dependence can be obtained by looking at the formula for the Kamara–Siegel hedge ratio in footnote 4.

Table III
HEDGING EFFECTIVENESS OF THE KAMARA–SIEGEL (KS) HEDGE (IN %) RELATIVE TO THE FULL HEDGE AND THE TIME-SERIES REGRESSION (TS) HEDGE

	KS Hedge vs. Full Hedge		KS Hedge vs. TS Hedge	
Hedge Duration	Soft Wheat	Hard Wheat	Soft Wheat	Hard Wheat
(A) Assuming spot-futures convergence—hedge lifted at minimum of soft and hard spot prices.				
1 week	17.26[a]	1.98	30.27[a]	13.46[a]
2 week	32.56[a]	0.38	35.98[a]	10.09
3 week	29.79[a]	5.81[a]	47.78[a]	21.23[a]
4 week	32.20[a]	12.52[a]	50.68[a]	35.11[a]
(B) Not assuming spot-futures convergence—hedge lifted at futures price.				
1 week	−1.24	−43.93[a]	17.95	−3.32
2 week	−3.59	−10.94	4.81	−0.52
3 week	−14.03	6.79	−2.34	10.37
4 week	3.50	14.64[a]	25.36	39.96[a]

Note: A positive number indicates that the Kamara–Siegel hedge ratio produces a lower variance of portfolio returns.
[a]Significant at the 5% level.

An easier way of making such an adjustment is to estimate the hedge ratio using a restricted sample of price changes as follows. Such an alternative "modified" regression method estimates the hedge ratio as the slope of the regression of spot price changes on futures price changes just as in the time-series regression. However, where the traditional regression method uses all spot and futures price changes, this method uses only the futures price changes over the same portion of the life of the contract as the actual hedge that the trader is interested in and the spot prices that correspond to the same period. An example makes this idea clear. Suppose the trader wishes to implement a two-week hedge on May 15, 1990 by using the June 1990 wheat futures. The hedge is to be lifted on June 1, 1990. Then, the hedge ratio on May 15, 1990, is computed as the slope of the regression of $P_{xT_i} - P_{xT_i-14}$ on $f_{T_i} - f_{T_i-14}$, where T_i is the first delivery day for the ith contract. In this case, the index i might stand for past contracts, e.g., the December 1989, September 1989, June 1989, etc. Since each contract yields one observation for the regression, this regression is called a *cross-contract* regression. This allows for the dependence of the hedge ratio on the hedge duration and the distance from maturity. However, this method does not take into account the specific dependence of the relative price levels of the deliverable grades at the time that the hedge is implemented. On the other hand, specific distributional assumptions do not have to be made, and hence, the resulting estimates are not sensitive to whether these assumptions hold or not. Which approach works better in practice is an empirical question, and is considered below.

For the evaluation of the cross-contract hedge ratios, data from the first 30 contracts are used. These hedge ratios are then implemented on the remaining 24 contracts and the resulting ROR calculated. To maintain strict comparability to the Kamara–Siegel methodology, the variance and covariance estimates used in the Kamara–Siegel hedge ratios are recomputed using the same spot and futures price changes over the hedging period for the first 30 contracts. These Kamara–Siegel hedge ratios are then implemented on the remaining 24 contracts. The hedge ratios are reported in Table IV, and the mean and standard deviation of the RORs for the different portfolios are reported in Table V.

As in Table I, all of the Kamara–Siegel hedge ratios are significantly different from 1.00; whereas, of the cross-contract hedge ratios, only the four-week hedge ratio for hard wheat is significantly different from 1.00. However, in contrast to the results for the time-series regression hedge ratio, the cross-contract hedge ratio is by far the best of the four alternatives investigated. Table VI summarizes the results on comparative-hedging effectiveness. If the hedge is lifted at the futures price on the first delivery day (i.e., if spot-futures convergence is not assumed) (panel A), then it is not possible to reject the hypothesis that the hedging effectiveness of the Kamara–Siegel and the cross-contract hedge ratios are equal. However, one can reject the hypothesis of equal effectiveness of the Kamara–Siegel and full hedges in the case of the four-week hedge for soft wheat in favor of Kamara–Siegel.

The surprising result occurs when the hedge is lifted at the minimum of the spot and futures prices (i.e., spot-futures convergence is assumed) (panel B). In this case, the cross-contract regression hedge ratio is better in each of the four cases for hard wheat. For soft wheat, it is significantly better for the one-week hedge and significantly worse than the Kamara–Siegel method for two-week and three-week hedges. The conclusion seems to be that the cross-contract hedge ratio works better if spot-futures convergence is guaranteed, that is, there are no timing options.

CONCLUSION

This article critically reexamines, from a practitioner's point of view, the suitability of the regression technique in determining hedge ratios in the case of futures contracts with multiple deliverable grades. For the purpose of demonstration, the Chicago Board of Trade wheat futures contract is chosen which has two principal deliverable grades, and for which a hedge ratio formula has recently been proposed

Table IV
KAMARA–SIEGEL AND CROSS-CONTRACT REGRESSION HEDGE RATIO ESTIMATES

	Hedge Duration							
	1 Week		2 Weeks		3 Weeks		4 Weeks	
	Soft[a]	Hard[a]	Soft	Hard	Soft	Hard	Soft	Hard
Cross-contract regression								
Mean	0.925	0.959	0.993	0.947	0.980	0.921	0.976	0.903
Kamara–Siegel								
Mean	0.979	0.988	0.978	0.990	0.981	0.992	0.987	0.994
SD	0.019	0.016	0.019	0.015	0.016	0.012	0.011	0.009
SE of Mean	0.004	0.003	0.004	0.003	0.003	0.003	0.002	0.002
Minimum	0.956	0.956	0.957	0.957	0.964	0.964	0.974	0.974
Maximum	1.001	1.001	1.020	1.001	1.000	1.000	1.000	1.000

[a]Wheat quality.

Table V
STANDARD DEVIATIONS OF RATE OF RETURN ON HEDGED PORTFOLIOS (IN %)

Hedge Duration	Unhedged	Full Hedge	Kamara–Siegel	Cross-Contract
(A) Assuming spot-futures convergence—hedge lifted at minimum of soft and hard spot prices.				
Soft wheat				
1 week	2.44	4.12	3.93	3.76
2 weeks	3.42	4.28	4.09	4.25
3 weeks	5.18	4.44	4.25	4.31
4 weeks	6.46	4.78	4.63	4.62
Hard wheat				
1 week	3.02	4.19	4.17	3.98
2 weeks	3.97	4.54	4.53	4.28
3 weeks	5.20	4.46	4.44	3.93
4 weeks	6.51	4.78	4.76	4.08
(B) Not assuming spot-futures convergence—hedge lifted at futures price.				
Soft wheat				
1 week	2.44	1.49	1.48	1.43
2 week	3.42	1.58	1.55	1.57
3 week	5.18	2.12	2.08	2.10
4 week	6.46	2.74	2.68	2.69
Hard wheat				
1 week	3.02	0.77	0.77	0.81
2 week	3.97	1.51	1.51	1.50
3 week	5.20	1.65	1.66	1.61
4 week	6.51	2.16	2.15	1.89

by Kamara and Siegel, assuming that hedges are lifted at maturity. Although the formula derived by Kamara and Siegel is theoretically superior under the maintained assumptions, it is shown that, in practice, the traditional time-series regression hedge ratio does very well if spot-futures price convergence at maturity is uncertain. A modified regression hedge ratio, which is constructed from a cross-section of contracts is introduced. This cross-contract hedge ratio does as well as Kamara–Siegel solution if spot-futures convergence at maturity is not guaranteed, and does substantially better than the Kamara–Siegel hedge ratios if spot-futures convergence is guaranteed. Hence, whether convergence is guaranteed or not, there is a regression-based hedge ratio estimation method that does as well or outperforms the Kamara–Siegel method.

In addition, there are problems in extending the Kamara–Siegel formula to a broader context: (1) the Kamara–Siegel solution becomes inapplicable if spot prices or spot price changes are not jointly normal—h^* may not be easy to compute for alternative distributional assumptions; (2) even when the assumption of Normal distribution is satisfied, it is very difficult to extend Kamara–Siegel's solution to the situation where there are more than two deliverable assets; and (3) the derivation of

Table VI
HEDGING EFFECTIVENESS OF THE
KAMARA–SIEGEL (KS) HEDGE (IN %) RELATIVE TO THE
FULL HEDGE AND THE CROSS-CONTRACT REGRESSION (CC) HEDGE

	KS Hedge vs. Full Hedge		KS Hedge vs. CC Hedge	
Hedge Duration	**Soft Wheat**	**Hard Wheat**	**Soft Wheat**	**Hard Wheat**
(A) Assuming spot-futures convergence—hedge lifted at minimum of soft and hard spot prices.				
1 week	9.29[a]	1.06	−9.26[a]	−9.64[a]
2 weeks	8.61[a]	0.13	7.16[a]	−12.07[a]
3 weeks	8.15[a]	1.10	2.70[a]	−27.42[a]
4 weeks	6.27[a]	0.84	−0.48	−36.28[a]
(B) Not assuming spot-futures convergence—hedge lifted at futures price.				
1 week	2.36	−0.19	−5.96	9.23
2 weeks	3.23	−0.91	1.91	−2.07
3 weeks	3.38	−0.31	1.77	−6.32
4 weeks	4.55[a]	0.11	0.28	−29.67

[a]Wheat quality

the formula depends crucially on the assumption that f_t converges to Min(P_{xt}, P_{yt}) at maturity.

Therefore, in spite of the theoretical shortcomings of the regression hedge ratio, in practice, it yields very good results. The moral of the story is that *complicated* is not necessarily *better*.

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