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Francesco S. Braga
and
Larry J. Martin

UNIVERSITY of GUELPH

Department of Agricultural Economics and Business

University of Guelph
Guelph, Ontario
Canada
N1G 2W1

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* Francesco Braga is a PhD candidate and Larry Martin is Professor and Chairman, Department of Agricultural Economics and Business, University of Guelph.

Abstract

This article investigates the effectiveness of the use of the Chicago Board of Trade corn and wheat futures as cross hedging instruments for the European Community variable levy risk. A simple model is provided to approximate the complex EC agricultural regulations and to cope effectively with the commodity and the exchange rate components of the variable levy risk. Daily data are used for the analysis that covers the four year period from August 1981 (the beginning of the 1981-82 crop year) to July 1985 (the end of the 1984-85 crop year). Johnson's optimal hedge ratio is calculated for hedge lengths of one, two and four weeks. The stability of the optimal hedge ratio for each single crop year is analyzed, and the ex post effectiveness of this approach is compared with that of a naive hedge. The empirical results emphasize the importance of hedging both components of the variable levy risk and indicate that the Chicago Board of Trade corn and wheat futures are good cross hedging instuments.

Introduction

The Common Agricultural Policy (CAP) of the European Economic Community (EC) protects the domestic market against cereal imports at a price below the threshold level, which is fixed for the different commodities at the beginning of each crop year. In order to achieve this objective when the world price is below the threshold level, a commodity specific variable import levy (VL) is imposed daily by the EC Commission on all cereals entering the European market for domestic consumption. As for any price set by the CAP, the VL is set in the European Currency Unit (ecu), and it is equal to the difference between the current threshold price for that cereal, which is known in advance to the traders, and the lowest of the previous day asking prices (c.i.f. the border of the Community) adjusted for quality and freight differentials to Rotterdam.

Forward values of the VL are set on the basis of forward commodity prices. Regardless of the forward price quoted, however, the forward VL cannot be lower than the spot one: in a normal carrying charge market traders are therefore strongly penalized. Traders have the option either to pay the VL valid the day the commodity is imported or to fix it at the current forward values, gross of any change in the threshold price, for the period of validity of the import licence, 45 days in the case of corn and wheat. A bond, which is higher if the prefixing option is selected, must be posted to ensure that the trade will take place according to the terms stated in the licence. The import licence may be transferred only once, although, according to Debatisse (1984), a loophole in the regulation does confer some liquidity to this market.

The EC Commission also enjoys a discretionary power in the VL setting process. This power is normally used to adjust any market data whenever this is felt necessary or when a domestic market disruption is feared: the VL setting proces is not a simple, automatic calculation.

The opinion that some form of speculative trading is possible, mostly by prefixing the VL, is quite common in the literature. Debatisse (1984) describes two simple trading strategies using futures contracts to hedge the commodity price risk until the prefixing of the VL takes place, or until the purchase price of the cereal is finalized. Debatisse uses the term "speculative profit" to indicate the levy saving obtained by prefixing the levy in a declining world price environment. The need for hedging the VL risk is clear and according to Debatisse, Dumas and Yon, better hedging devices should be estabilished, free of bureaucratic interference.

To the authors' knowledge, there is no published empirical work addressing the possibile use of existing futures contracts as a solution to this specific hedging problem.

This paper develops an expression for the commodity and the exchange rate component of the VL risk and investigates the effectiveness of the Chicago Board of Trade corn and wheat futures as cross hedging instruments for the VL risk.

The analysis covers the four year period from August 1981 (the beginning of the 1981-82 crop year) to July 1985 (the end of the 1984-85 crop year). Johnson's optimal hedge ratio is found for hedge lengths of one, two and four weeks. The stability and up/down symmetry of the hedge ratio is tested across crop years, and the ex post effectiveness of this approach is compared with that of a naive hedge.

Derivation of the model

The objective of this section is to derive a simple quantitative expression for the commodity price and exchange rate component of the VL changes; these two expressions will then be used to calculate the optimal hedge ratios .

According to the CAP rules, the VL is first set in ecu and this value is then used as a common basis to calculate the country specific VL, expressed in the currency of each member state. The importance of the Federal Republic of Germany (FRG) in the EC and stability of the Deutsche Mark (dm) within the European Monetary System (EMS) suggests the selection of this country to test the model.

Equation (1) gives the general value, in ecu, of the VL for commodity c on day t, whereas equation (2) gives the value in dm for a commodity imported in the FRG :

$$(1)\ VL(c,ecu,t) = T(c,ecu,t) - P(c,i,t-1) * ER(ecu/i,t-2)\ ,$$

$$(2)\ VL(c,dm,t) = [\ VL(c,ecu,t) * MC(FRG,t) + MCA(FRG,c,t)\ ] * \\ * GER(dm,t)\ ,$$

where T is the threshold price for the commodity; P is the lowest price of the "standard quality" commodity expressed in the ith currency, usually the US $; ER is the ecu value of the ith currency, obtained as the average of the exchange rates between the "narrow band" EC currencies and the ith currency, each multiplied by the respective central parity with the ecu [1]; MC is the monetary coefficient for Germany, MCA is the monetary compensatory amount for the commodity imported into the FRG; GER is the green rate of exchange for the dm. Beginning with the 1984-85 crop year new Central Green Rates have been introduced in the CAP (as a measure tending to the abolition of positive MCA, like Germany's ones) and as a result in (2) the prices c.i.f. Rotterdam should be divided by an appropriate coefficient [2]. The different timing of VL, P and ER is due to the communication inefficiency of the present regulations.

Using (1), equation (2) may be rewritten as (2') :

$$(2')\ VL(c,dm,t) = \{\ [\ T(c,ecu,t) - P(c,\$,t-1) * ER(ecu/\$,t-2)] * \\ * MC(FRG,t) + MCA(FRG,c,t)\ \} * GER(dm,t)\ ,$$

the commodity price in (2') is in US$ and the exchange rate used in the calculation is therefore ER(ecu/$,t-2).

From (2') it can be seen that the daily VL risk is essentially due to the joint effects of commodity price and the exchange rate changes, since all other CAP parameters can be considered fixed in the very short run, and any change is usually known well in advance.

The expected VL change due to a given change in the commodity price or the \$/dm exchange rate can be obtained by calculating the partial differential of (2') with respect to P(c,\$,t-1) and ER(\$/dm,t-2):

$$(3)\quad \frac{dVL(c,dm,t)}{dP(c,\$,t-1)} = - ER(ecu/\$,EC,t-2) * MC(FRG,t) * GER(dm,t) \;,$$

$$(4)\quad \frac{dVL(c,dm,t)}{dER(\$/dm,t-2)} = - P(c,\$,t-1) * \frac{\delta\, ER(ecu/\$,t-2)}{\delta\, ER(\$/dm,t-2)} * MC(FRG,t) * GER(dm,t) \;.$$

It is assumed that the derivatives of T(c,ecu,t), MC(FRG,t), MCA(FRG,t) and GER(dm,t) with respect to P(c,\$,t-1) and the derivatives of T(c,ecu,t), P(c,i,t-1), MC(FRG,t), MCA(FRG,t) and GER(dm,t) with respect to ER(\$/dm,t-2) are equal to zero in the short run[3].

In order to calculate (3) and (4), which are used as independent variables in the estimation of the optimal hedge ratio, two assumptions are quite useful:

$$(a.1)\quad ER(ecu/\$,t) = 1 / [\, ER(\$/dm,t) * MC(FRG,t) * GER(dm,t) \,] \;,$$

$$(a.2)\quad dP(c,\$,t) = dFP(c,t-1) \;,$$

where FP is the previous day's closing price on the nearby Chicago futures.

According to (a.1), ER(ecu/\$,t), the average of the exchange rates of the EMS "narrow band" currencies with the US \$, is equal to the inverse of the product of the US\$/dm financial exchange rate and the dm green exchange rate adjusted by the monetary coefficient appropriate for the Federal Republic of Germany[4].

According to (a.2), the EC standard Rotterdam price (at time t) - nearby Chicago futures (at time t-1) basis is approximately constant [5].

A further simplification is necessary, since P(c,\$,t-1), the EC standard commodity price in US \$ c.i.f. Rotterdam, is not normally known to the traders. A proxy can be obtained from (1) and (2):

$$(5)\ P(c,\$,t-1) \cong [\ T(c,ecu,t-2) - VL(c,ecu,t-2)\ ] * MC(FRG,t) *$$

$$* \ GER(dm,t) * ER(\$/dm,t-2)\ ,$$

where T(c,ecu,t) and VL(c,ecu,t), not known at time t-2, are approximated by T(c,ecu,t-2) and VL(c,ecu,t-2). The error induced by this last substitution is essentially negligible, once it is multiplied by the percentage change in the exchange rate as is done in (4).

Finally, the partial derivative of ER(ecu/\$,t-2) with respect to ER(\$/dm,t-2) can be easily calculated using (a1):

$$(6)\quad \frac{\delta\, ER(ecu/\$,t-2)}{\delta\, ER(\$/dm,t-2)} =$$

$$= 1 / \{ MC(FRG,t) * GER(dm,t) * ER(\$/dm,t-2)^2 \} .$$

Equation (3) can now be rewritten as (7), using (a1) and (a2), and equation (4) can be rewritten as (8), using (5) and (6). All information necessary to calculate (7) and (8) is known at time t-2, therefore enabling the calculation of the expected VL changes with at least one day in advance [6].

$$(7)\quad dVL(c,dm,t) = - dFP(c,T,t-2) / ER(\$/dm,t-2) ,$$

$$(8)\quad dVL(c,dm,t) = [dER(\$/dm,t-2) / ER(\$/dm,t-2)] *$$

$$* [T(c,ecu,t-2) - VL(c,ecu,t-2)] * MC(FRG,t) * GER(dm,t).$$

The US \$ value of the expected change in the VL can be calculated by multiplying the dm value resulting from (7) and (8) by ER(\$/dm,t); it is important to note however that these results refer only to the US \$ value of the expected VL change given dFP(c,T,t-2) and dER(\$/dm,t-2), not to the total change of the VL cost in US \$, which is determined also by dER(\$/dm,t).

The results of (7) are hardly surprising: they simply show that within this model any change in the relevant Chicago futures price will determine a proportional opposite change in the amount of the levy expressed in dm. If the assumptions used in the model derivation are correct, this change could be hedged by simply selling the appropriate quantity of commodity futures on the Chicago market.

The effect of an exchange rate fluctuation is, however, more complex, as shown in (8). It would appear that an efficient "solidarity" mechanism within the "narrow band" currencies of the European Monetary System is sufficient to justify the assumption (a.1) and to sign both results: in this case a stronger foreign currency will decrease the levy amount in dm [7]. The exchange rate component of the VL(c,dm,t) risk can be hedged by taking an appropriate position in dm: in a naive hedge this quantity would be approximately equal to the EC standard Rotterdam value of the commodity before the imposition of the VL.

Equation (9) will be estimated in this work: equations (7) and (8) will be used in the case of the VL in dm to calculate the price and exchange rate components of the expected one day change in the variable levy amount and will be used as independent variables; the observed change in the variable levy, reported in ecu in the Official Journal of the European Communities, net of the effects of changes in the threshold price the first market day of each month will be the dependent variable, expressed in dm/tonne using (2):

$$(9)\ dVL(t,t-1) = \alpha + \beta_1\, dER(t-2,t-3) + \beta_2\, dFP(t-2,t-3)\ ,$$

dVL(t,t-1) is the actual one day change in the variable levy, in dm for the commodity to be imported in the Federal Republic of

Germany, dER(t-2,t-3) and dFP(t-2,t-3) the values resulting from equations (7) and (8)[8].

Sets of binary variables are also used to test for parameter stability over the different crop years (Guajarati) and, for parameter asymmetry between "up" and "down" commodity and exchange rates changes (Martin and Garcia) [9].

The coefficient of determination of the regression is used as a measure of the ex post hedging effectiveness of each strategy; in the case of equations estimated with correction for first order autocorrelation and for the naive strategies the hedging effectiveness is measured by a rebuilt coefficient of determination, as proposed by Overdahl and Starleaf. The rebuilt statistic is defined as: R2 rebuilt = 1 - (RSS/TSS), where RSS is the sum of the squared residuals obtained by subtracting from the original dependent variable its predicted value using the GLS estimates or 1 for the naive strategies, respectively, and TSS is the variance of the untransformed dependent variable.

The data

The daily VL data in ecu/tonne for corn and wheat, and the appropriate MC(FRG,t), MCA(FRG,c,t) and GER(dm,t) were collected from the Official Journal of the European Community; the commodity futures daily closing prices were obtained from a CFTC data tape, or the Wall Street Journal when missing on the tape; the New York spot US $ / dm exchange rate, as reported by the Federal

Reserve, and the midpoint between the bid and ask closing price for the spot US $ / dm on the Frankfurt market were purchased from an I.P. Sharp data bank.

The empirical results

In the case of corn the value of the optimal hedge ratio for the commodity component of the expected levy change is quite stable both across crop years and hedge lengths, and it is seldom statistically different from one at the 5% level (never at the 1% level). Only for the four week hedge during the 1982-83 crop year was the yearly dummy found to be statistically different from 0 at the 5% level . No up/down asymmetry was statistically evident. In all cases the intercept was not statistically different from zero at the 5% level. These results and the fact that the optimal hedge does not differ from one seems to validate, at least for the short term, the assumption of a relative constancy of the EC standard Rotterdam cash price-Chicago nearby futures basis.

There is some evidence of an increase in basis instability at the beginning and at the end of each crop year: this does not affect the optimal hedge ratio in a significant way, but obviously decreases the hedge effectiveness during these periods. A possible explanation of this phenomenon could involve the old crop / new crop price instability both on the Chicago and the Community markets, as well as the traders' adjustment of their Rotterdam bids. The EC Commission's discretionary power could also play a significant role in this picture. No clear evidence exists in favour of any of these explanations, and it is unwise to speculate further on the matter.

The case of wheat is substantially more complex than that of corn: a higher number of optimal hedge ratios are significantly different from one, and the instability of the parameters both across crop years and hedge lengths seems to be larger than for corn.

During the 1982-83 and 1983-84 crop years the assumption of stability of the wheat basis fails during the last ten to twelve weeks of the crop year: if this period is dropped from the sample a substantial increase of the hedge effectiveness is obtained. A similar result is obtained by introducing a trend variable for the last observations. However in neither case is there a substantial change in the value of the optimal hedge ratio [10].

The wheat results are however not completely negative. The finding of a a clear basis pattern during the last 10 to 12 weeks of the crop year is clearly useful information for traders who could try and exploit it. As in the case of corn this increased instability of the wheat basis during the May-July period may be explained in terms of old crop-new crop price instability, since this pattern coincides with the North American harvesting period. The different quality price differentials set in the CBT contracts and in the EC regulations may also compound the problem as the EC fixes a common levy for all wheat qualities -from high quality breadmaking wheat to feed wheat, on the basis of somewhat outdated price differentials. A separate levy is set only for durum wheat [11].

In the case of corn the "optimal hedge ratio" estimated for the currency component of the expected levy change is never statistically different from one and the binary variables used to capture the year to year fluctuations are significantly different from 0 at the 5% level only for the 1983 crop year. In the case of wheat no exchange rate binary variable is statistically different from zero at the 5% level.

The exchange rate used in the estimation is the daily spot US$/dm rate on the Frankfurt market: the term "hedge ratio" should therefore be properly qualified. In this work the primary concern with respect to the exchange rate risk was to approximate its effects on the complex EC calculations, which was successfully achieved. The hedge of the US$/dm exchange rate with the IMM contracts, or any other strategy, should then be quite straightforward.

A caution is however necessary. The results obtained when the estimation was conducted on daily observations utilizing the New York exchange rate data were sometimes inferior to the one obtained from the Frankfurt data. A possible explanation of this finding is that the EC uses European exchange rate data, and, as equation (8) shows, the exchange rate component of the expected daily levy change is directly proportional to the percentage change in the exchange rate. In periods of high volatility of exchange rates, the few hours difference between the European and New York fixing may result in different daily percentage changes, hence explaining the different empirical results. Traders willing to cover the currency component of the variable levy risk could successfully achieve this objective by adjusting daily their currency position on the Frankfurt market on the basis of the standard EC commodity price, as seen previously. Other more advanced strategies are certainly possible: their short term effectiveness should however be measured against the European, not the US market fluctuations.

The hedge effectiveness of the joint optimal hedge is generally increasing with the hedge length and in the more recent years: when the hedge is placed with the nearby contract until its expiration, in the case of corn the range is 0.41-0.80 for the one week hedge, 0.54-0.85 for the two week hedge, 0.71-0.86 for the four week hedge. The corresponding ranges for wheat are: 0.41-0.86, 0.33-0.90, 0.36-0.87. The results of the corresponding joint naive hedges are marginally lower.

The use of the nearby contract until expiration gives better results than the use of the nearby contract until the beginning of the delivery month, with the exception of the wheat four week hedge.

As expected, given the estimated values of the optimal hedge ratios, the hedge effectiveness of a naive joint hedge is in general quite high, although it is inferior to the one theoretically obtainable with the ex post optimal hedge ratios[12]. For both commodities and both strategies, a price only naive hedge never gave a higher variance reduction than a joint naive hedge.

It appears that at least during some limited periods of time an exchange rate only hedge would have been more effective than a price only hedge.

As a final note, during the 1984-85 crop year a price only naive hedge for wheat would have increased the volatility of the VL, regardless of the hedge length considered; in the same period an exchange rate only hedge would have been more efficient than the optimal joint hedge. This in part could support what was said earlier about the non optimality, at times, of the CBT wheat contracts to hedge the EC wheat VL risk.

Conclusion

The general evidence supports the need to hedge both the commodity and the exchange rate risk associated with the EC's variable levies for wheat and corn. This article has provided a simple basic framework to approximate the complex CAP regulations and effectively cope with both components of the variable levy changes.

The commodity price component of the VL risks can be hedged with the CBT futures with reasonably good results; corn hedges are somewhat more stable than those for wheat when the hedge length is extended from one to two and four weeks, or different crop years are considered.

No evidence of up-down asymmetry was ever found in the VL changes due to commodity price or exchange rate changes.

During the four years of the analysis the adoption of the optimal hedge ratios for both commodity and exchange rate would have substantially reduced the variance of the variable levy. This reduction is in general not statistically different from the one that would have been obtained from a naive hedge.

An increase of the volatility of the VL was found at the beginning and at the end of the crop year for both commodities; in some instances a clear pattern was found in the wheat basis change during the last part (May to July) of the crop year. It would appear that traders interested in importing wheat into the EC during this time period could exploit this pattern in order to reduce the levy cost.

Footnotes

1 The Belgian, Danish, Dutch, French, German and Irish currencies observe the narrow band of fluctuation within the EMS.

2 This coefficient was set at 1.033651 on August 1, 1984.

3 Some of these assumptions may not hold for longer periods of time.

4 The actual degree of approximation implied by this assumption is determined by the relative strength or weakness of the dm with respect to the US $ compared with that of the other "narrow band" EMS currencies and by roundings in the calculation of the MCA and hence of the monetary coefficient.

5 This could be incorrect if the commodity imported in the EC is different from the one fixed by the futures contracts specifications, the quality premiums or discounts differ in the two markets, and if in two successive market days the standard quality price is obtained from commodities of different qualities, or two different ports of entry. On the other hand with a competitive market assumption (a.2) is not completely unrealistic, at least in the very short run.

6 The change in the nearby futures close can be observed after the close of the European markets, so that the real time advantage of (7) in this case is reduced to a single day. MC and GER can be considered constant, and any change is usually known in advance.

7 Note however that this is not sufficient to sign the change in the US $ value of the VL: as was seen previously,

dER($/dm,t-2) affects the value of d VL(c,dm,t), but also dER($/dm,t) should be considered when determining dVL(c,US$,t)

8 Equations (7) and (8) of the model are used to calculate the daily value of the independent variables; the observations are then aggregated to form the one, two and four week data corresponding to the three different hedge lengths tested. This allows also for an indirect solution to the problem of the VL "minimum change rule".

9 No up/down asymmetry is expected in the traders' or in the EC Commission's discretionary response to a commodity price or in the exchange rate change. A one to one relation between the CBT futures and the EC variable levy changes is thought to be a viable null hypothesis since most of the offers submitted daily in Rotterdam are strongly releted to the North American futures. Slabotzky (1984, page 5) notes that these offer are usually valid up to the opening of the North American futures markets the next business day, frequent is the use of basis contracts, and the EC Commission is supposed to base its decision also on the Chicago Board of Trade futures changes.

10 Some evidence of price response asymmetry and parameter instability during the 1984-85 crop year emerges from an equation estimated with daily data -not reported-: this anomaly, never observed in any of the previous crop years or for any of the longer hedge lengths, might probably explain the low optimal hedge ratio found for this crop year.

11 In some cases traders have complained because the levy was set on the basis of prices of low quality wheat (practically not imported in the EC) thus penalizing the high quality Argentinian and North American commodity effectively imported in the Community.

12 The difference in the reduction of the variance of the levy changes obtained with the optimal and naive hedge is not statistically significant at the 5% level when tested with an F test.

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Table 1 . Optimal hedge ratio and hedge effectiveness for a one week hedge.

	Corn			Wheat		
	Optimal Hedge Ratio			Optimal Hedge Ratio		
	Commodity	Currency	R2	Commodity	Currency	R2
1981 (a,b)	0.77	0.84	0.41	0.68 *	0.87	0.41
	0.83	0.84	0.41	0.67 *	0.82	0.39
1982	0.92	1.20	0.64	1.22 *	1.03	0.84
	0.92	1.13	0.64	1.20 *	1.02	0.82
1982 (c)	0.95	1.18	0.77	1.16 *	0.97	0.90
	0.92	1.11	0.75	1.15 *	0.97	0.88
1983 (b)	0.83 *	0.74	0.74	0.97	0.85	0.79
	0.88	0.77	0.71	1.07	0.94	0.81
1984 (d)	0.75	1.01	0.66	0.29 **	1.00	0.54
	0.84	1.03	0.66	0.26 **	0.97	0.52
1984 (e)	0.67 *	1.04	0.80	0.44 *	1.11	0.79
	0.80	1.06	0.80	0.49 *	1.07	0.77

*, ** Statistically different from 1 at the 5% and 1% level, respectively.

(a) For each crop year the first row refers to the strategy using the nearby contract until expiration, the second one to the strategy using the nearby contract until the beginning of the delivery period.

(b) In the case of wheat with a correction for first order autocorrelation the hedge effectiveness is calculated on the raw data using the parameters estimated with the correction for autocorrelation.

(c) With an intercept dummy for the first and for the last observation of the crop year in the cases of corn, and for the first and for the thirteenth in the case of wheat.

(d) In the case of corn with a correction for first order autocorrelation the hedge effectiveness is calculated on the raw data using the parameters estimated with the correction for autocorrelation.

(e) With an intercept dummy for the first observation of the sample in the case of corn and for the first and for the twentyeighth in the case of wheat.

Table 2 . Optimal hedge ratio and hedge effectiveness for a two week hedge.

	Corn			Wheat		
	Optimal Hedge Ratio			Optimal Hedge Ratio		
	Commodity	Currency	R2	Commodity	Currency	R2
1981 (a)	1.05	1.02	0.54	0.68	0.79	0.33
	1.07	1.09	0.53	0.70	0.74	0.34
1982	1.07	1.07	0.69	1.33	0.88	0.85
	1.06	1.10	0.69	1.31	0.90	0.83
1982 (b)				1.34	0.91	0.90
				1.33	0.92	0.88
1983 (c)	0.82 *	0.74	0.70	0.92	0.86	0.56
	0.89	0.81	0.70	1.01	0.92	0.65
1983 (d)				1.07	0.89	0.85
				1.06	0.92	0.87
1984	0.73	1.00	0.77	0.42 *(e)	1.08	0.51
	0.76	1.08	0.75	0.36 (e)	1.02	0.48
1984 (f)	0.70	1.03	0.85	0.64	1.27	0.79
	0.78	1.11	0.84	0.72	1.22	0.75

* Statistically different from 1 at the 5% level.

(a) For each crop year the first row refers to the strategy using the nearby contract until expiration, the second one to the strategy using the nearby contract until the beginning of the delivery period.

(b) Short sample, drops last four observations.

(c) In the case of wheat with a correction for first order autocorrelation the hedge effectiveness is calculated using the parameters estimated with the correction for autocorrelation and the untransformed data.

(d) Short sample, drops the last five observations.

(e) Statistically not different from 0 at the 5% level.

(f) With an intercept dummy for the first observation of the sample in the case of corn and for the first and for the fourteenth in the case of wheat.

Table 3. Optimal hedge ratio and hedge effectiveness for a four week hedge.

	Corn			Wheat		
	Optimal Hedge Ratio			Optimal Hedge Ratio		
	Commodity	Currency	R2	Commodity	Currency	R2
1981 (a)	1.08	0.70 (b)	0.71	0.79	0.67 (b)	0.36
	1.05	0.79	0.66	0.88	0.61 (b)	0.44
1982	1.42	1.46	0.79	1.33	0.97	0.87
	1.23	1.54	0.78	1.29	0.98	0.86
1983	0.78	0.86	0.79	0.64	0.76 (b)	0.47
	0.76	0.93	0.73	0.79	0.81 (b)	0.57
1983 (c)				1.00	0.87	0.85
				1.02	0.89	0.87
1984	0.86	1.08	0.86	0.35*(b)	1.09	0.67
	0.65 (b)	1.02	0.80	0.39 (b)	1.05	0.65

* Statistically different from 1 at the 5% level.

(a) For each crop year the first row refers to the strategy using the nearby contract until expiration, the second one to the strategy using the nearby contract until the beginning of the delivery period.

(b) Statistically not different from 0 at the 5% level.

(c) Short sample, drops the lase three observations.

Table 4 . Corn: hedge effectiveness of joint commodity price and exchange rate naive hedge, commodity price naive hedge, exchange rate naive hedge.

	Type of naive hedge				
	Joint		Price Only		Exchange
Crop Years	(a)	(b)	(a)	(b)	Rate Only
Hedge length: 1 week					
1981	0.39	0.40	0.12	0.13	0.21
1982	0.63	0.63	0.29	0.33	0.23
1982 (drop first and last observation)	0.73	0.71	0.36	0.37	0.24
1983	0.69	0.69	0.54	0.51	0.17
1984	0.65	0.66	0.05	0.04	0.53
1984 (drop first obs.)	0.73	0.75	0.00	NEG.	0.65
Hedge length: 2 weeks					
1981	0.54	0.52	0.32	0.27	0.30
1982	0.68	0.69	0.46	0.45	0.23
1983	0.66	0.68	0.44	0.41	0.07
1984	0.75	0.73	0.13	NEG.	0.65
1984 (drop first obs.)	0.83	0.82	0.13	NEG.	0.72
Hedge length: 4 weeks					
1981	0.68	0.65	0.55	0.47	0.27
1982	0.71	0.73	0.48	0.48	0.26
1983	0.74	0.67	0.42	0.26	0.15
1984	0.85	0.78	NEG.	NEG.	0.73

NEG. indicates a variance increase.
(a), (b) Indicate the strategy using the nearby contract until expiration, or until the beginning of the delivery period, respectively.

Table 5 . Wheat: hedge effectiveness of joint commodity price and exchange rate naive hedge, commodity price naive hedge, exchange rate naive hedge.

	Type of naive hedge				
	Joint		Price Only		Exchange
Crop Years	(a)	(b)	(a)	(b)	Rate Only
Hedge length: 1 week					
1981	0.36	0.34	0.01	0.01	0.18
1982	0.81	0.80	0.66	0.65	0.09
1982 (drop obs 1 and 13)	0.86	0.85	0.70	0.69	0.08
1983	0.79	0.81	0.61	0.60	0.15
1984	0.30	0.36	NEG.	NEG.	0.50
1984 (drop obs 1 and 28)	0.58	0.65	NEG.	NEG.	0.66
Hedge length: 2 weeks					
1981	0.28	0.29	NEG.	NEG.	NEG.
1982	0.80	0.78	0.72	0.70	0.04
1982 (drop last 4 obs.)	0.85	0.83	0.76	0.75	0.05
1983	0.53	0.65	0.28	0.38	NEG.
1983 (drop last 5 obs.)	0.84	0.87	0.55	0.55	NEG.
1984	0.35	0.38	NEG.	NEG.	0.45
1984 (drop obs 1 and 14)	0.62	0.65	NEG.	NEG.	0.61
Hedge length: 4 weeks					
1981	0.31	0.37	NEG.	0.19	NEG.
1982	0.83	0.82	0.73	0.72	0.19
1983	0.35	0.53	0.10	0.29	0.02
1983 (drop last 3 obs.)	0.85	0.86	0.58	0.58	0.03
1984	0.41	0.54	NEG.	NEG.	0.61

NEG. indicates a variance increase.
(a), (b) Indicate the strategy using the nearby contract until expiration, or until the beginning of the delivery period, respectively.

Table 6. Comparative analysis of variances: unhedged versus optimally hedged strategy and unhedged versus naively hedged strategy, F ratios for a one week hedge.

	Corn		Wheat	
Crop Year	Optimal	Naive	Optimal	Naive
1981 (a)	1.70 *	1.64 *	1.69 * (b)	1.56
	1.70 *	1.66 *	1.64 * (b)	1.51
1982	2.81 **	2.69 **	6.10 **	5.34 **
	2.80 **	2.74 **	5.55 **	5.00 **
1982 (c)	4.42 **	3.73 **	9.74 **	7.25 **
	4.00 **	3.44 **	8.47 **	6.52 **
1983	3.78 **	3.23 **	4.84 ** (b)	4.66 **
	3.47 **	3.18 **	5.21 ** (b)	5.23 **
1984	2.92 ** (b)	2.84 **	2.17 **	1.42
	2.91 ** (b)	2.91 **	2.07 **	1.55
1984 (d)	4.95 **	3.73 **	4.83 ** (e)	2.38 **
	4.94 **	4.00 **	4.30 **	2.83 **

*, ** Statistically different from 1 at the 5% and 1% level, respectively.

(a) For each crop year the first row refers to the strategy using the nearby contract until expiration, the second one to the strategy using the nearby contract until the beginning of the delivery period.

(b) Calculated using the untransformed data and the parameters estimated with a correction for first order autocorrelation .

(c) With an intercept dummy for the first and for the last observation of the sample in the case of corn and for the first and the thirteenth in the case of wheat.

(d) With an intercept dummy for the first observation of the sample in the case of corn and for the first and for the twentyeighth in the case of wheat.

(e) The optimal hedge is statistically different from the naive one at the 5% level.

Table 7 . Comparative analysis of variances: unhedged versus optimally hedged strategy and unhedged versus naively hedged strategy, F ratios for a two week hedge.

	Corn		Wheat	
Crop Year	Optimal	Naive	Optimal	Naive
1981 (a)	2.17 *	2.17 *	1.49	1.38
	2.11 *	2.09 *	1.53	1.41
1982	3.20 **	3.17 **	6.60 **	4.93 **
	3.22 **	3.18 **	5.73 **	4.55 **
1982 (b)			10.18 **	6.48 **
			8.40 **	5.86 **
1983	3.39 **	2.93 **	2.27 * (c)	2.13 *
	3.32 **	3.12 **	2.86 ** (c)	2.83 **
1983 (d)			6.51 **	6.09 **
			7.83 **	7.43 **
1984	4.31 **	4.01 **	2.04 *	1.54
	3.94 **	3.71 **	1.91	1.61
1984 (e)	6.55 **	5.73 **	4.86 **	2.65 *
	6.10 **	5.42 **	4.07 **	2.88 *

*, ** Statistically different from 1 at the 5% and 1% level, respectively.

(a) For each crop year the first row refers to the strategy using the nearby contract until expiration, the second one to the strategy using the nearby contract until the beginning of the delivery period.

(b) Short sample, drops the last four observations.

(c) Calculated using the untransformed data and the parameters estimated with a correction for first order autocorrelation .

(d) Short sample, drops the last five observations.

(e) With an intercept dummy for the first observation of the sample in the case of corn and for the first and for the fourteenth in the case of wheat.

Table 8 . Comparative analysis of variances: unhedged versus optimally hedged strategy and unhedged versus naively hedged strategy, F ratios for a four week hedge.

	Corn		Wheat	
Crop Year	Optimal	Naive	Optimal	Naive
1981 (a)	3.45 *	3.17 *	1.56	1.45
	2.93 *	2.82 *	1.77	1.59
1982	4.68 **	3.51 *	7.86 **	5.92 **
	4.55 **	3.67 *	7.10 **	5.71 **
1983	4.87 **	3.87 *	1.87	1.53
	3.67 *	3.05 *	2.32	2.14
1983 (b)			6.75 **	6.51 **
			7.43 **	7.18 **
1984	7.28 **	6.75 **	3.03 *	1.69
	5.07 **	4.58 **	2.84 *	2.17

*, ** Statistically different form 1 at the 5% and 1% level, respectively.

(a) For each crop year the first row refers to the strategy using the nearby contract until expiration, the second one to the strategy using the nearby contract until the beginning of the delivery period.

(b) Short sample, drops the last three observations.