Hedging Short-term Corn Price Risks In Tokyo versus Chicago's Project A

Raymond M. Leuthold and Min-Kyoung Kim

Raymond M. Leuthold
T.A. Hieronymus Professor
Department of Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign

And

Min-Kyoung Kim
Graduate Research Assistant
Department of Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign

OFOR Paper Number 00-02
January 2000

Hedging Short-term Corn Price Risks
In Tokyo versus Chicago's Project A*

Abstract

This study investigates whether U.S. corn merchants can effectively manage the overnight price risk of cash corn purchased after the Chicago Board of Trade closes at 1:15 p.m. on either the electronic Project A market or in the corn contract traded on the Tokyo Grain Exchange. Three scenarios are examined: 1) overnight hedges; 2) day-to-day hedges; and 3) two-day hedges. Overnight hedges are the least effective of the three scenarios on both markets. E*hedging on Project A is more effective than hedging in Tokyo, yet trading of corn futures contracts on Project A remains relatively thin and illiquid. Steps need to be taken to encourage more trading of this contract.

*The authors thank Joost Pennings for critical review of this paper.

Hedging Short-term Corn Price Risks
In Tokyo versus Chicago's Project A

I. Introduction

Cash corn merchants in the U.S. have long faced the problem of how to manage the short-term price risks of grain purchased after the Chicago Board of Trade (CBOT) futures market closes at 1:15 p.m. In a relatively short time two new markets quickly became available enabling these merchants to hedge price risks overnight. In 1996, the CBOT initiated Project A, a mechanism for trading futures contracts electronically at night. The same corn contract traded daytime on the CBOT is traded electronically on Project A. Prior to Project A, the Tokyo Grain Exchange (TGE) in 1993 began trading a corn futures contract designed as an alternative to the CBOT corn contract.

This paper examines: 1) the daily co-movement and behavior of prices between Chicago and Tokyo corn futures markets, and between Chicago daytime and Project A markets, and hence, 2) the feasibility and effectiveness of e*hedging overnight cash corn on Project A versus hedging in the TGE. This analysis is useful to domestic corn merchants and to grain importers and exporters in managing short-term price risks, and to market arbitragers. We find that e*hedging on Project A shows promise as being reasonably effective, certainly more effective than hedging in Tokyo, but that trading on Project A is possibly too thin and illiquid to be a viable hedging alternative for many large cash grain merchants.

The next section describes the contracts in the Chicago and Tokyo markets, followed by Section 3 outlining the framework of analysis, data and methodology. Section 4 presents the results, contrasting Tokyo and Project A outcomes, and the last section contains a discussion of the implications and conclusions.

II. Historical Perspective

Traditionally, cash corn merchants in the U.S. have not had a mechanism available for hedging grain that is purchased in the afternoon after daytime futures trading on the CBOT is closed. One marketing possibility, of course, is to immediately cash sell or forward cash contract this purchased grain, providing there is another buyer available, and hence, pass on the price risks to the next party. Nevertheless, the most commonly used procedure for cash merchants who purchase corn in the country is to 'take protection', which means that if their cash price bid during the day when the CBOT is open is P cents below the nearby futures contract (basis of -P cents), then their bids after daytime CBOT closes will be P+X cents below the nearby futures (basis of -[P+X] cents). They lower their bids for cash corn in the afternoon and overnight, giving themselves more 'protection' in case prices were to fall before they could sell futures contracts the next morning on the CBOT against these cash transactions. The size of X, termed a downside risk premium, varies depending on the merchant's view of the market, location, expectation of overnight price changes, level of risk aversion and competition for acquiring grain. This procedure leaves the grain merchant bearing the cash price risks for a few hours until the next morning. Two hedging alternatives now exist, e*hedging on Project A or hedging in the TGE.

The first overnight hedging alternative began in 1993 when the TGE launched their corn futures contract, with specifications different from the CBOT contract. Because of the time difference between Chicago and Tokyo, a corn merchant in the U.S. can hedge (or cross hedge) the price risk on cash corn purchased after the CBOT futures market closes (1:15 p.m.) in the Tokyo market during the night. This corn merchant would not have to wait until the following morning when the CBOT opens (9:30 a.m.) to hedge in the futures market. A second mechanism for hedging these price risks has now been in place since 1996, electronic hedging (e*hedging) on Project A at the CBOT. Trading corn futures contracts on Project A resulted partly because the CBOT became concerned that the TGE market was drawing trades away from the daytime futures market at the CBOT, and partly because of the move toward electronic trading of futures contracts. Recent trading volume of corn futures contracts in these markets is as follows.

Year	Chicago (total)	Tokyo	Project A
1994	11,529,884	3,053,244	---
1995	15,105,147	6,899,593	---
1996	19,620,188	16,034,716	134,621
1997	16,984,951	13,856,595	160,737
1998	15,795,493	7,267,043	184,495

Clearly, the Tokyo futures contract grew very rapidly in trading volume in its short history, reaching a volume of just 3 million fewer contracts than the Chicago contract by 1997, but then diminishing considerably in 1998. Interestingly, the trend in both markets is identical, peaking in 1996, then declining.[1] In contrast, the volume of corn futures contracts on electronic Project A is relatively quite small, yet increasing. It now is only about 1% of the CBOT corn trading volume.

[1] The Tokyo contract is 21% smaller in size than the Chicago corn contract.

The corn contract traded electronically on Project A is specified identically to the contract traded by open outcry during the day on the CBOT. Table 1 lists the contract specifications of this corn futures contract traded in Chicago and the corn futures contract traded on the TGE in Tokyo. There are several differences between the contracts, including size, deliverable grade, tick size, price limits, contract months, currency and last day of trading. Most notable is that the Chicago market trades continuously from when the market opens until closing time. In contrast, the Tokyo market is not open continuously, but it has at least four different trading sessions during the day. However, this difference does not impact this analysis as it is assumed all trades are conducted at either the opening or closing times for the day for both markets. Nevertheless, the different contract specifications may impact individual market participants.

III. Framework of Analysis, Data and Methodology

Time Line

Tokyo is 15 hours ahead of Chicago (standard time). Hence, when the Chicago market closes at 1:15 p.m., it is 4:15 a.m. the next morning in Tokyo (see Figure 1). The Tokyo exchange opens 4 hours and 45 minutes after the Chicago market closes. This creates a gap when neither market is open. Similarly, the last trading session in Tokyo closes at 4:00 p.m. (Tokyo time), which corresponds to 1:00 a.m. in Chicago the same day. The market in Chicago will not open for another 8 ½ hours, creating another time gap when neither market is open. However, the corn contract on Project A begins trading at 9:00 p.m. and closes the next morning at 4:30 a.m., reducing this second time gap. In a strict time line, after daytime trading on the CBOT closes, the Tokyo exchange opens before Project A begins trading, and Tokyo also closes earlier than does the corn contract on Project A.

This research investigates if a merchant in Chicago were to purchase cash corn in the afternoon in the U.S., could the merchant effectively hedge this position in the Tokyo Grain Exchange, or on Project A, before the Chicago daytime market opens the next morning? Since cash grain merchants may need to hold their cash grain, and subsequently its hedge, longer than overnight, due to various cash marketing constraints and illiquidity, this study also extends the time horizon. So, the following three different hedging scenarios are analyzed: 1) overnight hedge; 2) day-to-day hedge; and 3) a two-day hedge.[2] Each is defined next.[3]

Overnight Hedge

This study does not concern itself with basis risks. The goal is to analyze the general behavior and co-movement of prices between futures exchanges. Hence, for the overnight hedge it is assumed that the merchant buys cash corn at the closing daytime price of the nearby contract on the CBOT on day t and sells it at the opening CBOT daytime price of the same contract the next morning, day t+1.[4] During this time of holding cash grain the merchant hedges this position on the TGE by selling a corn futures contract at the opening TGE price on day t+1 and liquidating this position at the closing TGE price on the same day, day t+1.[5] Both of these

---

[2] See Leuthold, Junkus and Cordier, pp. 145-148 for descriptions of common grain merchant hedges.

[3] These types of hedges are termed *operational hedges*, meaning they are held for only a short time to facilitate merchandising. The hedge is a temporary substitute for subsequent cash market transactions (Leuthold, Junkus, Cordier, p. 145; Working).

[4] Technically, including actual cash prices and a basis would not change the relative results of this study, but only complicate the comparisons and analysis. The following hedging effectiveness results may be upward biased, but only slightly since Norvell and Leuthold report hedging ratios of 0.94 for Illinois corn producers, meaning cash and futures prices are highly positively correlated. Also, this study is not concerned with optimal hedge ratios, presuming all hedges are on a bushel-for-bushel basis.

[5] Discussion relative to Project A follows.

futures trades on the TGE are conducted between the times of the cash transactions. The following table shows this scenario.

Overnight Hedge

Chicago-Cash	TGE-Futures
BUY at the close, day t	SELL at the open, day t+1
SELL at the open, day t+1	BUY at the close, day t+1

Day-to-Day Hedge

For practical cash grain merchandising reasons (e.g., inability to immediately move the cash grain purchased overnight), the relative price behavior and co-movements in the two markets over longer periods is also analyzed. For the second scenario cash grain and the corresponding hedge are both held for one day. That is, the corn merchant again buys cash corn at the closing price of the nearby contract on the CBOT on day t, the same action as in the first scenario. This time the merchant holds the grain 24 hours before selling it at the close on day t+1. The merchant sells corn futures on the TGE at the opening price of day t+1 and sells these contracts at the opening price of day t+2. The holding of these futures contracts in Tokyo is again in between the buy and sell times of the cash grain in the U.S. The following table shows this scenario.

Day-to-Day Hedge

Chicago-Cash	TGE-Futures
BUY at the close, day t	SELL at the open, day t+1
SELL at the close, day t+1	BUY at the open, day t+2

Two-Day Hedge

For the two-day hedge, it is assumed that the corn merchant in the U.S. again buys corn at the closing daytime price of the CBOT on day t. This cash grain is held until the opening daytime price of the CBOT on day t+2. Again, a hedge is placed by selling futures contracts on the TGE at the opening price on day t+1 (same as the above two scenarios), but this time the hedge is held until the closing price of day t+2. As before, the time period of holding the hedge in Tokyo is in between the buy and sell times for cash grain in Chicago. The following table shows this scenario.

Two-Day Hedge

Chicago-Cash	TGE-Futures
BUY at the close, day t	SELL at the open, day t+1
SELL at the open, day t+2	BUY at the close, day t+2

The identical three scenarios are also created using the electronic Project A opening and closing price data instead of Tokyo Grain Exchange data. Notation remains the same as above because Project A data are recorded relative to its closing time, which for these scenarios occurs at 4:30 a.m. on day t+1.[6] As with the TGE trades, all futures trades conducted on Project A occur in between the two cash transactions.

Data

The data used for this study are the daily opening and closing prices on the CBOT and TGE for the years 1994-1998, and Project A for 1996-1998. The nearby futures contract for TGE and Project A is selected for each hedge, except prices during the delivery or maturity

[6] Technically, settlement for Project A trades occurs at the settlement price for the day-traded contracts on the CBOT, determined in the afternoon on the same day Project A closes. Nevertheless, of concern here is the closing price on Project A, not its settlement price.

month of the contract are not used. Interestingly, in the Tokyo corn futures market the nearby contract typically has the smallest open interest, and subsequent more distant contracts have progressively larger open interest, just the opposite to the structure of open interest usually observed in Chicago. Consequently, we repeat our analysis using a distant, more liquid, contract rather than the nearby futures contract for Tokyo (cash transaction prices remain the same). The rule followed in this case is to select that TGE corn contract with the largest open interest, which averages 10 months forward.

Special care is taken in managing the data. Specifically, holidays and other market events are different in the two markets. So, data management ensured that if a futures position began using one delivery month, this trade was liquidated using the same delivery month. Also, to avoid the effect of holidays, care was taken to ensure that if a transaction occurred in one country, the offsetting transaction could be completed as specified in the above scenarios in the other country without interruption. If there was a holiday in one country within the trading period, that observation was deleted.

Methodology

The methodological procedures followed in this study are straight forward. We calculate the mean cash price changes in Chicago and the corresponding futures prices changes along with their standard deviations for each hedging scenario and market described above, and summarize these statistics annually as well as for the total sample. We examine the co-movement of cash and futures prices through cointegration tests, but for a quantitative measure of co-movement we also compute the correlation coefficient between each of these matched cash and futures price series (simulated hedges), and test for the significance of these coefficients.[7] We follow the

---

[7] Cointegration implies that there is a long-term linear equilibrium between the two markets and any disruptions are due to temporary forces.

standard cointegration testing procedures, such as those outlined in Davidson and Mackinnon, Chapter 20.

The typical procedure in the literature for demonstrating the effectiveness of simple hedges is to utilize the R^2 coefficient taken from regressing the cash price change on the futures price change (Ederington; Leuthold, Junkus and Cordier, pp. 90-101). This coefficient, coming from the standard hedge ratio regression, shows the reduction in variance as a proportion of total variance that results from maintaining a hedged position rather than an unhedged position. A 'perfect' hedge would have an R^2 of nearly 1.0.

Finally, to see the distribution of the hedging results in detail, we report the percent of all the final hedge outcomes falling into 1-cent increments, both positive and negative. This distribution, which shows the range of profits and losses occurring from individual hedges, demonstrates the benefits and risks resulting from hedging in Project A and TGE.

IV. Results

Price Relationships

Table 2 shows for the hedges utilizing the nearby corn futures contract in Tokyo: 1) the number of observations, 2) mean cash and futures price change and standard deviation in cents/bushel for each market, 3) the correlation coefficient between the cash and futures price changes in the two markets, and 4) the R^2 from regressing the Chicago cash price change on the Tokyo futures price change. Each of these statistics is presented by hedging scenario and individual year, then totaled over the years. Table 3 shows the same summary statistics when using a distant Tokyo corn futures contract instead of the nearby contract. The price of corn on the TGE in yen/1,000 kilograms was converted to dollars/bushel at the exchange rate on the day of the trade.

First, in Table 2 the means of the price changes are small, with only one mean exceeding one cent/bushel in absolute value (Chicago, two day, 1996). No mean price change is significantly different from zero, and the standard deviations appear relatively large. That is, there is a wide range of short-term price changes in both markets, but they average near zero. Most of the paired means are of the same sign, meaning prices in general change in the same direction. The overall 5-year means are all very close to zero. One must interpret these results with caution because they are averages of a large set of observations, and most important for a hedger is how closely do the prices move together on each trade, not the movement on the average trade. This topic will be addressed shortly.

All of the correlation coefficients are positive, and all but two are significantly different from zero.[8] Regardless of scenario, correlation coefficients decrease from 1994 to 1995, then increase sharply for the next two years, but deceased again in 1998 relative to 1997. It is not clear from these data why CBOT and TGE corn futures markets move more closely together in 1996 and 1997 than in other years. The overnight correlations are the lowest, while the day-to-day correlations are the largest (except for 1998), with the day-to-day and two-day correlations being substantially larger than the overnight coefficients. The tests for cointegration over the whole sample period also show that the paired series are in fact cointegrated, adding to the notion that these cash and futures prices tend to move together in the long run.[9]

The R^2s show the same pattern as that just described for the correlation coefficients. These R^2 coefficients are quite low, with the largest being 0.38. A substantial proportion of the

---

[8] The critical levels for the Pearson's product-moment t-ratios are 1.645 for 95% and 1.282 for 90%.

cash price variation is not explained by, or covered by, the futures price in the TGE. That is, these hedges are not very effective for managing price risks, with overnight hedging being the particularly poor. Nevertheless, recall that these regressions were performed on price changes, which typically have lower R^2 coefficients than do regressions in price levels. The improved hedging effectiveness for the one- and two-day relative to overnight hedges is consistent with results shown by Castelino and Gebbert. There is a time dimension to hedging effectiveness because of decreasing noise in the data.

Three alternative currency conversions were used in analyzing the trading scenarios. The first was to convert yen to dollars at the exchange rate on the day of the trade. The second alternative converted the yen to dollars at the same exchange rate on day the hedge was placed as on the day the hedge was lifted. That is, there was no variation in the exchange rate during the trade. This scenario fits large firms who have accounts in both countries and do not need to convert currencies every day. Many of the means changed under this second currency exchange procedure relative to the first one, but not perceptively. The basic results remain the same, and the correlation coefficients were nearly identical to those shown in Table 2.

The third alternative was to correlate the Chicago cash price change in dollars to the Tokyo futures price change in yen during the trade without any currency conversion. Again, the correlation coefficients are nearly identical to those in Table 2. Hence, variations in the treatment of exchange rates had no substantial effect on the analysis performed in this study.

Table 3 shows similar summary statistics as Table 2, but this time using distant futures contracts in Tokyo rather than a nearby contract. The pattern of results is very similar between

---

[9] The matched cash and futures price series utilizing Project A and distant TGE corn futures contracts are also cointegrated. Critical values for these tests were obtained from Davidson and Mackinnon.

the two tables. First, the same proportion as in Table 2 of paired mean price changes have the same sign. Nevertheless, all means are one cent or less in absolute value, and none is significantly different from zero. Second, most, but not all, of the correlation and R^2 coefficients are larger than their corresponding coefficient in Table 2. All but one of the correlation coefficients are significantly different from zero. Third, the correlation and R^2 statistics for the full 5 years are nearly identical between the two tables. Hence, although there is a slight tendency for closer co-movement of prices when utilizing distant rather than nearby corn contracts in Tokyo, the results are not perceptibly different, and the basic implications remain the same.

Table 4 shows the same summary statistics between CBOT daytime and Project A electronic nighttime prices, and clearly the co-movement of cash and futures prices is much closer in this case than when examining Tokyo prices. The means remain small and not significantly different from zero. However, the correlation and R^2 coefficients are much higher than those shown in Tables 2 and 3, and the signs of the mean price changes are more in accordance with each other.[10] While the correlation coefficients for the full-sample Tokyo results range from 0.21 to 0.54, the full-sample Project A coefficients range from 0.58 to 0.89. The R^2 coefficients for Project A for the one- and two-day hedges are 0.79, indicating the potential for highly effective e*hedges.

Hedging Results

Since the hedges simulated in this study are 'operational hedges', those held for only a short time, a cash grain merchant would expect, and desire, a hedge where the net profit or loss

---

[10] Correlation coefficients between Project A and Tokyo approximate those between Chicago daytime prices and Tokyo.

from the combined cash and futures positions would approximate zero. Assuming opposite positions in the cash and futures markets, results from Tables 2, 3, and 4 show no full-sample net mean from hedging exceeding one-quarter cent in absolute value. All are technically zero. For individual years, only in the case of distant Tokyo contracts for 1996 do the combined cash and futures positions exceed 1-cent per bushel, and this occurs for all three scenarios. Thus, for the merchant buying grain and hedging every day, both Project A and TGE futures markets will offset virtually all the cash price risks on average. However, involvement in these markets every day is unlikely for many merchants.

Table 5 presents the percent of net profit and losses from all simulated hedges in 1-cent intervals. These distributions provide more detail about the nature of the results from combined cash and futures positions. For Tokyo, these results assume, as previously, that yen are converted to dollars each day. No perceptible difference occurred if the exchange rate was constant for each trade.

Examining Tokyo results first, there appears to be a fairly wide distribution to the individual hedge outcomes. And, the distributions are wider and flatter the longer the cash and futures positions are held. This would be expected as there is more chance for larger adverse price moves between the two markets.

For the overnight trades using the nearby futures contract, only 27% of the trades resulted in a profit or loss of less than 1-cent per bushel, while 61% (80%) resulted in a profit or loss of 2.9 (4.9) cents or less per bushel. Less than 5% of the trades show a profit or loss of 10.0 cents or greater. Recall from Table 2 that for the most volatile year, 1996, two standard deviations for Tokyo futures was about 15 cents and for Chicago cash about 8 ½cents. Hence, for two markets quite different contract specifications, location and time of trading, the hedges would appear to be modestly effective on average, but with the range of the profits and losses from individual hedges being quite large.

Continuing with the nearby TGE futures contract, the distribution for day-to-day trades is slightly wider and flatter than for the overnights trades with 48% (68%) showing profit or loss of 2.9 (4.9) cents or less. About 9% of the day-to-day trades show profits and losses greater than 10 cents. Finally, for two-day hedges 42% (63%) show profits or losses of 2.9 (4.9) cents or less. Nearly 13% of the two-day hedges show profits and losses greater than 10 cents. This wider and flatter distribution of the individual hedging profits and losses for longer hedging periods is consistent with the larger standard deviations as shown in earlier tables.

The distributions for all three scenarios show that about half of the trades result in a trading loss while the other half result in a gain. Thus, the hedger appears to have an even chance of making or losing money on a hedge, given no other information. This would be expected given the short duration of the hedges.

The distribution of profits and losses when using the distant contract in Tokyo shows a very similar pattern to that for the nearby contract. The prime difference is that the percentage of trades with profits and losses of 4.9 cents or less are 6 to 8 percentage points higher than those for the nearby contract, while the percentages in the tails beyond 5.0 cents are compensatingly lower. So the distribution of individual hedging results are slightly narrower and more peaked when using distant TGE futures contracts as opposed to nearby contracts, a desirable trend.

In contrast, the distribution of e*hedging profits and losses on Project A as shown in Table 5 appear to be much narrower and tighter than those demonstrated for Tokyo. Regardless of hedging duration, nearly 95% of all profits and losses are within 5-cents per bushel. Clearly from these data, Project A provides a more attractive hedging alternative than does the corn contract in Tokyo, but Project A is constrained by being a relatively thin market. Thin markets are characterized by additional market-depth costs due to illiquidity when the trades are executed.

Without specific data, it is difficult to directly compare these results to the practice of 'taking protection' in the cash market. This procedure is followed only in the case of 'overnight' price protection, and we can see from Tables 2 and 3 that over the full 5-year period that two standard deviations from the cash mean is approximately 5-cents per bushel. This infers that the downside risk premium is approximately 5 cents. Thus, if a grain merchant were interested in protecting against adverse price moves, 'taking 5 cents protection' would on average be comparable to e*hedging on Project A, where 95% of profits and losses are within 5-cents per bushel. However, 'taking protection' may be preferable to using the Tokyo market where the 95% level of the hedging outcome distribution (Table 5) is nearer 10 cents/bushel profit or loss when using the Tokyo market overnight.

V. Implications and Conclusions

U.S. cash corn merchants have long faced the problem of managing short-term price risks for grain purchased after the Chicago Board of Trade daytime futures trading closes at 1:15 p.m. Two alternatives now exist, e*hedging on Project A, or hedging on the corn contract traded on the Tokyo Grain Exchange. This study examines three alternative hedging scenarios, overnight, day-to-day, and two-day hedging of these price risks on both markets.

The price changes between Chicago cash and Tokyo futures, as well as Project A futures, are positively correlated with each other and cointegrated, but none of the mean price changes is significantly different from zero. There is a wide range of price movements. Results in this study are not affected by alternative procedures for managing exchange rate variations.

Hedging short-term price risks in Tokyo is not very effective, especially for overnight hedges. Day-to-day and two-day hedges demonstrate higher correlation and R^2 coefficients than overnight hedges, yet neither is highly effective. Regarding the distribution of individual hedges, the overnight hedges have a high proportion of results with small profits and losses, but day-to-day and two-day hedges show increasingly larger number of hedges with profits and losses beyond 10-cents per bushel. Regardless of the length of the hedge, the hedger has an even chance of making or losing money on the hedge.

The overnight electronic trading on Project A overlaps with some of the hours that trading occurs in Tokyo. E*hedging on Project A clearly provides a more attractive short-term risk-management opportunity than does the Tokyo market. The Project A contract is the same contract as that traded daytime on the CBOT, giving Project A an inherent advantage over TGE. But the thinness of the market makes it problematic that a large commercial merchant could use Project A effectively due to increased costs resulting from lack of market depth. The Tokyo market, which could under some definitions be considered a cross hedge for U.S. corn merchants, does provide a potential price risk management mechanism in a market with reasonable liquidity if the merchant is in the market every day. But, contract specification differences could create technical problems for some merchants. One could conclude from these results that Project A provides a better alternative because of its electronic trading procedure versus the open outcry auction in Tokyo, but more data are needed for that analysis. Nevertheless, overnight hedges in both markets are not very effective relative to day-to-day and two-day hedges, and the risk (opportunity) for fairly large profits and losses from simple hedges is quite high.

The CBOT needs to consider various mechanisms and procedures to increase the volume of trading on Project A. These could include lower commissions, expanded hours, easier trader access, and advertising and promotion. Especially, the CBOT should consider electronic trading of corn futures contracts during all the hours that daytime open outcry trading is closed, covering current time gaps where no contracts are trading. Expanded hours, however, are effective only if volume is also higher. E*hedging on Project A has considerable potential in terms of managing short-term price risks, but the market may currently be too thin and illiquid for active use by large cash corn merchants.

References

Castelino, M.G. "Hedge Effectiveness: Basis Risk and Minimum-Variance Hedging." *Journal of Futures Markets.* 12(1992):187-201.

Davidson, R. and Mackinnon, J.G., *Estimation and Inference in Econometrics*. Oxford: Oxford University Press, 1993.

Ederington, L. "The Hedging Performance of the New Futures Markets." *Journal of Finance*. 34(1979):157-170.

Geppert, J.M. "A Statistical Model for the Relationship Between Futures Contract Hedging Effectiveness and Investment Horizon Length." *Journal of Futures Markets.* 15(1995):507-536.

Leuthold, R.M., J.C. Junkus, J.E. Cordier. *The Theory and Practice of Futures Markets.* Lexington, MA: Lexington Books, 1989.

Norvell, J.M. and R.M. Leuthold. "Simultaneously Derived Optimal Hedge Ratios for East Central Illinois Corn and Soybean Producers." *Proceedings of NCR Conference on Applied Commodity Price Analysis, Forecasting and Market Risk Management*. 1992, pp. 100-114.

Working, H. "Hedging Reconsidered." *Journal of Farm Economics*. 35(1953):544-561.

Table 1. Contract Specifications (Corn Futures)

	Chicago Board of Trade	Tokyo Grain Exchange
Trading Unit	5,000 bushel	100,000 kg (3,937 bushel)
Deliverable Grades	No.2 yellow at par and substitutions at differentials established by the exchange.	No.3 yellow corn produced in the U.S.A. with less than 15 % moisture.
Price Quote	Cents and quarter-cents/bushel	Yen per 1,000 kg
Tick Size	¼ cent/bushel ($12.50/contract)	10 yen/1,000 kg (1,000 yen per contract)
Daily Price Limit	12 cents/bushel ($600/contract) above or below the previous day's settlement price (expandable to 18 cents/bushel). No limit in the spot month (limits are lifted two business days before the spot month begins).	400 yen per 1,000 kg, if the standard price is under 15,000 yen. 500 yen per 1,000 kg, if the standard price is from 15,000 yen to, but not including 25,000 yen. 600 yen per 1,000 kg, if the standard price is from 25,000 yen to, but not including 35,000 yen. 700 yen per 1,000 kg, if the standard price is from 35,000 yen and up. No price limits in the current month from the 1st day of the month proceeding the delivery month.
Contract Months	December, March, May, July, September	January, March, May, July September and November within a 12 month period.
Last Trading Day	7th business day preceding the last business day of the delivery month.	15th day of the month (or nearest business day) preceding the delivery month.
Last Delivery Day	Last business day of the delivery month.	The last day of the delivery month.
Trading Hours	9:30 a.m. – 1:15 p.m. central time, Monday-Friday Trading in expiring contracts closes at noon on the last trading day.	Morning 1st session 09:00-10:00 3rd session 11:00-12:00 Afternoon 1st session 13:00-14:00 3rd session 15:00-16:00
Delivery Places	Chicago, St. Louis, and Toledo	The pier of Kashima, Chiba, Kawasaki, and Yokohama ports.

Table 2. Summary Statistics for the Three Hedging Scenarios
(Chicago Cash – Nearby Tokyo Futures)

	Overnight		Day-to-Day		Two Day	
1994	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	219	219	204	204	204	204
Mean	-0.26*	0.02	-0.35	-0.40	-0.64	-0.37
SD	1.92	3.53	3.16	5.97	3.60	7.24
Correlation	0.04**		0.48		0.39	
	(0.57)		(7.79)		(6.08)	
R^2	0.0015		0.2309		0.1546	
1995	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	223	223	204	204	204	204
Mean	0.14	-0.10	0.31	0.28	0.42	0.08
SD	1.64	3.46	2.49	5.94	3.08	6.62
Correlation	0.02**		0.39		0.31	
	(0.26)		(5.98)		(4.69)	
R^2	0.0003		0.1505		0.0982	
1996	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	194	194	170	170	170	170
Mean	0.38	0.14	0.74	0.48	1.25	0.56
SD	4.16	7.58	5.75	10.63	7.70	13.88
Correlation	0.27		0.58		0.53	
	(3.93)		(9.32)		(8.16)	
R^2	0.0743		0.341		0.2839	
1997	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	221	221	206	206	205	205
Mean	0.22	-0.16	0.09	-0.08	0.25	-0.29
SD	4.16	7.58	3.94	6.45	4.49	6.84
Correlation	0.27		0.62		0.57	
	(5.79)		(11.20)		(9.83)	
R^2	0.1329		0.3807		0.3226	
1998	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	233	233	232	232	226	226
Mean	-0.03	0.13	-0.37	-0.15	-0.51	-0.21
SD	2.99	2.20	3.16	5.36	3.71	5.60
Correlation	0.12		0.33		0.36	
	(1.81)		(5.29)		(5.74)	
R^2	0.0139		0.1085		0.1282	
Total	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	1090	1090	1016	1016	1009	1009
Mean	0.07	0.01	0.04	0.01	0.10	-0.07
SD	2.57	4.59	3.78	6.93	4.70	8.26
Correlation	0.22		0.51		0.47	
	(7.31)		(19.03)		(16.94)	
R^2	0.0468		0.2632		0.2219	

*****Results shown in cents per bushel. ** Correlation coefficient is not significant.
The numbers in parentheses are Pearson's product-moment *t*-ratios.

Table 3. Summary Statistics for the Three Hedging Scenarios
(Chicago Cash – Distant Tokyo Futures)

	Overnight		Day-to-Day		Two Day	
1994	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	219	219	213	213	213	213
Mean	-0.26*	-0.08	-0.39	-0.30	-0.76	-0.35
SD	1.92	3.02	3.11	5.14	3.72	5.48
Correlation	0.24		0.64		0.49	
	(3.68)		(12.17)		(8.12)	
R^2	0.0589		0.4125		0.238	
1995	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	223	223	214	214	215	215
Mean	0.17	-0.03	0.33	0.36	0.43	0.36
SD	1.72	3.50	2.46	6.21	3.29	6.72
Correlation	-0.02**		0.43		0.32	
	(0.24)		(6.88)		(4.99)	
R^2	0.0003		0.1825		0.1048	
1996	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	194	194	186	186	192	192
Mean	0.44	-0.65	0.72	-0.49	0.91	-1.00
SD	4.07	4.92	5.75	8.06	7.71	8.24
Correlation	0.22		0.57		0.54	
	(3.16)		(9.42)		(8.89)	
R^2	0.0495		0.3253		0.2936	
1997	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	219	219	205	205	215	215
Mean	0.20	0.12	0.09	-0.15	0.30	-0.10
SD	2.44	3.59	3.96	5.64	4.57	5.73
Correlation	0.35		0.66		0.53	
	(5.52)		(12.57)		(9.23)	
R^2	0.1233		0.4377		0.2856	
1998	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	235	235	225	225	226	226
Mean	0.01	0.20	-0.42	-0.19	-0.54	-0.07
SD	2.43	3.49	3.22	4.21	3.73	4.23
Correlation	0.29		0.40		0.40	
	(4.55)		(6.60)		(6.50)	
R^2	0.0816		0.1636		0.1586	
Total	Chicago	Tokyo	Chicago	Tokyo	Chicago	Tokyo
N	1090	1090	1043	1043	1061	1061
Mean	0.10	-0.07	0.04	-0.15	0.04	-0.21
SD	2.60	3.49	3.82	5.91	4.82	6.16
Correlation	0.21		0.54		0.46	
	(7.19)		(20.75)		(16.97)	
R^2	0.0453		0.2925		0.2137	

*****Results shown in cents per bushel. ** Correlation coefficient is not significant.
The numbers in parentheses are Pearson's product-moment *t*-ratios.

Table 4. Summary Statistics for the Three Hedging Scenarios (Chicago Cash – Nearby Project A Futures)

	Overnight		Day-to-Day		Two Day	
1996	Chicago	Project A	Chicago	Project A	Chicago	Project A
N	165	165	158	158	155	155
Mean	0.43*	0.25	0.69	0.90	0.85	0.72
SD	4.44	2.23	6.18	7.13	8.11	7.39
Correlation	0.60		0.89		0.92	
	(9.53)**		(24.35)		(28.99)	
R^2	0.358		0.7917		0.846	
1997	Chicago	Project A	Chicago	Project A	Chicago	Project A
N	204	204	217	217	218	218
Mean	0.24	0.31	-0.05	0	0.05	0.25
SD	2.47	1.17	4.12	4.19	4.72	4.18
Correlation	0.51		0.86		0.81	
	(8.42)		(24.81)		(20.65)	
R^2	0.2602		0.7411		0.6638	
1998	Chicago	Project A	Chicago	Project A	Chicago	Project A
N	244	244	240	240	238	238
Mean	-0.10	0.26	-0.39	-0.37	-0.48	-0.13
SD	2.23	1.07	3.13	2.91	3.65	3.13
Correlation	0.62		0.94		0.89	
	(12.27)		(44.26)		(29.89)	
R^2	0.38		0.8917		0.7904	
Total	Chicago	Project A	Chicago	Project A	Chicago	Project A
N	613	613	615	615	612	612
Mean	0.16	0.27	0.01	0.09	0.04	0.22
SD	3.06	1.50	4.44	4.77	5.47	4.89
Correlation	0.58		0.89		0.89	
	(17.71)		(47.94)		(47.47)	
R^2	0.3393		0.7895		0.787	

*****Results shown in cents per bushel.

**The numbers in parentheses are Pearson's product-moment *t*-ratios.

Table 5. Percent of Trading Profits and Losses in One-Cent Intervals for the All Hedging Scenarios[a]

Range[b] (cents/bu)	Chicago-Nearby Tokyo			Chicago-Distance Tokyo			Chicago-Project A		
	Overnight	Day-to-Day	Two Day	Overnight	Day-to-Day	Two Day	Overnight	Day-to-Day	Two Day
-25.0~-29.9	0.09	0.10	0.59	0.00	0.10	0.09			
-20.0~-24.9	0.09	0.30	0.59	0.00	0.00	0.28			
-15.0~-19.9	0.28	0.89	1.19	0.18	0.19	0.19			
-10.0~-14.9	1.38	2.95	3.47	0.46	1.73	3.20	0.16	0.49	0.33
-9.0~-9.9	0.83	1.28	1.39	0.18	0.96	0.94	0.16	0.16	0.49
-8.0~-8.9	0.92	1.87	2.18	0.55	0.86	1.23	0.33	0.33	0.33
-7.0~-7.9	1.19	2.85	1.98	0.55	1.44	1.32	0.65	0.33	0.16
-6.0~-6.9	2.29	1.77	3.07	1.01	2.59	2.73	0.16	0.81	0.16
-5.0~-5.9	2.84	3.84	3.67	2.75	4.12	3.58	0.65	0.65	0.82
-4.0~-4.9	4.22	5.22	4.66	3.67	5.56	5.00	1.47	1.30	1.96
-3.0~-3.9	5.50	5.51	5.65	5.96	6.04	6.69	2.61	1.46	3.59
-2.0~-2.9	6.88	6.10	6.14	9.17	7.96	8.39	5.38	1.95	4.58
-1.0~-1.9	10.92	8.27	7.53	13.76	8.15	8.11	18.27	7.97	17.32
-0.1~-0.9	13.12	8.96	8.23	14.40	9.78	9.05	24.14	25.53	25.00
0~0.9	13.94	7.78	7.04	12.94	8.82	8.01	28.55	46.18	28.27
1.0~1.9	9.54	8.56	7.23	10.09	8.92	9.99	8.32	7.32	7.52
2.0~2.9	6.61	8.07	5.85	7.52	8.72	6.79	3.10	1.79	2.94
3.0~3.9	4.77	5.71	5.15	5.05	5.37	3.49	0.98	0.49	1.80
4.0~4.9	4.13	4.04	5.15	3.30	4.99	4.90	1.63	1.30	2.12
5.0~5.9	2.75	3.44	4.06	1.93	4.12	3.11	0.82	0.16	0.49
6.0~6.9	1.74	2.56	3.27	1.74	3.45	2.17	0.33	0.65	0.00
7.0~7.9	1.28	1.77	1.98	0.92	1.15	2.26	0.33	0.33	0.49
8.0~8.9	1.28	1.77	1.39	0.92	1.92	1.70	0.33	0.00	0.16
9.0~9.9	0.55	1.57	1.19	0.83	0.48	1.32	0.16	0.33	0.16
10.0~14.9	2.02	3.54	4.46	1.74	1.53	3.96	1.31	0.49	1.14
15.0~19.9	0.55	0.89	1.88	0.18	0.67	0.85	0.16	0.00	0.16
20.0~24.9	0.00	0.30	0.40	0.09	0.19	0.47			
25.0~29.9	0.28	0.10	0.59	0.09	0.19	0.19			

a Each column sums to 100 percent.

b Results beyond 10 cents are combined into larger intervals due to few observations.

Figure 1. Chicago-Tokyo Time Line