Optimal Cross Hedging Winter Canola

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Abstract:

Winter canola in the southern Great Plains has shown large price fluctuations and there have been questions about which futures market could be used to reduce price risk. Our results indicate that the optimal futures contract to cross hedge winter canola is soybean oil futures.

Keywords: Cross hedge, winter canola, overlapping data, futures market

Introduction

In the early 2000s winter hardy canola was introduced as a rotation crop, and canola acreage has dramatically increased in the southern Great Plains. Winter canola provides many advantages for wheat growers. First, the yield and quality of wheat increases by planting canola since cultivation of canola interrupts the cycle of diseases and stops the growth of grassy winter weeds, especially ryegrass (Boyles et al., 2005). Moreover, winter canola is more profitable than winter wheat (Bushong et al., 2011). For example, the annual average price per bushel of winter wheat is $7.32, but that of winter canola is $11.53 in 2012 (USDA, 2013a). In addition, winter canola varieties suitable for growth in the southern Great Plains are steadily developed by various programs such as the Kansas Agriculture Experiment Station. As a result, canola production has increased rapidly in the southern Great Plains. For example, Oklahoma canola production has increased from 89.6 million pounds in 2010 to 161 million pounds in 2012, making Oklahoma the second largest canola producing state in the US (USDA, 2013b).

Despite increasing canola supply, the U.S canola supplies have been slow to respond to increasing demand. The increased demand for canola originates from canola oil being considered healthy due to its lower levels of saturated fatty acids and low-density lipoprotein cholesterol (Eskin and McDonald, 1991). This imbalance in U.S. canola supply and demand is solved through an increase of imported canola. For example, the quantity of canola oil imported into the U.S has steadily increased from 1,108 million pounds in 2002 to 3,289 million pounds in 2012, accompanied by a steady increase in price, which can also be seen in domestic canola prices as well (USDA, 2013c).

Even though winter canola has shown a large price change, price risk management tools may not be readily accessible to canola producers and processors. For instance, the percentage of canola farmers who use yield and revenue insurance to reduce their price risk is estimated to be less than 70% in Oklahoma, Kansas, and Texas (USDA, 2013d). This percentage is significantly lower compared with North Dakota which shows a 98% insured rate (USDA, 2013d). Since the large price fluctuation of canola is a challenge not only to the farm sector, but also to the processor sector, an effective method to reduce price risk is needed for stable winter canola supply in the southern Great Plains.

Futures trading is an efficient way to reduce price risk. The futures market functions not only for price discovery but also hedging (Kolb and Overdahl, 2007). However, it is impossible to use a direct hedge for winter canola since it is not traded in any U.S. futures market. To deal with this issue, there are two alternatives. One is to cross hedge by using other U.S. futures contracts and the second is using canola futures traded in the IntercontinentalExchange (ICE) Futures Canada, which is largely spring canola. In the latter case, the exchange rate between the US and Canada needs to be taken into account.

Anderson and Danthine (1981) suggested a theoretical cross hedging model and there has been substantial empirical research on cross hedging (Wilson, 1989; Brorsen, Buck and Koontz, 1998; Rahman, Turner, and Costa, 2001; Flaskerud, Dahl, and Wilson, 2002; Rahman, Dorfman, and Turner, 2004). Flaskerud, Dahl, and Wilson (2002) suggest that canola futures at the Winnipeg Commodity Exchange (WCE) as a more effective market to manage price risk of North Dakota spring canola than U.S. soybean futures. However, there is no similar research related to managing the price risk of winter canola.

The purpose of this study is to determine the optimal futures contracts to cross hedge winter canola. Specifically, this study will determine the hedge ratio and hedging effectiveness of the selected futures contracts on three different hedging horizons; one day, one week (5 contract days) and one month (20 contract days) .

Procedures

To estimate the simple hedge ratio, the conventional method involves estimating the following linear regression model:

(1) $$S_t = \alpha + \beta^* F_t + e_t$$

where S_t and F_t are the spot and futures returns for period t. The ordinary least squares (OLS) estimator of β provides an estimate of the minimum-variance (risk minimizing) hedge ratio. The hedging effectiveness of the minimum variance hedge, that is, the proportion of the reduction in variance of the hedged portfolio over an unhedged portfolio is calculated by:

(2) $$HE = 1 - \frac{Var(H)}{Var(UH)}$$

where the HE is hedging effectiveness, $Var(H)$ is variance of the hedged portfolio, and $Var(UH)$ is variance of the unhedged portfolio. The measure of hedging effectiveness for the minimum variance hedge model is equal to R^2 from the linear regression model (1). Since Ederington (1979), this approach has been extensively applied in the voluminous literature.

Overlapping Data Problem and Missing Value Problem

The conventional regression model (1) faces a major problem with this study, since this study uses overlapping data in calculating the spot and futures returns for period t. Using overlapping time periods of the price change model causes a moving average process with order equal to the length of the hedge period (Harri and Brorsen, 2009). The change in price from day t to day $(t-k)$ is equal to the sum of daily price change over the same $(t-k)$ period, and thus OLS method is inefficient and biased hypothesis test due to autocorrelation in the residuals. Moreover, daily log return data of Oklahoma canola include missing values. To deal with these overlapping data and missing value problem, this study uses two alternative methods to estimate the hedge ratio: generalized least squares (GLS) and maximum likelihood estimation (MLE).

Generalized Least Squares (GLS) Method

If there is no source of autocorrelation except overlapping data in equation (1), the GLS estimator of the aggregate model will be best linear unbiased and asymptotically efficient (Harri and Brorsen, 2009). In terms of the missing value problem, the correlation matrix can be calculated as if all Oklahoma canola data do not exist and then delete the respective rows and columns for missing values. To handle an overlapping data problem and missing value problems, coefficient and variance of the aggregated model can be obtained as follows:

$$(3) \qquad \hat{\beta} = (F_{it}'\Omega^{-1}F_{it})^{-1}F_{it}'\Omega^{-1}S_t$$

$$(4) \qquad var[\hat{\beta}] = \sigma_e^2(F_{it}'\Omega^{-1}F_{it})^{-1}$$

where σ_e^2 is the variance of error term e_t in the aggregated model and Ω is the correlated matrix following Gilbert (1986, p.1156).

Maximum Likelihood Estimation (MLE) Method

The moving average process is corrected by approximating it based on an autoregressive process. Using an autoregressive process has the advantage that it is easier to estimate than the moving average process. The autoregressive process could also capture autocorrelation from sources other than overlapping data. The parameter estimates of the moving average process are different from their expected values when the overlapping data are the only source of autocorrelation (Brorsen, Buck, and Koontz, 1998). The error term in equation (2) is redefined for autoregressive model as follows:

$$(5) \qquad e_t = -\sum_{j=1}^{n} \varphi_j e_{t-j} + v_t$$

where φ_j and v_t indicate coefficient and error term, which is normally and independently distributed with zero mean and constant variance.

Data

The futures contracts of Chicago soybean, soybean meal, soybean oil, corn, wheat, Kansas City wheat and Canada Canola were selected as the potential contracts for cross hedging winter canola. Oklahoma canola spot prices were obtained from the USDA's Market News and directly from Equity Marketing Alliance. The prices of Chicago soybean, soybean meal, soybean oil, corn, wheat, Kansas City wheat and Canadian Dollar futures were gathered from Price-

Data.com. The Canada canola futures were obtained from the Commodity Research Bureau (CRB).

Daily log returns of Oklahoma canola spot price and futures price are used from September 19, 2009, when Oklahoma canola trading data started to be listed on the USDA Market News, to January 14, 2013. Oklahoma City canola prices only exist for the period of September 19, 2009 through March 7, 2012. In this study, the canola price of Dacoma, a town in Woods County, Oklahoma, is substituted for Oklahoma canola price from July 26, 2011, since the Dacoma region canola price has the largest number of observations. Price from the nearby futures contract month is used until the 19th of the month preceding the futures contract month. After the 19th of the preceding month, the price for the next nearby futures contract month is used and differences were taken before splicing to avoid outliers on the rollover day. To calculate the daily log returns of Canada canola futures, the Canada canola futures price is converted into U.S. dollars by multiplying Canada canola futures price by Canadian dollars futures price. The hedge ratios and hedging effectiveness are calculated for 1, 5 and 20 market-day hedge periods which correspond to one day, one week, and one month calendar hedge, respectively.

Results

Summary statistics are presented in Table 1. The mean values of the daily log return can be interpreted as the percent change of the daily price. The average returns of all variables are interpreted as essentially zero in the daily price and the returns of wheat futures show relatively higher price volatility. The results of the Bera-Jarque normality test indicate that all variables violate the assumption of normality.

Table 2 shows the estimated Pearson correlation coefficients among the daily returns of Oklahoma canola spot, domestic futures, and Canada canola futures. The results show that there is a high correlation between the returns of Oklahoma canola spot and the returns of soybean oil futures with the correlation coefficient of 0.775. However, the correlations between Oklahoma canola and Kansas City wheat, wheat and corn are low with the correlation coefficients of around 0.4, suggesting that corn, wheat and Kansas City wheat futures are inappropriate for cross hedging Oklahoma canola.

Table 3 shows the hedge ratios using domestic futures on Oklahoma canola spot for the hedging periods of 1 day, 5 days and 20 days. The parameter estimates of soybean, wheat, Kansas City wheat, and corn futures are not significant at the 5 % level, except Kansas City wheat futures with 20 days of hedging period in MLE. The results imply that soybean, wheat, Kansas City wheat, and corn futures contracts are not good candidates to cross hedge Oklahoma canola.

Table 4 and Table 5 report the hedge ratios and hedging effectiveness on Oklahoma canola by using soybean oil futures and Canada canola futures respectively. Although both futures contracts show significant explanatory power, soybean oil futures have higher hedging effectiveness than Canada canola futures. Market participants who want to reduce price volatility risk of canola should select soybean oil futures rather than Canada canola futures based on the greater hedge effectiveness. For example, Oklahoma canola processors can hedge their price change risk as much as 61% by using the soybean oil futures for 5 days. The results suggest that the most appropriate futures for cross hedging Oklahoma canola is soybean oil futures.

Table 6 reports the hedge ratios and hedging effectiveness of multiple hedging using both soybean oil and soybean meal futures on Oklahoma canola. All parameter estimates are significant at the 1% level. The results of multiple hedges show slightly higher hedging effectiveness, roughly 3%, 4% and 2% on 1 day, 5 days, and 20 days hedge, respectively than that with only soybean oil alone as seen in Table 4. The result is consistent with Sephton (1993) pointing out that the variance of a portfolio constructed with multiple-markets would be lower than that with only one market. This result implies that the higher hedging effectiveness using multiple markets grantees the higher hedger's utility only if the additional transaction cost is offset by the reduced price risk originated from additional market.

Summary and Conclusion

The aim of this paper is to determine optimal futures contracts for hedging on the Oklahoma canola spot.

In the domestic futures contracts, soybean oil and soybean meal futures have significant explanatory power at the 1% and 5% significance level, respectively and show higher correlation with Oklahoma canola. To decide the optimal futures contract for hedging on Oklahoma canola between soybean oil and Canada canola, hedging effectiveness is used. They both indicate significant explanatory power for Oklahoma canola spot price, but soybean oil futures shows higher hedging effectiveness than Canada canola futures. This result suggests that soybean oil futures is the optimal cross hedging vehicle to reduce Oklahoma canola spot price risk of all the futures contracts studied in this paper. This is consistent with the general perception that the main purpose of canola cultivation is to obtain its oil. In the comparison between multi-market hedge with soybean oil futures and soybean meal futures and single market hedge with soybean oil future, the hedging effectiveness of multiple markets is slightly higher, roughly 3%, than the single market hedge.

This study indicates a different result than Flaskerud, Dahl, and Wilson (2002). They state that changes of canola cash prices in Velva, North Dakota are most closely correlated with canola futures in Winnipeg Commodity Exchange in Canada, while soybean oil futures at CBOT are only second best using 1993-2000 data. However, this study indicates that soybean oil shows the highest correlation and Canada canola futures is in the third position. The different results might originate from the fact that winter canola in Oklahoma is harvested earlier than spring canola in North Dakota. Moreover, different periods of data are used. In addition, the exchange rate between the US and Canada was not considered as an explanatory variable in their paper. Our results favor that hedger of winter canola should use soybean oil futures in the domestic futures market.

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Table 1. Summary Statistics on Daily Returns (September 19, 2009 through October 19, 2012)

Variables	Mean	SD	Skewness	Kurtosis	Bera-Jarque
Oklahoma canola	0.068	1.950	-0.043	5.010	115.000
Soybean oil futures	0.021	1.333	-0.036	3.911	29.160
Soybean meal futures	0.062	1.611	-0.120	3.895	30.001
Soybean futures	0.048	1.414	-0.150	4.475	79.079
Wheat futures	0.000	2.278	0.094	4.368	66.576
Kansas City wheat futures	0.028	2.041	0.110	4.105	44.310
Corn futures	0.080	1.983	0.115	4.318	62.477
Canada canola futures	0.062	1.393	-0.455	5.009	165.412

Note: The Bera-Jarque test statistic, BJ, is defined as $BJ = T[\frac{Skewness^2}{6} + \frac{(Kurtosis-3)^2}{24}]$, where T is the number of observations. The BJ statistic is asymptotically distributed $\chi^2_{(2)}$.

Table 2. Pearson Correlation Coefficients

Variable	Oklahoma Canola	Soybean Oil Futures	Soybean Meal Futures	Soybean Futures	Wheat Futures	Kansas City Wheat Futures	Corn Futures
Oklahoma canola	1						
Soybean oil futures	0.775	1					
Soybean meal futures	0.609	0.601	1				
Soybean futures	0.729	0.816	0.923	1			
Wheat futures	0.412	0.506	0.504	0.576	1		
Kansas City wheat futures	0.404	0.503	0.502	0.572	0.963	1	
Corn futures	0.419	0.491	0.556	0.609	0.726	0.698	1
Canada canola futures	0.658	.	.	.	.	.	.

Note: Correlation coefficients are all significant at the 1% level.

Table 3. Multiple Hedge Ratios Using Domestic Futures and Oklahoma Canola

Variable	Generalized Least Square			Maximum Likelihood		
	1 Day	5 Days	20 Days	1 Day	5 Days	20 Days
Intercept	0.015 (0.34)	0.034 (0.16)	0.159 (0.19)	0.015 (0.42)	0.023 (0.12)	0.243 (0.26)
Soybean oil futures	0.947** (11.61)	0.939** (10.77)	0.948** (10.85)	0.926** (11.37)	0.929** (10.47)	0.963** (11.35)
Soybean meal futures	0.274** (2.68)	0.265* (2.44)	0.286** (2.63)	0.233* (2.27)	0.229* (2.05)	0.313** (2.98)
Soybean futures	0.039 (0.24)	0.051 (0.30)	0.016 (0.09)	0.103 (0.63)	0.085 (0.48)	-0.089 (-0.53)
Wheat futures	0.058 (0.76)	0.048 (0.60)	0.053 (0.66)	0.081 (1.09)	0.090 (1.14)	0.148 (1.88)
Kansas City wheat futures	-0.098 (-1.17)	-0.083 (-0.96)	-0.082 (-0.95)	-0.120 (-1.49)	-0.135 (-1.59)	-0.171* (-2.01)
Corn futures	-0.017 (-0.47)	-0.011 (-0.29)	-0.017 (-0.45)	-0.037 (-1.08)	0.013 (0.36)	-0.018 (-0.50)

Note: The t-values for the test statistics are presented in parentheses.
* and ** indicate statistical significance at the 5% and 1% levels, respectively.

Table 4. Hedge Ratios and Hedging Effectiveness Using Canada Canola Futures and Oklahoma Canola

Variable	Generalized Least Squares			Maximum Likelihood		
	1 Day	5 Days	20 Days	1 Day	5 Days	20 Days
Intercept	0.005 (0.08)	-0.047 (-0.18)	-0.188 (-0.18)	0.005 (0.11)	-0.063 (-0.30)	-0.178 (-0.25)
Canada canola futures	0.918** (22.42)	0.912** (21.77)	0.917** (21.34)	0.913** (22.70)	0.912** (22.28)	0.947** (23.55)
Hedging effectiveness	0.432	0.474	0.518	0.432	0.474	0.516

Note: The t-values for the test statistics are presented in parentheses.
** indicates statistical significance at the 1% level.

Table 5. Hedge Ratios and Hedging Effectiveness Using Soybean Oil Futures and Oklahoma Canola

Variable	Generalized Least Squares			Maximum Likelihood		
	1 Day	5 Days	20 Days	1 Day	5 Days	20 Days
Intercept	0.036 (0.75)	0.086 (0.38)	0.370 (0.41)	0.033 (0.91)	0.074 (0.39)	0.315 (0.33)
Soybean oil futures	1.142** (31.94)	1.150** (30.26)	1.137** (29.31)	1.132** (33.02)	1.160** (31.21)	1.105** (30.06)
Hedging effectiveness	0.600	0.610	0.571	0.600	0.610	0.580

Note: The t-values for the test statistics are presented in parentheses.
** indicates statistical significance at the 1% level.

Table 6. Hedge Ratios and Hedging Effectiveness Using Soybean Oil and Meal Futures and Oklahoma Canola

Variable	Generalized Least Squares			Maximum Likelihood		
	1 Day	5 Days	20 Days	1 Day	5 Days	20 Days
Intercept	0.015 (0.32)	0.026 (0.12)	0.115 (0.13)	0.014 (0.40)	0.012 (0.07)	0.132 (0.14)
Soybean oil futures	0.942** (21.97)	0.941** (20.47)	0.936** (20.37)	0.943** (23.23)	0.951** (21.43)	0.913** (20.53)
Soybean meal futures	0.276** (7.73)	0.280** (7.49)	0.279** (7.49)	0.265** (7.87)	0.277** (7.83)	0.253** (7.03)
Hedge effectiveness	0.632	0.649	0.586	0.632	0.648	0.602

Note: The t-values for the test statistics are presented in parentheses.

** indicates statistical significance at the 1% level.