The Potential to Use Futures and Options to Manage Crop Insurance Losses

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Introduction and Background

Crop insurance is faced with the challenge of adverse weather, including frost, drought or flooding, with severe events potentially destroying crops across large areas (Porth, Seng Tan and Weng, 2013; Porth, Pai and Boyd, 2014). Crop insurance premiums are based on expected losses, or average loss over a period of time, typically during planting and through to harvest. Moderate declines in yield below insured levels would not likely result in significant losses for insurers. However, widespread damage across many farms in a region could potentially lead to catastrophic loss, which would cause more difficulty for the insurer. Miranda and Glauber (1997) estimated that the spatially correlated nature of crop insurance losses increases the risk to insurers by between 20 and 50 times compared to if yields were independent.

Another challenge for insurers is that the ability to manage the risk of losses is limited once premiums are set. Rates are determined in the period prior to seeding, leaving a window of time where farmers still have some ability to adjust their planting decisions. Decisions could change in response to factors such as fluctuating crop values or weather conditions that occurred after insurance rates were calculated. All farmers in the same geographic area face similar market and weather risks, and potentially could behave in a similar fashion, thereby amplifying any changes to the underlying risk factors for the insurers after premiums and insured values have been established, and after which insurers have limited ability to respond.

In Canada the provincial crop insurance agencies participate in the federal – provincial reinsurance agreement, where the federal government will cover crop insurance losses beyond a certain threshold. Some insurers may also purchase private reinsurance to protect against significant losses. But any additional instruments or methods that enhance the ability for insurers to reduce their risk between when premiums are set and when final yields are determined can further help to manage potential losses.

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There is little published research that examines the role of grain futures contracts in hedging crop insurance losses. Our method draws largely from Woodard and Garcia's (2008) examination on the efficacy of weather derivatives in hedging crop insurance exposures.

An important factor that determines the value of a commodity is the balance between available supply and expected demand. A sharp decline in yields, and resulting decrease in the supply of a commodity, would be expected to result in a price increase. If the relationship between yields and prices is statistically significant, crop insurers may have the potential to hedge crop insurance losses from widespread yield declines with grain futures markets.

Miranda and Glauber (1997) suggest that the hedging potential of grain futures markets is limited since domestic output and futures price movements have become less correlated due to the increased buffering effects of more widespread and integrated international trade. This could be the case in crops such as corn, where U.S. production is approximately 30 percent of the world total and has a market share of roughly 30 percent of world trade, half of what it was a decade ago. Wheat (United States has less than 10 percent of world production and only 20 percent of world exports) and soybeans (United States production of approximately 30 percent of the world total and 38 percent of world exports) are also important crops where a large portion of production and trade happens in countries outside the United States (USDA Foreign Agricultural Service).

The Chicago Board of Trade (CBOT) corn, wheat and soybean futures contracts are deliverable at different points in the Midwestern United States, implying a strong connection between domestic production and futures values[4]. But beyond just the fact that the U.S. share of world production and trade is declining, these futures contracts are also increasingly used by traders as the primary tool to hedge price risk on a global basis. This, in turn, causes domestic production to have a relatively smaller role in driving futures values than in the past.

However, the ability to use futures and options to hedge the risk of crop insurance losses may be stronger in instances where futures values are more directly impacted by changes to domestic production. For example, Canada represents just over 30 percent of global production of canola (also referred to as rapeseed), but accounts for as much as 60 percent or more of world trade. The Intercontinental Exchange (ICE) Canada (formerly the Winnipeg Commodity Exchange) has a canola futures contract. This contract has more volume and open interest than the rapeseed contract listed on the MATIF exchange in Paris, and is considered the primary futures contract for global canola traders. But Canada's dominant position in global canola trade should also make the ICE contract more sensitive to Western Canadian yield outcomes. All of these factors contribute to the ICE Canada canola contract potentially being less influenced by outside forces and more closely linked to domestic fundamentals, which may tighten the link between Western Canadian yields and futures prices.

[4] Corn, wheat and soybeans are physical delivery contracts, where the actual commodity is used to make or take delivery of any contracts that don't get liquidated prior to the delivery month. This delivery process is designed to force convergence between spot cash markets and the futures price on the first notice day. The threat of physical delivery is an important part in ensuring the integrity of the contract.

One measure of the severity of crop insurance losses is the Loss Cost Ratio[5] (LCR). The LCR is calculated as the total indemnities paid relative to the total liabilities, and is often expressed as a percentage (Josephson, Lord, and Mitchell, 2000). The LCR will typically be under 25 percent, with any year above that considered a disaster (Porth, Pai and Boyd, 2014).

This paper will examine the effectiveness of using ICE Canada canola futures and options contracts to manage canola crop insurance losses in Western Canada. This includes comparing changes in yields with canola futures prices, and whether various hedging strategies could reduce the LCR for insurers compared to an unhedged position. If hedging in this manner is effective in managing crop insurance exposure, it could act as an additional risk management strategy for the industry.

Data

This study uses seeded area, yield and final production figures for canola in Canada from 1977 to 2009 from Statistics Canada. Canola futures prices for the November contract from 1977 to 2009 are from ICE Canada (formerly the Winnipeg Commodity Exchange). Soybean oil futures prices are from the Chicago Board of Trade. Actual premiums and liabilities for canola from Manitoba, Saskatchewan and Alberta from 1977 to 2009 were obtained from Agriculture and Agri-Food Canada's Production Insurance National Statistical System (PINSS).

Methodology

The connection between canola yields and the change in the futures price are examined for each year during the observation period. The actual yields are then compared to what would be expected based on trendline yields. Three different hedging strategies are examined in terms of their effectiveness in reducing the LCR or the variability of the LCR during the observation period.

Step 1 : Impact of Yield and Soybean Oil Price Changes on Canola Futures Price Changes:

The first step is to assess the impact of changes in Canadian canola yield with changes in the ICE Canada futures price. A simple linear regression is used to examine the impact of yield on canola futures prices:

$$\gamma = \beta_0 + \beta_1 X_1 + \varepsilon \qquad (1)$$

where γ is the percentage change in the ICE Canada November canola futures price from April 1 to October 15, and X_1 is the difference in the canola yield from the expected trend yield.

[5] Loss Cost Ratio is the sum of the indemnities paid divided by the sum of total coverage.

While canola prices are influenced by production, they are also affected by price changes in other vegetable oil markets. A linear regression also examined the impact on canola futures prices of both the yield and the influence of other markets.

$$\gamma = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \qquad (2)$$

where γ is the percentage change in the ICE Canada November canola futures price from April 1 to October 15, X_1 is the difference in the canola yield from the expected trend yield, and X_2 is the percentage change in the CBOT soybean oil futures price in Canadian dollar terms during the same period.

The period from April 1 to October 15 is chosen as this represents the period between when premiums are established and crop insurance policies are taken out by farmers, and hence the insurers' exposure is defined, and when final production can be estimated with reasonable confidence as harvest is in its final stages. This is also a window of time when markets are particularly attentive to weather and overall growing conditions.

It should be noted that final official Statistics Canada estimates on production for each year typically only gets released in early December. An earlier estimate is released in October, although the farmer survey that produces the results is conducted before harvest is fully completed. But futures markets are continually responding to and incorporating new information. This includes the cumulative opinion on the size of the canola crop in an informal way from farmers, traders and other industry participants. This allows the market to adjust to expected production figures, even prior to the release of the final official government estimates.

The reason for not using prices after October 15 is because the liquidity of the November futures contract starts to decline as the open interest decreases in the final trading sessions leading up to the first notice day for delivery. Declining liquidity leaves the potential for erratic price movements in the November contract, specifically, that may not necessarily be representative of the value of canola in the broader marketplace.

The November canola futures contract is used throughout the period instead of the nearby futures price as this contract represents production for the particular growing season of interest. The nearby futures price series between April 1 and October 15 would incorporate the prices from the May and July futures months, but these are reflective of production from the previous growing season.

While the importance of the April to October growing season on production can be expected to have a significant influence upon canola prices, other factors also affect futures values, including the broader vegetable oil market. For example, a sharp decline in canola yield may not have a material impact on futures prices if global vegetable oil markets see a large drop in prices. Accounting for the impact of other vegetable oil markets allows us to more closely determine the actual impact of yield on prices. The difference in the soybean oil futures price during this window is included in the regression equation to account for the impact of global oilseed markets on the value of canola during this time.

Step 2 : Futures and Options to Hedge Indemnities Paid and LCR: Once the impact of yield on canola prices has been determined, the next step is to examine the link between changes in canola futures prices and the actual indemnities paid to farmers from a shortfall in yield below the insured levels. Indemnities paid on canola are examined for the provinces of Alberta, Saskatchewan and Manitoba from 1977 to 2009. Together these provinces account for over 95 percent of Canadian canola production.

Indemnities are aggregated across all three provinces rather than examined for each province individually. This aggregation is critical in assessing the efficacy of using grain futures contracts as losses in any single province may not have enough of an impact on the total supply of the crop to result in a change in the price. But losses across all three provinces combined would affect supplies in a significant way given the total impact it would have on Canadian production.

It should be noted that each provincial crop insurance agency acts as an independent entity. As a result, the effectiveness of hedging aggregated losses would primarily work if there was cooperation between the provincial crop insurance companies in managing their exposure, or for reinsurers that have risk across the three main canola producing provinces.

The decision to aggregate indemnities across the three provinces was influenced by the work of Vedenov and Barnett (2004), in which their analysis found weather derivatives of limited use as a hedging instrument for crop losses at the farm and individual county level. Woodard and Garcia (2008) found that better hedging opportunities existed for weather derivatives at higher levels of spatial aggregation.

Conventional hedging methodology involves estimating a simple hedge ratio through the following linear regression model:

$$S_t = \alpha + \beta^* F_t + \varepsilon_t \qquad (3)$$

where S_t and F_t are the spot and future returns for period *t*. The ordinary least squares estimator of β provides an estimate of the minimum-variance hedge ratio.

The challenge with the conventional hedging methodology is that the analysis of the canola futures contract is being considered to manage crop insurance losses, and not a spot cash price that the traditional model assumes.

Since it is not a spot market cash price for canola that is being hedged, methods used in cross hedging were also considered. There has been extensive work on cross hedging in a range of agricultural and other commodity markets, including Franken and Parcell (2011) who study hedging fishmeal with corn and soybean meal futures, Adams and Gerner (2012) who examine hedging jet fuel with a number of crude oil and other energy futures contracts and Kim, Brorsen and Yoon (2014) who compare hedging winter canola with canola and soybean oil futures. But the basic model for most cross hedging analysis is similar to that for more conventional hedging, with futures values compared against spot cash prices.

Step 3 : Examining the Semivariance of the Hedged and Unhedged Positions: Furthermore, using minimum-variance to determine the hedge ratio creates challenges for crop insurers as it regards all extreme outcomes as undesirable. In the case of crop insurers, there is the desire to manage against large declines in yield. But there is no benefit when yields come in above the insured levels. In other words, crop insurers face one-directional risk.

The semi-variance of the unhedged and hedged positions was also examined to reflect the one-directional risk that insurers face. In this case, the hedge ratio is better determined by minimizing the semivariance of the portfolio, which is defined as

$$E\{[max(K-T),0]^2\} \qquad (4)$$

where E is the expectation operator, K is a random variable, and T is a specific target value. Thus, semivariance is measured as the expected value of squared deviations below a fixed target value. The portfolio is efficient when semivariance is minimized for a given expected value. Analysis of semivariance in the agricultural sector includes work by Turvey and Nayak (2003) and Mattos, Garcia and Nelson (2008).

The reference point, T, is a specific target LCR that is viewed as within an acceptable level of loss, and beyond which losses become more damaging. The average LCR of the unhedged portfolio during the observation period is 9.4 percent. A target LCR of 8 percent and 9.4 percent were examined for the semivariance calculation.

An efficient portfolio would be determined by solving the semi-variance minimizing hedge ratio, ω, as follows (Woodard and Garcia, 2008):

$$Min\ \sum\{Min\big[Y_k - \big(Y_{t,k}^{IPd} - \omega_k f_{t,k}\big),\ 0\big]\}^2 \qquad (5)$$

where ω is the hedge ratio measured in the number of metric tonnes of canola, $Y_{t,k}^{IPd}$ is the dollar value of indemnities paid, Y_k is the targeted level of acceptable indemnities paid out and $f_{t,k}$ is the change in the price of the November canola futures contract between April 1 and October 15.

This research assumed a hedge position for 10 percent of expected production for each growing season. This level was not determined by an optimal hedge ratio, but rather reflected the limited open interest in the ICE Canada Futures canola futures contract. While the size of the open interest varies, recent figures have an open interest that equates to approximately 25 percent of the size of the Canadian canola crop. This liquidity constraint limits the size of any potential hedge position.

Results

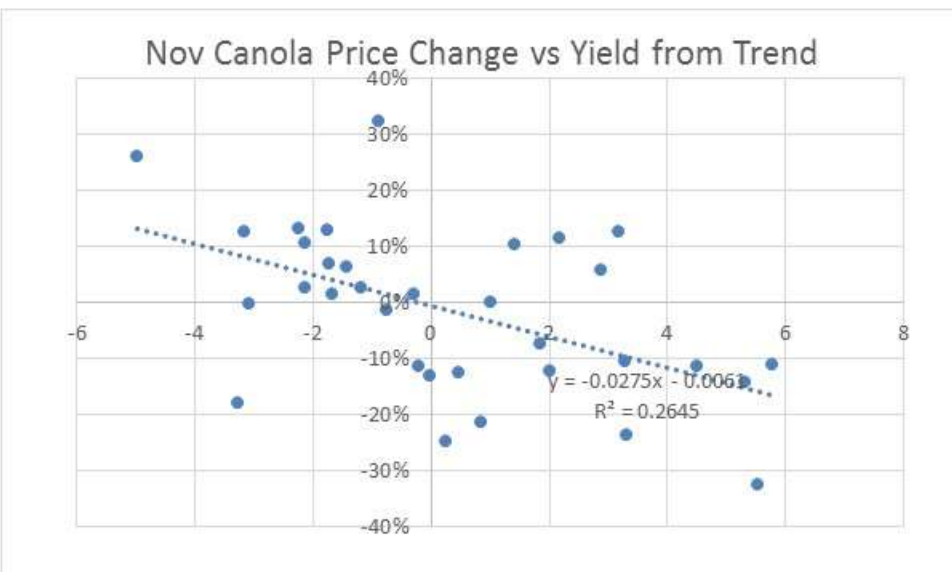
Impact of Yield Changes on Futures Prices: In comparing the change in the futures price of the November canola futures contract between April 1 and October 15 with the deviation from the expected trend yield, the results show a relatively weak relationship. The expected trend yield is estimated by running a regression of historical yields prior to the observation period. The regression shows a coefficient of -0.0275, suggesting that that the November futures price change is inversely related to the deviation in yield from the expected trend yield by 2.75 percent for every 1 bushel per acre shift in the yield. The R-square of the model is low, at just 0.2645, suggesting the relationship isn't very robust.

Graph 1 depicts the scatter plot and regression line of this relationship. The x-axis denotes the deviation in the actual yield from the expected trend yield. The y-axis measure the percentage change in the November canola futures price. Observations in the upper left and lower right quadrants show years when the futures price increased and the yield came in below expectations and when the futures price decreased and the futures price decreased, respectively. This is the relationship that would be expected given the negative coefficient.

Observations in the upper right and lower left indicate years when the futures price either increased even though yields were above expectations, or the price dropped even when yields were below the expected trend. These observations are contrary to what one would expect if price was strongly affected by the deviation from expected yield.

While most of the observations are in the expected upper left and lower right quadrants, six of the 33 years are in quadrants that go counter to what would be expected.

Graph 1. November Canola Futures Price Change vs Yield Deviation from Expected Trend.



From the perspective of implementing a hedge, the biggest risk is if yields decline and the futures price also declines (i.e. observations in the lower left quadrant, which indicated both large crop insurance losses and a loss on the hedge position). There is only one observation where there is both a sharp drop in yield from the trend and the futures price saw a meaningful decline. There are several observations where futures prices saw a meaningful decline, but where yields varied only marginal from trend expectations.

The results of the model that included both canola yields and the percentage change in the CBOT soybean oil futures price showed a similarly weak relationship, with an R-square of just 0.2738. This reflects that there are other factors that influences the canola futures price between April and October. In this model the coefficient for the deviation from trend line yields was -0.0285, very similar to the value in the previous equation.

Yields and Loss-Cost-Ratio:

The importance of the average yield in a given year in Western Canada also doesn't always correlate with the LCR of that season. For example, of the ten years where the LCR exceeded 12 percent, a relatively high level, six had an actual yield that was below the predicted trend yield, while four years had a yield that was actually above the predicted trend line yield. In other words, there are several years where crop insurance payouts were relatively large, even though the average yield in Western Canada came in above expectations. This could be due to heavy losses in a few areas, resulting in lots of claims, whereas other areas had above average yields, bringing the overall average yield levels up. This also reflects the one-sided risk nature of crop insurance losses, where payouts are required in any cases where losses exceed threshold levels, but where the income is limited to the premiums paid.

Table A provides a summary of the LCR, actual yields as reported by Statistics Canada and the predicted trend yield for each year from 1977 to 2009.

The Effectiveness of a Long Futures Hedge in Reducing Crop Insurance Losses:

Even if there is not a strong consistent relationship between the average yield in Western Canada and the change in the November canola futures price, the effectiveness of using futures contracts to manage crop insurance losses ultimately lies in whether a long futures position reduces the LCR over time.

The actual LCR for each year was compared to an LCR that was adjusted to reflect a long November canola futures position on 10 percent of anticipated production for each year from 1997 to 2009. Anticipated production was estimated by taking the seeded area for each year and the expected trend yield. This provides a forecast for the number of tonnes of expected production. The position was established on April 1 and liquidated on October 15, with any gains or losses added to or removed from the indemnities paid, resulting in an adjusted LCR for that year.

For example, in 1977 there were 3,500,000 acres of canola planted in Manitoba, Saskatchewan and Alberta. The estimated trendline yield for that year was 18.9 bushels per acre (or 0.429 metric tonnes per acre), which points to an expected production of 1,500,272 metric tonnes. A 10 percent hedge equates to a long position in the November canola futures contract of 150,027 tonnes.

Table A. Loss-Cost-Ratio, Yields and Futures Price Changes for Canola from 1977 to 2009.

Year	LCR	Statistics Canada Yield (bu/acre)	Trend Yld (bu/acre)	Difference	Futures Price Change (Canadian Dollars per MT)	Percent Futures Price Change
1977	4.8%	24.2	18.9	5.3035	-45.5	-14.35%
1978	4.3%	22.1	19.2	2.8718	16.5	5.82%
1979	12.9%	17.9	19.6	-1.6599	4.7	1.53%
1980	16.6%	21.3	19.9	1.4084	31.8	10.32%
1981	4.4%	23.5	20.2	3.2767	-39	-10.55%
1982	12.5%	22.4	20.6	1.845	-24.8	-7.36%
1983	11.5%	20	20.9	-0.8867	107	32.47%
1984	13.4%	19.8	21.2	-1.4184	23.9	6.33%
1985	14.1%	22.4	21.6	0.8499	-86.6	-21.43%
1986	12.0%	25.2	21.9	3.3182	-74.6	-23.68%
1987	6.1%	25.4	22.2	3.1865	29.8	12.61%
1988	14.7%	20.3	22.5	-2.2452	41.7	13.12%
1989	16.4%	19.6	22.9	-3.2769	-62.6	-17.80%
1990	8.2%	23	23.3	-0.2086	-38.5	-11.43%
1991	6.0%	24	23.5	0.4597	-39.4	-12.64%
1992	23.9%	22.7	23.9	-1.172	8.1	2.73%
1993	11.7%	23.9	24.2	-0.3037	4.9	1.58%
1994	6.5%	22.4	24.5	-2.1354	36.6	10.54%
1995	8.5%	21.8	24.9	-3.0671	-0.6	-0.15%
1996	3.0%	26.2	25.2	1.0012	0.3	0.07%
1997	5.0%	23.4	25.5	-2.1305	9.4	2.56%
1998	5.6%	25.1	25.9	-0.7622	-4.8	-1.29%
1999	2.4%	28.2	26.2	2.0061	-39.1	-12.21%
2000	5.2%	26.5	26.5	-0.0256	-37.9	-13.06%
2001	6.9%	23.7	26.9	-3.1573	36.4	12.75%
2002	33.3%	22.2	27.2	-4.989	87.6	26.24%
2003	8.6%	25.8	27.5	-1.7207	24.2	6.86%
2004	9.2%	28.1	27.9	0.2476	-95.9	-24.72%
2005	7.8%	32.7	28.2	4.5159	-32.9	-11.23%
2006	1.9%	30.7	28.5	2.1842	32.6	11.58%
2007	3.6%	27.1	28.8	-1.7475	49.8	12.82%
2008	1.7%	34.7	29.2	5.5208	-194.2	-32.57%
2009	5.0%	35.3	29.5	5.7891	-47.7	-11.01%

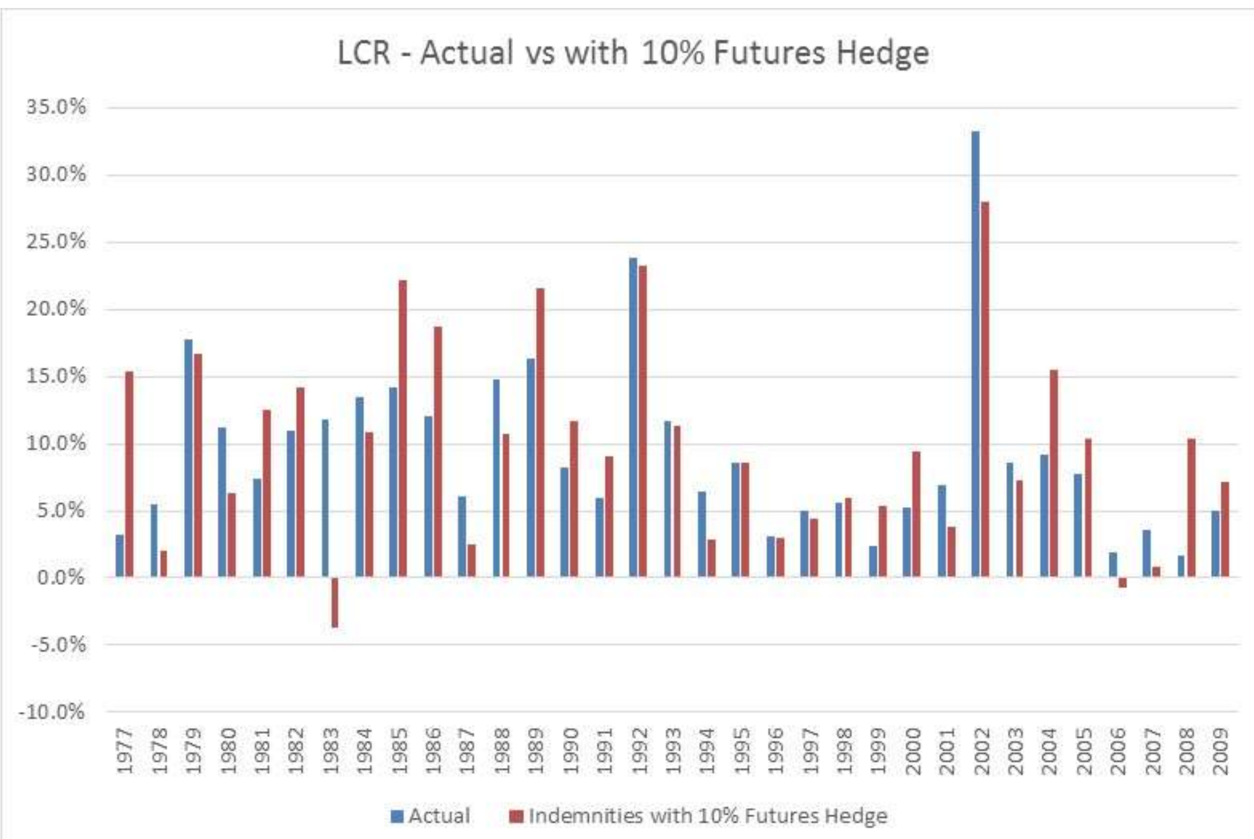
The long futures position will reduce the adjusted LCR in years when the futures price increases from April 1 to October 15 and increase it in years when the futures price declines. The futures price declined in 16 of the 33 observation periods, which is roughly what one might expect if market moves are assumed to be random in nature.

However, the direction of the change in the futures price didn't always correspond with a relatively higher or lower LCR for that same year. In some years the long futures position reduced the LCR, including in the two highest years (1992, when the LCR would have been reduced from 23.9 percent to 23.2 percent and 2002 when the LCR would have been reduced from 33.3 percent to 28 percent). In 1983 a moderate LCR of 11.5 percent was actually reduced to a negative LCR due to a sharp rise in the futures price.

But in other years the LCR was increased when incorporating a long futures hedge, including in some years when the LCR was already relatively high (such as 1985 when the LCR increased from 14.1 percent to 22.2 percent and 1989 when the LCR increased from 16.4 percent to 21.5 percent). There were also several years where the LCR was relatively low, but where a sharp drop in the futures price resulted in a much higher LCR than was actually realized (2004, 2009 and 2009).

The average actual LCR during the observation was 9.4 percent, while the LCR when incorporating a long futures hedge on 10 percent of expected production was 9.9 percent. The results of incorporating this long futures hedge can be seen in Graph 2 and Table B below.

Graph 2. Actual LCR for Canola in Western Canada vs Adjusted LCR with a Long Futures Hedge on 10 percent of Expected Production.



While the actual LCR would have been reduced in the two biggest loss years in the observation period, the increase in the average LCR over the period, and the number of years when it was increased even though the LCR was moderately high suggests that a long futures hedge isn't very effective in consistently reducing crop insurance losses.

The Effectiveness of a Long Call Option Hedge in Reducing Crop Insurance Losses:

One challenge with a long futures hedge position is the potential losses when the futures price goes down. In some years these losses can be substantial. Unlike a traditional hedge, where the value of the hedging instrument and underlying asset move up and down together, and losses in one market are offset by gains in the others, crop insurers face one-dimensional risk. Losses increase when yields are poor, but premium income is set regardless of how far above the insured threshold level that production may be.

In addition, as shown above, large declines in futures prices don't only correspond with years of bigger yields, but also can happen during years when yields are relatively low. In these instances, the long futures position actually adds to already relatively large losses, rather than reduce them.

The benefit of a long call option hedge position is that any potential hedging losses are confined to the cost of the option premium paid, while the hedge position gains are theoretically infinite. The limited liability nature of a long option position may more closely reflect the one-directional nature of crop insurance risks.

The call option hedge position assumes purchasing an at-the-money (ATM) call option on April 1, and then determines the intrinsic value as of October 15th, and assumes there is no time value remaining on the option (canola call options actually expire a few business days after the 15th of the month, but any time value remaining on the options would be negligible, and would not affect the effectiveness of the hedge).

In determining the value of the ATM option premium, we examined the average ATM option value for each year from 1998 to 2007. When the futures price was not exactly at the strike price (since strike prices are set in $10 per metric tonne increments, and the futures price trades in $0.10 per metric tonne ticks), the option value was adjusted to reflect this difference assuming a delta of 0.5. The average cost of an ATM call option during this period was $19 per metric tonne, ranging from a low of $16.25 to a high of $23.40. For purposes of our analysis we assumed an ATM option cost of $19 per tonne for each year.

Once again we assumed a hedge position on 10 percent of expected production. The net gain or loss on the call option position was subtracted or added to the indemnities paid to calculate an adjusted LCR for each year. There was a reduction in the net indemnities paid in years when the increase in futures price increase exceeded the $19 cost of the call option. There was a net increase in the net indemnities paid when the futures price increase was less than $19.

Table B. Actual LCR and Adjusted LCR Based on Canola Futures Hedge, Canola Call Option Hedge a Long Canola Minus Short Soybean Oil Futures Hedge.

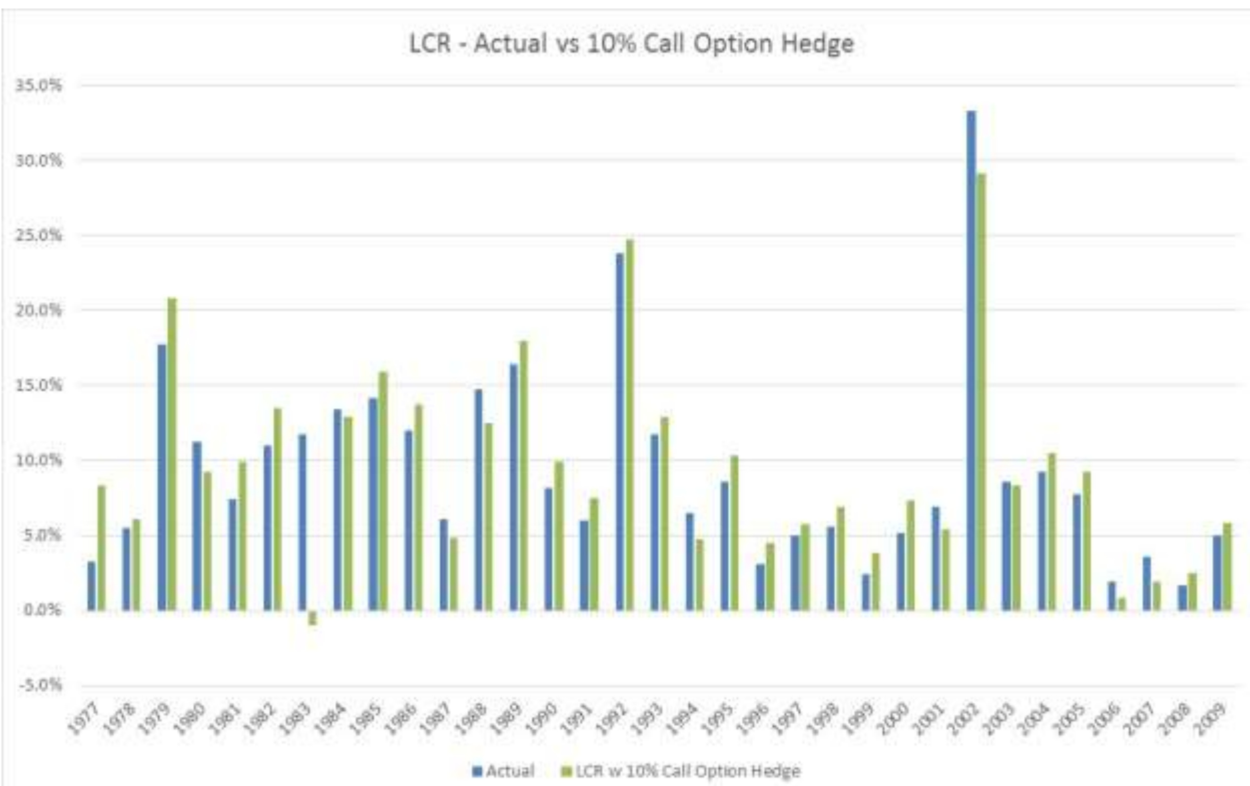
Year	Actual LCR	LCR 10% Futures Hedge	Difference from Actual	LCR 10% Call Option Hedge	Difference from Actual	LCR 10% Long Canola Minus Short Soybean Oil Futures Hedge	Difference from Actual
1977	4.8%	15.4%	-12.1%	8.3%	-5.1%	-8.5%	-11.7%
1978	4.3%	2.0%	3.5%	6.1%	-0.5%	14.8%	9.3%
1979	12.9%	16.7%	1.0%	20.8%	-3.1%	18.5%	0.8%
1980	16.6%	6.3%	5.0%	9.3%	2.0%	12.6%	1.4%
1981	4.4%	12.6%	-5.2%	9.9%	-2.5%	4.5%	-2.9%
1982	12.5%	14.2%	-3.2%	13.5%	-2.5%	9.3%	-1.7%
1983	11.5%	-3.7%	15.5%	-1.0%	12.7%	17.8%	6.1%
1984	13.4%	10.8%	2.6%	12.9%	0.5%	13.2%	-0.3%
1985	14.1%	22.2%	-8.0%	15.9%	-1.8%	15.2%	1.1%
1986	12.0%	18.7%	-6.6%	13.7%	-1.7%	12.2%	0.2%
1987	6.1%	2.6%	3.6%	4.8%	1.3%	4.5%	-1.6%
1988	14.7%	10.7%	4.1%	12.5%	2.2%	11.8%	-2.9%
1989	16.4%	21.5%	-5.1%	18.0%	-1.6%	16.0%	-0.4%
1990	8.2%	11.6%	-3.4%	9.9%	-1.7%	12.3%	4.1%
1991	6.0%	9.1%	-3.0%	7.5%	-1.5%	5.9%	-0.1%
1992	23.9%	23.2%	0.6%	24.7%	-0.9%	22.5%	-1.3%
1993	11.7%	11.3%	0.4%	12.9%	-1.2%	13.2%	1.5%
1994	6.5%	2.8%	3.6%	4.7%	1.7%	0.6%	-5.9%
1995	8.5%	8.6%	-0.1%	10.4%	-1.8%	9.4%	0.8%
1996	3.0%	3.0%	0.0%	4.5%	-1.4%	-0.7%	-3.8%
1997	5.0%	4.4%	0.7%	5.7%	-0.7%	4.0%	-1.0%
1998	5.6%	5.9%	-0.3%	6.9%	-1.3%	6.2%	0.6%
1999	2.4%	5.3%	-2.9%	3.8%	-1.4%	2.2%	-0.2%
2000	5.2%	9.4%	-4.2%	7.3%	-2.1%	3.1%	-2.1%
2001	6.9%	3.8%	3.1%	5.4%	1.5%	0.8%	-6.1%
2002	33.3%	28.0%	5.3%	29.1%	4.2%	30.2%	-3.1%
2003	8.6%	7.2%	1.4%	8.3%	0.3%	9.9%	1.3%
2004	9.2%	15.6%	-6.3%	10.5%	-1.3%	7.5%	-1.7%
2005	7.8%	10.4%	-2.6%	9.3%	-1.5%	11.3%	3.5%
2006	1.9%	-0.8%	2.7%	0.8%	1.1%	-0.6%	-2.5%
2007	3.6%	0.8%	2.8%	1.9%	1.7%	0.5%	-3.1%
2008	1.7%	10.3%	-8.7%	2.5%	-0.8%	4.4%	2.7%
2009	5.0%	7.2%	-2.2%	5.9%	-0.9%	4.7%	-0.3%
Average LCR	9.4%	9.9%		9.6%		8.8%	
Std Dev	6.5%	7.3%		6.5%		7.1%	
Semivariance 8%*	12.35	14.30		12.05		12.15	
Semivariance 9.4%	9.90	11.07		9.42		9.29	

*Semivariance is the sum of the squared deviations above the threshold level.

The results show that a call option hedge is not particularly effective at reducing crop insurance losses over a period of time. Some of the deep hedging losses experienced in the long futures hedge were avoided due to the limited liability nature of a long option position. In addition, the single biggest LCR observation was reduced (2002, when the actual LCR would have been reduced from the actual level of 33.3 percent down to 29.1 percent). However, in each of the next three highest LCR years (1979, 1989 and 1992) the hedge adjusted LCR was actually higher than the actual LCR. This reflects the fact that the futures price didn't increase by more than the $19 per tonne cost of the option premium, resulting in a net loss on the hedge position in those years.

Overall only 11 of the 33 years resulted in the LCR being lowered by having a long call option hedge. The average actual unhedged LCR over the observation period was 9.4 percent, compared to 9.6 percent for the call option hedge adjusted LCR. The call option hedge did have a lower average LCR than the futures hedge adjusted LCR of 9.9 percent, which again reflects that the limited liability of a long call option position helps to avoid some of the deep hedging losses experienced by a long futures position. The results of incorporating a long call option hedge can be seen in Graph 3 below and Table B above.

Graph 3. Actual LCR for Canola in Western Canada vs Adjusted LCR with a Long Call Option Hedge on 10 percent of Expected Production.



<u>The Effectiveness of a Long Canola Futures : Short Soybean Oil Futures Hedge in Reducing Crop Insurance Losses:</u>

The third hedge analysis considered a hedge position that was comprised of a long canola futures hedge and an equal short soybean oil futures hedge. While canola futures prices are influenced by the size of Western Canadian production, there are other factors that influence prices as well. This includes the strength or weakness of competing global vegetable oil markets.

This means that, for example, there may be years when canola production falls short of expectations in Canada, which in turn leads to canola prices being relatively stronger than other vegetable oil markets, but where canola prices still decline in absolute terms due to a weak global vegetable oil market overall.

By matching a short soybean oil futures position with the long canola futures position, the effects of global vegetable oil prices can be reduced from the canola futures price direction. In other words, the offsetting soybean oil futures position makes the results of the hedge focused on the relative strength or weakness of canola compared to other oilseed markets. This may allow for, i.e. canola futures to perform relatively stronger even if trading lower in absolute terms, which in turn could result in a more effective hedge position for managing crop insurance losses than simply being outright long the canola futures position.

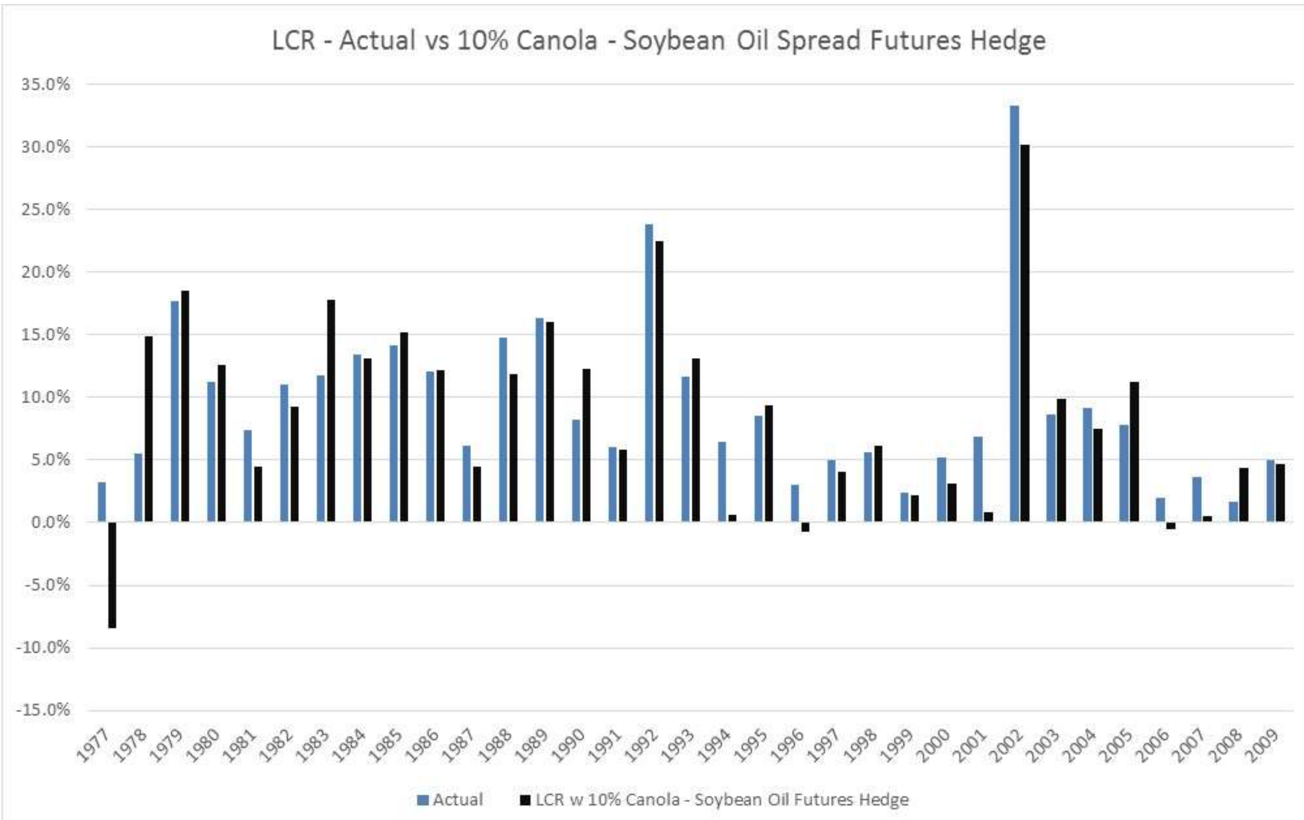
The canola futures contract size is 20 metric tonnes of the raw seed. The CBOT soybean oil futures contract size is 60,000 pounds of soybean oil. In measuring an offsetting number of soybean oil futures contracts, we considered the amount of oil in a canola futures contract. Canola is approximately 42 percent oil and 58 percent meal. This means there is approximately 18,514 pounds of vegetable oil in each canola futures contract. When compared to the 60,000 pound soybean oil contract, one would sell one soybean oil contract for every three long canola contracts. The analysis examined putting this spread position on for 10 percent of expected production.

The results of the futures spread hedge are more favorable than for either the outright long canola futures hedge or the canola call option hedge. In three of the four largest LCR years, the spread position modestly reduced the adjusted LCR (1989, 1992 and 2002). During the observation period a total of 20 of the 33 years saw a lower LCR when including the futures spread hedge.

The average actual LCR over the observation period was 9.4 percent, compared to an adjusted LCR of 8.8 percent when incorporating a 10 percent spread hedge. It should be noted that the first year in the observation period (1977) showed the adjusted LCR as being a negative 8.5 percent (i.e. the spread position saw substantial gains, which resulted in the hedging gains exceeding the indemnities paid). This single observation did skew the overall results somewhat. However, even with this observation removed from the analysis, the average LCR during the subsequent 32 years showed an actual rate of 9.5 percent, compared to an adjusted rate of 9.3 percent. The results of incorporating this long canola futures : short soybean oil futures hedge position can be seen in Graph 4 below and Table B above.

Because the spread position provided a net benefit to the LCR over the observation period, the adjusted LCR goes down as the proportion of the hedge relative to the size of the crop is increased. For example, a hedge of 20 percent of expected production reduces the adjusted LCR even more than the 10 percent used in the analysis above.

Graph 4. Actual LCR for Canola in Western Canada vs Adjusted LCR with a Long Canola Minus Short Soybean Oil Futures Hedge on 10 percent of Expected Production.



<u>Standard Deviation and Semivariance of LCR on unhedged and hedged positions:</u>

Even in instances where the average LCR over a period of time isn't reduced significantly, there may be value to insurers if the variability of the LCR from one year to the next is reduced through the use of hedging. The results show that the various hedge position did not reduce the variability of LCR during the observation period in a substantial way.

The standard deviation of the LCR during the period was 6.5 percent. This compares to a standard deviation of 7.3 percent for a canola futures hedge, 6.5 percent for a hedge using canola call options, and 7.1 percent for the canola-soybean oil futures spread position.

The results were modestly better when considering the semivariance of the various positions. A lower semivariance is favorable, reflecting a lower downside risk. The sum of squared deviations at the 8 percent LCR threshold level for the unhedged position was 12.35. The same figure for the long canola futures hedge was 14.30. The seminvariance for the canola call option hedge and the long canola futures : short soybean oil futures hedge were both below the unhedged position, at 12.05 and 12.15, respectively.

At the 9.4 percent threshold level the semivariance of the LCR for the unhedged position was 9.90. This compares to 11.07 for the long canola futures hedge. The semivariance for the long call option hedge and long canola futures : short soybean oil futures hedge position were again below the unhedged position, at 9.42 and 9.29, respectively.

While hedging showed no reduction in the standard deviation of the LCR during the observation period, there was some reduction in the semivariance at both threshold levels that were examined for the canola call option hedge and the long canola : short soybean oil futures hedge.

Summary

This paper analyzed the effectiveness of using futures and options to manage crop insurance losses on canola in Western Canada. A long canola futures position was not effective in reducing crop insurance losses. The average LCR over the observation period was higher when incorporating a long futures position into the portfolio. Any time that the futures price declined during the observation period, this would result in losses to the portfolio that wouldn't exist in an unhedged position. While this would be expected during a number of years (approximately 50 percent of the time if price changes were assumed to be random), it also happened in some years when it might not be expected, such as when canola production came in below expectations. This caused losses to be increased even in some years when the LCR was already relatively high. The average LCR over the observation period was higher with the long futures hedge than the unhedged LCR during the same timeframe. In addition, the long canola futures hedge position showed a higher standard deviation and semivariance than the nonhedged position. As a result, a long canola futures position doesn't appear to be effective in managing canola crop insurance losses in Western Canada.

The use of a long call option position didn't prove to be much more effective than the long futures position. The limited liability of a long option position helps reduce some of the instances of deep hedging losses that come with a sharp decline in the futures price, but in most years the increase in the futures price didn't exceed the premium paid for the option. This means that the hedge position added to the crop insurance losses, including in some years when the LCR was already relatively high. When factoring in the cost of the option premium, the average LCR using a call option hedge on 10 percent of anticipated production resulted in an average adjusted LCR that was higher than the actual LCR during that period. The long call option position showed the same standard deviation as the unhedged position, and a slightly lower semivariance at both of the threshold levels that were examined. However, this benefit wouldn't be enough to offset for the higher average LCR during the observation period.

The long canola futures minus short soybean oil futures hedge showed to be somewhat more effective. The short soybean oil position acts to partially offset the effect of world vegetable oil markets on the canola futures price, which might result in the net hedging gains or losses being more closely related to canola production itself. The average adjusted LCR with the futures spread hedge was lower than the actual LCR. This includes reducing losses in a number of the years when the LCR was the highest during the observation period. The spread position showed a slightly higher standard deviation, but a lower semivariance at both threshold levels. This shows that there is some potential in considering a futures spread position to manage crop insurance losses for canola in Western Canada.

Some further opportunities for study include a deeper analysis of the LCR and official Statistics Canada yields, including the possible impact of acres that were seeded but not harvested, whether optimizing the strike price of the call option may improve the effectiveness of an option hedge, or whether incorporating some flexibility in the hedge position, such as using stop-loss orders, may improve the performance of hedge positions.

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