Pricing an OTC Basket Option to Manage Cattle Price Risk in Canada: Comparing the Cost of COPP and of a CME-Based "2 Legs" Strategy

by

Francesco Braga

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Abstract

A put option covering the risk of a decrease in the Canadian dollar value of a US live cattle futures price is offered over the counter to Canadian cattlemen. The empirical results confirm that the pricing of the over the counter derivative is consistent with prevailing market conditions, and this, thanks to the low correlation between currency and live cattle price fluctuations, reduces the cost of this instrument to approximately 80% of the total cost of a portfolio consisting of one CME Canadian dollar call and one CME live cattle put.

Introduction

The Cattle Options Pilot Program (COPP) offers Canadian cattle producers the possibility to purchase an Over The Counter (OTC) basket futures options written on the Canadian dollar value of a given CME live cattle futures price. A market maker provides the wholesaling of the instrument to an agricultural financial institution which in turn ensures the retailing and back office servicing function across Canada. COPP premium are posted on electronic services and a 1-800 phone line, and are guaranteed for 3 1-hour windows every trading day: the first 1-hour windows starts 15 minutes after the CME open, the second starts 1 hour and 30 minutes after the open and the third starts 2 hours and 45 minutes after the open.

Producers access the COPP market via 1-800 lines, and funds are transferred electronically from and to a client's bank account. In order to avoid the need for a margin account, producers are restricted to no-net-short positions, and may only trade enough COPP contracts to cover their self-certified projected 1 year production. Contract size is 10,000 lbs of live weight. Expiry matches CME's futures options, new positions may only be open up to 2 weeks before expiry. A total of 4 tenors are actively priced. Strikes are in 2 C$/cwt intervals, and the 6 highest out of the money strikes are available for purchase or offset by producers. All strikes with open interest are also priced for offset only.

The program started in May 1995, and its development and delivery has been funded by

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Agrifood Canada. As requested by the Canadian Cattlemen's Association, a
in place for a complete privatization of the program in the next few months.

s an unique opportunity to empirically verify the realized savings from a
nd to comment on different aspects of a really innovative program.

e paper

tive of this paper is to empirically investigate the pricing of COPP in relation arket conditions. COPP is the first basket option to be made available to retail pricing assessment is of primary importance in order to document the ween potential and realized premium savings.

icing approach used in the paper follows Reiner (1992) pricing of a foreign struck in the domestic currency, with the appropriate modifications for a futures

futures put option premium is estimated using Black's futures options approach, rlying price defined in C$/cwt and equal to the product of the relevant futures ce and the forward exchange rate, the strike price in Canadian dollars/cwt, the dian risk free interest rate, the relevant time to expiry, and a volatility value illustrated in equation 1:

$$\sigma_{lc,C\$} = (\sigma_{lc}^2 + \sigma_{C\$}^2 + 2\, \rho_{lc,C\$}\, \sigma_{lc}\, \sigma_{C\$})^{0.5} ,$$

s the volatility used in COPP, σ_{lc} is the live cattle volatility, $\sigma_{C\$}$ is the Canadian ity, and $\rho_{lc,C\$}$ is the correlation of cattle and currency changes.

s possible to see that $\sigma_{lc,C\$} = \sigma_{lc} + \sigma_{C\$}$ for $\rho_{lc,C\$} = 1$, that is the cost of an at the CME live cattle put and C$ call will be equal to the cost of an at the money COPP d the correlation $\rho_{lc,C\$}=1$. By the same token, as long as $\rho_{lc,C\$}<1$ a volatility ensue. In a sense, then, COPP offers the trader a choice between a simpler and on or a "2-leg" strategy that is richer and more flexible but also more expensive. further advantages of COPP are its simplicity, smaller contract size, known set v transaction fees.

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Assessing COPP Pricing Consistency

From a trader's perspective, the practical aspects of "pricing consistency" are addressed by answering the following two questions:

a) How well does the COPP posted underlying price match its time-stamped calculated value?

b) Does the market maker charge a reasonable correlation risk, that is does COPP's implied volatility match the cattle and currency ones, once a reasonable correlation coefficient is used in equation 1?

The first question is addressed by comparing the posted and calculated underlying values. The latter is defined as the product of the relevant CME live cattle futures and the relevant forward exchange rate. The calculated underlying is defined as the average of 10 consecutive price observations, separated by 1 minute, and that proceed the official posting of the COPP premia by at least 5 minutes. In the case of the June and December COPP tenors the exchange rate used is the one corresponding to the CME futures, whereas a linear interpolation is used to obtain a forward rate for the February, April, August and October COPP contracts. The empirical analysis focuses on the instability of the value mismatch (if any) between posted and calculated underlying for each of the three COPP windows. An F test is used to verify that the variance of the mismatch distribution is not different across COPP windows. A higher likelihood of instability exists for the first window due to the relative low liquidity of cattle futures at the open.

The second question is answered by comparing the values of the implied volatility for the given COPP strike with the sum of the implied volatility of a CME live cattle put and a C$ call; the calculation is completed for at the money options. The implied volatilities for the CME are calculated using time stamped premium and futures values, observed between 15 and 5 minutes before the official posting of the COPP premia. US interest rates are derived (using linear interpolation when necessary) from concurrent CME t-bill futures prices, whereas Canadian risk free rates are derived from the time stamped US rates by addition or subtraction of the noon spread between Canadian and US T-bills with maturity of 1, 3, 6 and 12 months.

The implied volatility for the posted at the money COPP strike is compared with the corresponding implieds traded at the CME, and a volatility saving is obtained most of the times. As it may be misleading to compare a simple volatility saving across changing market conditions, in particular when the implied cattle and currency volatilities are quite different from one another, the saving is expressed as % of the sum of the CME volatilities.

Another approach calls for solving eq. 1 for the value of $\rho_{lc,C\$}$ that would equate the cost of the at the money COPP strike with the sum of the at the money cattle and C$ strikes. The implied correlation is then compared to an ex-ante expected value obtained from long term mean correlation of 0 with a standard deviation of 0.2 . It is suggested that the implied correlation comparison over time is preferable to comparing volatility savings over the same observations, as the former measure remains consistent across changing market conditions. Indeed, COPP pricing should be assessed in terms of the implied correlation traded more than in terms of the amount of premium saved. This argument is based on the observation that the market maker is absorbing the correlation risk, whereas it is transferring the implied volatility one by trading futures. The difficulty here is that the % of premium saved will depend on market conditions, even when the market maker internalizes the same risk level. This is illustrated in table 1, that shows how an increasing currency implied volatility -that is a condition when cattle and currency volatilities are becoming more similar- leads to increased savings even if the market maker is wearing exactly the same correlation risk

Data Sources

All time stamped futures and futures options prices were collected from a DTN server. COPP data were collected from the official prices posted. Noon interest rates were collected from the financial press.

Empirical Results

The following figure illustrates the extent of the mismatch between the posted and the calculated underlying price, for all active contracts during the 4-week period ending on February 13, 1997.

This evidence presented in this figure is consistent with what observed over the previous months. As documented in table 2, there is a tendency for a larger instability to coincide with the first of the three daily windows.

An F test confirms that the instability of the difference is higher for W1 than W2 or W3, whereas no difference is statistically evident between W2 and W3. From a practical standpoint, to the extent that producers do not need to trade W1, this evidence may -in theory- be considered as an opportunity to arbitrage short term distortions. From a practical standpoint, a low (ie negative difference) in the graph implies that the premium is more expensive, at least from an opportunity cost standpoint. This "expensiveness" would be mediated by delta, that for the at the money strike would be 0.5 and for the out of the money ones would decrease significantly, the closer one contract was to its expiry. Considering a delta of approximately 1/2, the maximum premium fluctuation induced by this instability would be around C$0.1 - C$0.2/cwt, for at the money strikes. This fluctuation may be of the same order of magnitude of a potential premium saving achievable with COPP relative to the sum of the CME 2-leg strategy.

Table 3 documents the average savings measured for at the money strikes for all windows and all active contracts for a random sample of 41 market days during the period July 1996 - February 1997. As can be seen, the average COPP volatility is almost 3% lower than the sum of the two CME implied volatilities, and this saving translates in a premium saving of about 15.6% . The average of implied correlation traded is 0.18, which is essentially consistent with the value of the long term average correlation plus 1 standard deviation.

Table 4 documents a change in the average premium saving as different contract maturities are considered. Although all contracts provide statistically significant average saving, the savings are highest for the contract immediately following the nearby, and are lowest for the longest contract.

A similar picture is presented by table 5, documenting the average implied correlation coefficient applied by the market maker (this is the value of $\rho_{lc,C\$}$ that is obtained by setting equation 1 equal to the COPP implied volatility, and by using the cattle and currency implied volatilities). Also in this case the cheapest premium is that of the first deferred contract, with an average correlation coefficient that is marginally negative and not statistically different from 0. The average correlation coefficient for the nearby and the second deferred contract is not statistically different from 0.2, whereas that of the third deferred contract is higher than 0.2 but still statistically lower than 1.

Conclusions

COPP offers traders a viable choice between a more sophisticated and more expensive strategy -using a CME cattle put and C$ call- or a simpler but also more economical basket option one.

Overall, the savings are statistically significant, around approximately 20% of the cost of the direct CME strategy, although they tend to be lower for the shortest and longest maturities. It would be inappropriate not to mention that other substantial benefits offered by COPP are not captured by the simple premium saving. COPP offers extremely low transaction costs thanks to the single price to buy and to sell (although in the money options normally trade lower volatilities than out of the money ones), the guaranteed premium for an entire hour long window (for trades of up to 20 contracts per window). Whether such a low transaction costs may survive in a fully privatized instrument is to be seen, although that appears unlikely, in particular as far as the single price to buy and to sell is concerned.

The possibility of a mismatch between the posted and the calculated underlying price was noted in particular in the case of the first window. Whereas this mismatch may at times induce a premium bias comparable to the expected savings, the fact that it tends to concentrate on the opening window may really be considered as a trading opportunity rather than a major concern. The more interesting implication is that this may indicate the objective difficulty in making a market in an exotic instrument when the underlying futures -and relative options- are still rather illiquid. In essence, this result confirms that the exotic option performs as expected only when the market maker has available a liquid market to transfer the risk.

The end users still show a form of sticker shock, that is they still consider quite expensive what in reality is a relatively low cost form of price protection. The retailing of the instrument, in theory very effective, appears to be not very convenient to the end users. Perhaps, packers and cattle wholesalers should be allowed to purchase it for resale to their suppliers. Since the end users show a rather limited risk management culture, it may be difficult to ignore the opportunity to increase convenience by making COPP available through the same traditional channels used to sell cattle.

References

Reiner, Eric, (1992) Quanto Mechanics, in "From Black-Scholes to Black Holes, New Frontiers in Options", pp 147-154, Risk Magazine, London, 1992

Figure 1: Difference between posted and calculated underlying futures price, C$/cwt.

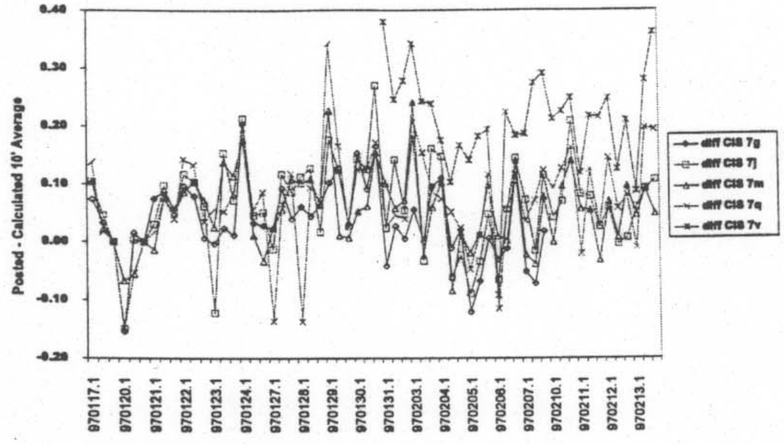

Table 1: Impact of changing currency implied volatilities on expected premium savings.

Cattle implied vol	15%			
Currency implied vol	5%	7%	9%	11%
Correlation	0.2	0.2	0.2	0.2
Resulting COPP implied vol	17%	18%	19%	20%
Vol saving	3.3%	4.2%	5.0%	5.7%
Vol saving %	16%	19%	21%	22%

Table 2: Differences between posted and calculated underlying price, by contract and window, C$/cwt, for the four weeks ending on 13-Feb-97

	February	**April**	**June**	**August**	**October**
Average,all windows	0.04	0.07	0.06	0.07	0.21
St. deviation, all windows	0.07	0.08	0.07	0.09	0.09
Average, first window	0.03	0.06	0.07	0.05	0.18
Average, second window	0.03	0.06	0.04	0.08	0.21
Average third window	0.05	0.08	0.07	0.09	0.24
St. deviation, first window	0.10	0.10	0.08	0.13	0.13
St. deviation, second window	0.06	0.07	0.06	0.06	0.06
St. deviation, third window	0.05	0.07	0.05	0.05	0.06

Table 3: Implied volatility, volatility savings and implied correlation traded, average values for at the money strikes for all three windows (sample of 41 days).

	Volatility			Volatility Saving		Implied correlation
	COPP	CME LC	CME C$	LC+C$-COPP	%	
Overall	15.6%	14.4%	4.1%	2.9%	15.6%	0.18
Jan-Feb 1997	15.2%	13.1%	4.8%	2.6%	14.8%	0.33
Nov-Dec 1996	16.4%	15.3%	4.2%	3.0%	14.9%	0.18
Sep-Oct 1996	15.0%	13.5%	3.9%	2.4%	14.4%	0.25
Jul-Aug 1996	15.3%	14.8%	3.8%	3.3%	17.5%	0.04

Table 4: Premium saving for different COPP contract maturity, average values for at the money strikes for all three windows (sample of 41 days).

	Nearby	Deferred Contracts		
		First	Second	Third
Avg saving	$16\%^{f,t}$	$21\%^{s,t}$	$16\%^{t}$	8%
t(avg saving = 0)	8.178	16.208	12.193	6.485

In the table the superscript indicates a statistically significant difference between the given saving and that of the first (f) second (s) or third (t) deferred contract.

Table 5: Implied correlation, at the money COPP contracts, average for all three windows (sample of 41 days).

	Nearby	Deferred Contracts		
		First	Second	Third
Average implied correlation	$0.11^{s,t}$	$-0.07^{s,t}$	0.21^{t}	0.59
t(avg corr =0)	1.074	-1.104	3.515	9.457
t(avg corr =0.2)	-0.800	-4.320	0.243	6.254
t(avg corr =1)	-8.295	-17.187	-12.846	-6.555

In the table the superscript indicates a statistically significant (5%) difference between the given value and that of the second (s) or third (t) deferred contract.