Managing Producer Price Risk in Mexico with Quantos and Dual Risk Commodity-Foreign Exchange Hedges

Leslie J. Verteramo
Charles H. Dyson School of Applied Economics and Management, 235 Warren Hall, Cornell University, Ithaca, New York 14853, USA

Calum G. Turvey
Charles H. Dyson School of Applied Economics and Management, 356 Warren Hall, Cornell University, Ithaca, New York 14853, USA

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Leslie J. Verteramo, and Calum G. Turvey
Charles H. Dyson School of Applied Economics and Management, Cornell University,

Introduction
Price uncertainty is a major risk in agricultural production but it is one that can be hedged in financially sophisticated economies. Countries that have institutionalized commodities exchange can provide the services to hedge against market risk. However, in less developed economies, producers do not have access to these services and in many instances governments have to adopt minimum price programs, which are not available to all farmers and have a limit in the amount insured. The motivation for this research is originated from the problem of creating financial products that could be supplied at an OTC market in developing countries.

This paper examines the use of cross-currency options (Turvey and Yin, 2002) by Mexican farmers to hedge against price risk. That is, pricing a European put option on a cash commodity in Mexico while the underlying commodity is priced relative to a U.S. futures market. We assume that the U.S. grain prices and the exchange rate USD/MXP follow a geometric Brownian walk. Then we develop a two factor minimum variance hedging model, by using options on the domestic market and futures denominated in Mexican peso. The results are then used to examine the value of a hedge position with the cash prices of white corn with the cash basis at 3 locations in Mexico.

Methods
The data used consist of 1370 daily observations on cash prices on diverse locations in Mexico. P, from July 18/2003 to Dec/31/2007, and a corresponding number of observations on the exchange rate (impl.) E, and future closing price of yellow corn quoted at CBOT. Even though white corn is not traded on futures markets, its price depends on the U.S. price of yellow corn.

The cash grain price at location i and time t is defined as:

\[ P_i = P_0 \times E_i 	imes B_i \]

\[ B_i = \text{basis in } 

\text{N} \times \text{basis difference between cash and futures price} \]

We assume that F, E and B follow a geometric Brownian motion of the form:

\[ dF_i = [(\mu_F + \sigma_F \sigma_B \rho_{FB})F_i \sigma_B \mu_B + \sigma_B \sigma_B \rho_{FB} \mu_F \sigma_F - \mu_B \sigma_B]F_i dt + \sigma_F \sigma_B \rho_{FB} \sigma_B \sigma_F dw_i \]

Where the annual geometric mean (natural growth rate) \( \mu \) is the standard deviation of the growth rate \( \sigma \), and \( \rho_{FB} \) is the correlation coefficient between F and B.

From the above we get the cash grain growth rate and variance as:

\[ \mu_c = (\mu_F + \sigma_F \sigma_B \rho_{FB} \mu_B + \sigma_B \sigma_B \rho_{FB} \mu_F \sigma_F - \mu_B \sigma_B)F_i dt + \sigma_F \sigma_B \rho_{FB} \sigma_B \sigma_F dw_i \]

We then estimate the risk premium of white corn at each location using the CAPM:

\[ R_i = \beta_i \left( R_m - r \right) \]

Where \( \beta_i \) is measure of systematic risk between the commodity basis and the market portfolio. \( R_i \) is return on the IPC index of the Mexican Stock Exchange.

The price of the European put option calculated as:

\[ P = X e^{-rT} \Phi(-d_1) - P_0 e^{-\theta t} \Phi(-d_2) \]

\[ X = \text{strike price}, \quad T = \text{maturity time}, \quad P_0 = \text{cash price} \]

\[ \Phi(-d_1) = \text{normal distribution function} \]

\[ \Phi(-d_2) = \text{normal distribution function} \]

\[ \theta = \frac{\text{log}(P_0/X) + (\mu + \sigma^2/2)T}{\sigma \sqrt{T}} \]

We calculated the option prices at the three locations with a coverage of 80, 100 and 120% of the cash price, with and without basis. Payoffs for the put option was calculated for Guadalajara for a 80% coverage with and without basis.

Results
The following tables show the prices of the strike price and the corresponding call and put option prices given three levels of coverage, with and without the basis effect. All option prices were calculated using a one year time to maturity.

The options and cash prices are the same for all locations when estimating the price without the basis effect. This is equivalent as pricing the commodity delivered at the US in Mexican pesos before adding transportation costs. All prices are in mxp.

We used Monte Carlo simulations to estimate the put option payoff distribution for Guadalajara with a coverage of 80% with and without the basis effect. This would represent the expected payoff of a farmer who wants to assure a minimum price of 80% of the current local price.

Conclusions
By using a quantos approach we estimated option prices for white corn and its expected payoff distribution for different locations in Mexico. Currently only through government programs producers can get price insurance in Mexico. This model provides a way to hedge against price uncertainty in a country where most producers don’t have access to agricultural derivative products. It creates a free market approach for price insurance. This model can easily be extended to many other agricultural products as long as the underlying commodity at local markets is correlated to a commodity in a futures market and its basis is known or estimated.

Literature cited


For further information

Please contact:
Leslie J. Verteramo
Crops and Livestock Program, Cornell University, Ithaca, NY 14853, USA
Email: ljv9@cornell.edu

For the CME option prices we used the Dec/2008 expiry, and the corn price quoted at CME.

Relative option prices (with basis) as a percentage of local cash prices compared to yellow corn options prices and futures at the CME for different levels of coverage.

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<th>Coverage</th>
<th>Without Basis</th>
<th>With Basis</th>
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Mean and standard deviation of the put option payoffs.

With basis: \( \mu = 287, \sigma = 180 \)

Without basis: \( \mu = 28, \sigma = 21 \)