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

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Introduction

Price uncertainty is a major risk in agricultural production but it is one that can be hedge 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 basis 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 (mxp/usd), E, and future closing price of yellow corn quoted at CBOT, F. Even though white corn is not traded on future markets, its price depends on the U.S. price of yellow corn.

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

$P_{t,i} = F_t * E_t + B_{t,i}$

B = basis in MXP, difference between cash and futures price

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

$dF = F[\mu_F\, dt + \sigma_F\, dw]$, $dE = E[\mu_E\, dt + \sigma_E\, dw]$, $dB = B[\mu_B\, dt + \sigma_B\, dw]$

Where the annual geometric mean (natural growth rate) is μ, the standard deviation of the growth rate σ, and dw is a Weiner process of the form $et^{0.5}$, where $e \sim N(0,1)$.

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

$\mu_p = (FE/P)(\mu_F + \mu_E + \rho_{F,E}\, \sigma_F\, \sigma_E) + (B/P)\, \mu_B$

$\sigma^2_P = (FE/P)^2)(\sigma^2_F + \sigma^2_E + \rho_{F,E}\, \sigma_F\, \sigma_E) + (B/P)^2 \sigma^2_B + (FE)B/P^2 (\rho_{F,B}\, \sigma_F\, \sigma_B + \rho_{EB}\, \sigma_E\, \sigma_B)$

We then estimate the risk premium of white corn at each location using the CAPM: $\beta_i [R_m - r]$

β_i = measure of systematic risk between the commodity basis and the market portfolio

R_{mt} = return on the IPC index of the Mexican Stock Exchange

r_t = risk free rate in Mexico

The price of the European put option calculated as:

$f_p = Xe^{(-rT)} N(-d_2) - P_0\, e^{(\theta - r)T} N(-d_1)$

X = strike price, T = maturity time, P_0 = cash price

$\theta = (\omega r - \delta + \rho_{F,E}\, \sigma_F\, \sigma_E) + (1 - \omega)(\mu_B - \beta_i [R_m - r])$

$\omega = (EF/P)$

$d_1 = [\ln (P_0 / X) + (\theta + 0.5\, \sigma_P^2)\, t] / \sigma_P \sqrt{t}$

$d_2 = d_1 - \sigma_P \sqrt{t}$

$\delta = \mu_F - r$

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.

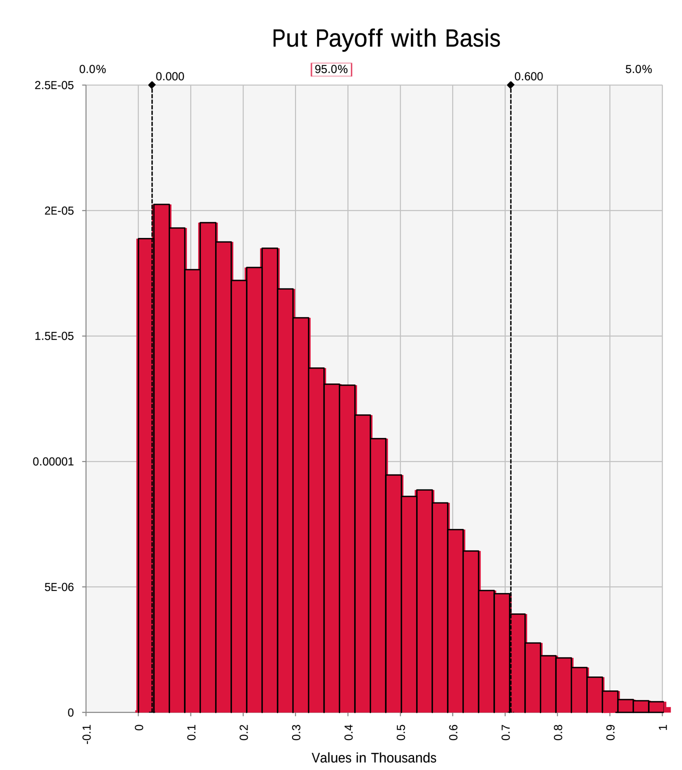
The options and cash prices are the same for all locations when estimating the price without the basis effect. This is equivalent as pricing the commodity delivered at the US in Mexican pesos before adding transportation costs.

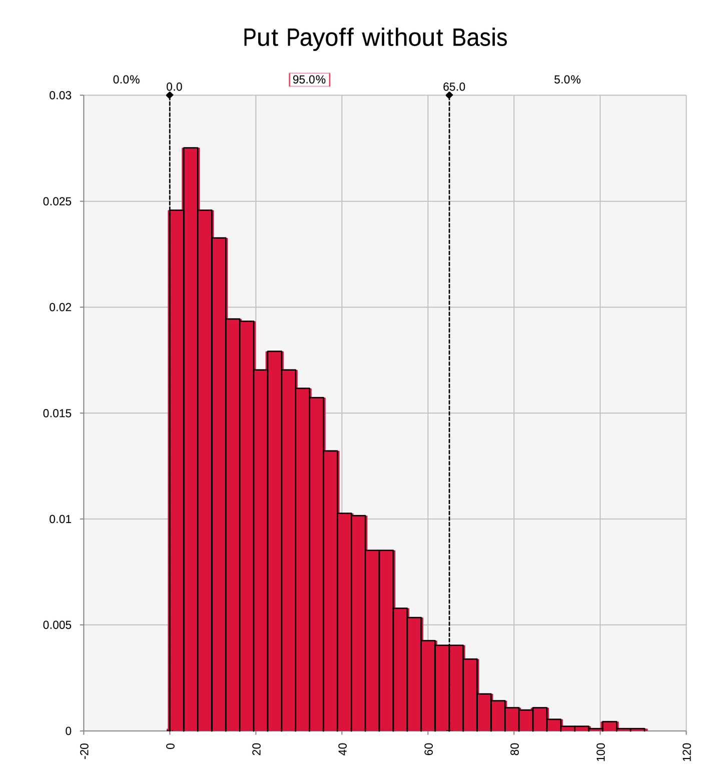
All prices are in mxp/ton.

	With Basis		
Coverage	**80 %**	**100 %**	**120 %**
Strike Price			
Culiacan	2264	2830	3396
Guadalajara	2297	2872	3446
Cd. Victoria	2213	2766	3320
Call Price			
Culiacan	723	378	176
Guadalajara	771	425	213
Cd. Victoria	722	387	187
Put Price			
Culiacan	61	241	563
Guadalajara	71	258	578
Cd. Victoria	65	243	555

	Without Basis		
Coverage	**80 %**	**100 %**	**120 %**
Strike Price			
Culiacan	1566	1958	2349
Guadalajara	1566	1958	2349
Cd. Victoria	1566	1958	2349
Call Price			
Culiacan	488	247	109
Guadalajara	488	247	109
Cd. Victoria	488	247	109
Put Price			
Culiacan	37	159	383
Guadalajara	37	159	383
Cd. Victoria	37	159	383

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.





Mean and standard deviation of the put option payoffs.

With basis: $\mu = 287$, $\sigma = 180$

Without basis: : $\mu = 28$, $\sigma = 21$

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.

	80%	**100%**	**120%**
Call Option			
Culiacan	0.255	0.133	0.062
Guadalajara	0.268	0.148	0.074
Cd. Victoria	0.261	0.140	0.067
Put Option			
Culiacan	0.021	0.085	0.199
Guadalajara	0.025	0.090	0.201
Cd. Victoria	0.023	0.089	0.200
CME Call Option	0.257	0.126	0.051
CME Put Option	0.013	0.076	0.121

For the CME option prices we used the Dec/2008 expiry, and the corn price quoted on Dec/31/07.

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

- Calum G. Turvey and Shihong Yin, *On the Pricing of Cross Currency Futures Options for Canadian Grains and Livestock*, Canadian Journal of Agricultural Economics 50 (2002) 317-332.

For further information

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