SRR Project Description

1)     A spread option function: This deceivingly simple projects is actually very complicated, as no closed form solution exists and the problem needs to be solved numerically for general cases. In the literature you’ll be able to find the Margrabe and Kirk approximations, which are good for very specific cases but not good enough in general (however this is a good starting point in terms of research). What we would need from you is a standalone algorithm that does the calculation numerically and efficiently by integrating over the 2 dimension (or 1 dimension if you use some clever changes of variables) of the underlying lognormal stochastic processes for F1 and F2 (with F a forward contract and 1 and 2 two arbitrary commodities). As a minimum, my view is that the Pearson’s approach would work for us, although I know there are a couple of slightly more refined approaches out there. I will leave it up to you to do the research and let me know your thoughts. My estimated time for this would be about 2 weeks (weeks 1-2).

2)     Multifactor model to simulate the full forward curve of a given commodity: This involves the calibration of the full term structure of volatilities and correlations as a first step (based on historical data and current market quotes), and an engine to simulate the full forward curve + spot prices thereafter. My estimated time for this would also be 2 weeks (weeks 3-4).

3)     An optimization algorithm that takes the outputs of 2 above and solves a linear of MIP process based on a hedging or trading strategy. We can discuss the details if/when we get there.

Guys,

I hope all is well on your end. It was very nice getting to talk to you last week and answering some of your initial questions.

As discussed, this follow-up email contains more details in terms of the project and some of the topics we discussed last week.

1.     Programming language: Preferably VBA, although Python would work too. If it really comes down to using a less high-level language, C/C++ is also an option. Again, this will depend on your and your TA’s programming experience.

2.     Frequency of communication: Once per week is OK, via email. More than once is fine if you’re stuck with some aspect of the project or need clarification.

3.     Deliverable: Standalone function, with the syntax

SOPT(value\_date, expiry, F1, W1, F2, W2, K, V1, V2, C12, Rf)

where the quantities in parenthesis are inputs to the function and are defined as

value\_date = Valuation date

expiry = Expiration date

F1 = Forward price of commodity 1

W1 = Weight of commodity 1 in the payoff (see below)

F2 = Forward price of commodity 2

W2 = Weight of commodity 2 in the payoff (see below)

K = Strike of the spread-option

V1 = Black-implied volatility of commodity 1

V2 = Black-implied volatility of commodity 2 C12 = Correlation coefficient between commodity 1 and commodity 2

Rf = Risk-free rate

The payoff of the function at maturity is:

Payoff = Max(W1\*F1 + W2\*F2 – K, 0)

            and in general it should be:

            Exp(-Rf\*T) \* E[ Max(W1\*F1 + W2\*F2 – K, 0) ]

            with T being the fraction of a year between value\_date and expiry, and E[ x ] denoting the expected value of x.

            In computing the expected value above is where your technical expertise will come in handy since in general this expectation is the integral of the Payoff times a density function, which is two-dimensional for this problem, and no closed form solution exists.

            For your background, a way to get to the Black formula is analogous to what I’m proposing, where the payoff is defined as

            Payoff = Max(F – K, 0)

            and the value of the call option is

Exp(-Rf\*T) \* E[ Max(F – K, 0) ] = Exp(-Rf\*T) \* Integral[ Max( Fo\*Exp(-V^2\*T/2 + V\*Sqrt(T)\*x) – K, 0) \* rho(x)]

            where the integral goes from -Inf to +Inf, Fo is the quoted price of the forward contract F that matures in T years, V is the volatility, and rho(x) is the Normal density function. Fortunately for the Black case you can make some clever changes of variables and arrive at a closed form solution. Not so for the spread-option problem above, where a numerical integral needs to be performed.

I hope that drawing the analogy with the Black formula gives you more clarity in what this part of the project entails.

Finally, we should have another call either on Jan 5 or 6 to see where things stand and to answer any remaining questions.

In the meantime, happy holidays to all and a prosperous 2015.