**Fin 514 Project 1 Report**

**Nonlinearity and Solution**

This coupon is similar to a discrete barrier option that the barrier is 55.00% of its Initial Level.

If the binary tree of prices does not exactly encounter barrier, we can only convert the value below barrier. However, this is not the same as the price represented by the original barrier, and the result of the evaluation will of course be different from the actual price. This is a nonlinear error.

In order to decrease this nonlinear error, I want to use Trino-binomial Tree (TBT model) which was proposed by Tian-Shyr Dai, Yuh-Dauh Lyuu, and Chih-Jui Shea in 2006. This model will solve discrete barrier through(1) calculating of the time length of each time step; (2) describing of the value of CRR binary tree; (3) constructing the first time step of the model and calculating probability.

1. **Calculating of the time length of each time step**

First, set T’ as the time between two barrier day (in our model, it’s the observation day), and cut T' into m parts, so the time length of each time step is delta t =T'/m, which m is a positive even number. Because T/delta t may be not an integer, if T/delta t is not an integer, we set the part that will not be divisible as delta t1 which is the first time step and other time steps are delta t which must be integer.

1. **Describing of the value of CRR binomial tree**

In TBT model, the binomial tree is same as CRR model except the first time step. Assuming the barrier level is L, we set the value of barrier is l=ln(L/S0). In CRR model, the value difference of each node at the same time point should be 2sigma\*deltat^0.5, so we can calculate other value on the other node at the same time point.

1. **Constructing the first time step of the model and calculating probability**

In TBT model, initial price S0 connect to node of the next time step with three probabilities of Pu, Pm and Pd respectively to node A,B,C in second time step. When we set mu =(r- sigma$^2/2)\*deltat1, the value of B is mu1 , the node which is closest to mu, beta=mu1-mu, alpha=beta+2sigma\*deltat^0.5, gamma=beta-2sigma\*deltat^0.5.

Then, calculate 1)Pu\*alpha+Pm\*beta+Pd\*gamma=0

2) Pu\*alpha^2+Pm\*beta^2+Pd\*gamma^2=sigma^2\*deltat1

3) Pu+Pm+Pd=1

Finally, V0=exp(-r\*deltat1)\*(Pu\*Va+Pm\*Vb+Pd\*Vc)

In TBT model, the binary tree of prices exactly encounter barrier level, so the nonlinearity error can be removed.