Canadian Company: RioCan Real Estate Investment Trust

Computing Risk Free Rate (government yield curve)

Similar to A1, collecting 10 Canada government bonds to compute risk free rate. I select bonds “CAN 0.25 Aug 1 (2022)”, “CAN 1.75 Mar 1 (2023)”, “CAN 0.25 Aug 1 (2023)”, “CAN 2.25 Mar 1 (2024)”, “CAN 1.5 Sep 1 (2024)”, “CAN 2.25 Jun 1 (2025)”, “CAN 0.5 Sep 1 (2025)”, “CAN 0.25 Mar 1 (2026)”, “CAN 1.00 Sep 1 (2026)”, “CAN 1.5 Mar 1 (2027)”. By bootstrapping, P = $\sum_i p_i e^{-r(t_i)t_i}$, using the same code as A1 we can get risk free rate from year 1 to 5, r_1=2.13%, r_2=2.39%, r_3=2.47%, r_4=2.58%, r_5=2.57%.

Merton Model

Collecting data (S, K, V, σ_s)

https://ca.finance.yahoo.com/quote/REI-UN.TO/key-statistics?p=REI-UN.TO

From yahoo finance, we can find out

Market Capitalization (S) = 7.674B

Total Liabilities (K) = 5.9B

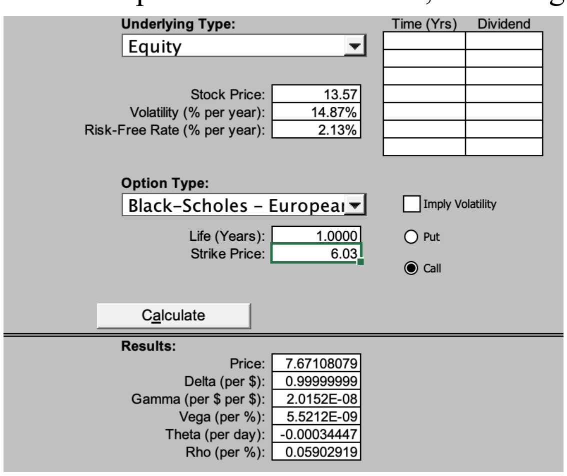
Firm’s Value (V) = 13.574B

Base on previous 1 year stock price (2021-04-16 to 2022-04-16), we get the stock daily volatility 0.937%, and we can get the stock annual volatility $\sigma_s = \sqrt{252} * 0.973\%$=14.87%.

Computing σ_v, Probability of Default

1 year

The strike price is 5.9B*e^{r_1}=6.03, then we get



Thus, by using the result that the call option price=7.671B, we can calculate the asset volatility $\sigma_v = \sigma_s S\partial V/V\partial S$=0.1487*7.671*1/13.57=8.41%.

By merton model S=VN(d_1)-Ke^{-rt}N(d_2), d_1=-ln(Ke^{-rt}/V)/σ$\sqrt{T}$+σ$\sqrt{T}$/2, d_2=d_1-σ$\sqrt{T}$

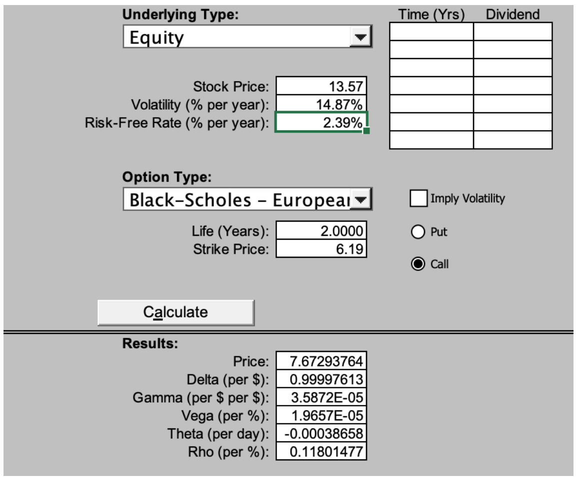
Then apply all the value, we get d_1=-ln(6.03$e^{-0.0213}$/13.57)/0. 0841$\sqrt{1}$+0. 0841$\sqrt{1}$/2=9.93996,

d_2=9.93996-0. 0841$\sqrt{1}$=9.8559.

Then we get the 1 year probability of default is 1-N(d_2)=0

2 year

The strike price is 5.9B*e^{r_2*2}=6.19, then we get



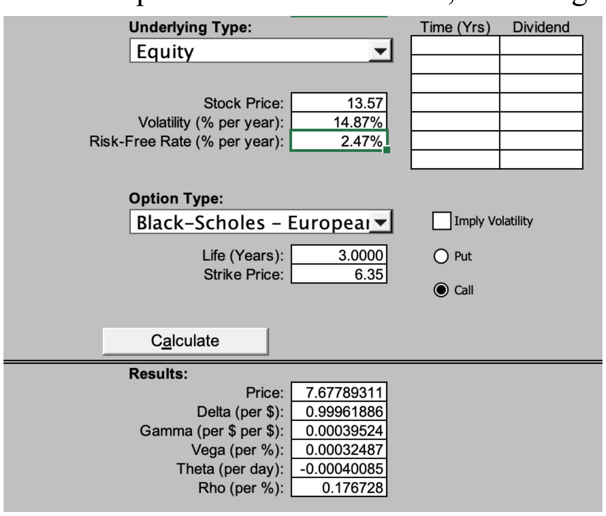
Thus, by using the result that the call option price=7.6729B, we can calculate the asset volatility $\sigma_v = \sigma_s\, S\partial V/V\partial S$=0.1487*7.6729*1/13.57=8.41%.

Similar to year 1, we get d_1= 7.06266, d_2= 6.9437,

Then we get the 2 year probability of default is 1-N(d_2)=0

3 year

The strike price is 5.9B*e^{r_3*3}=6.35, then we get



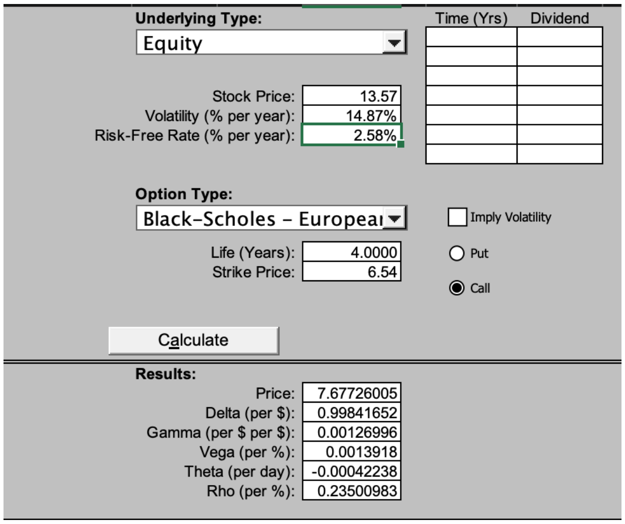
Thus, by using the result that the call option price=7.6779B, we can calculate the asset volatility $\sigma_v = \sigma_s S\partial V/V\partial S$=0.1487*7.6779*1/13.57=8.41%.

Similar to year 1, we get d_1= 5.8808, d_2= 5.7351,

Then we get the 3 year probability of default is 1-N(d_2)=0

4 year

The strike price is 5.9B*e^{r_4*4}=6.54, then we get



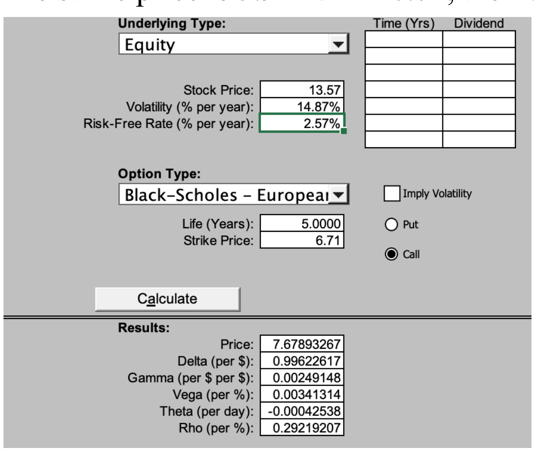
Thus, by using the result that the call option price=7.6773B, we can calculate the asset volatility $\sigma_v = \sigma_s S\partial V/V\partial S$=0.1487*7.6773*0.998/13.57=8.396%.

Similar to year 1, we get d_1= 5.0441, d_2= 4.8762,

Then we get the 4 year probability of default is 1-N(d_2)=0

5 year

The strike price is 5.9B*e^{r_5*5}=6.71, then we get



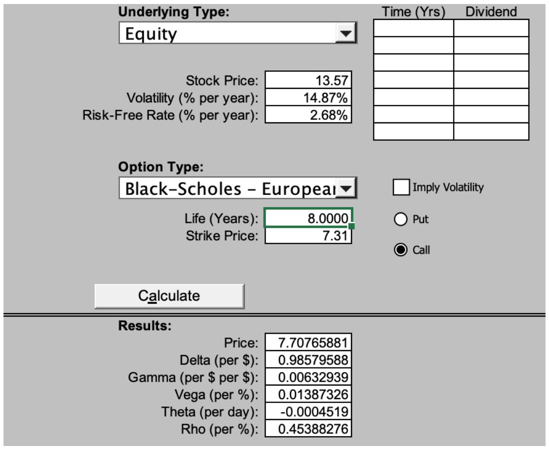
Thus, by using the result that the call option price=7.6789B, we can calculate the asset volatility $\sigma_v = \sigma_s S\partial V/V\partial S$=0.1487*7.6789*0.996/13.57=8.38%.

Similar to year 1, we get $d_1 = 4.5387$, $d_2 = 4.3513$,

Then we get the 5 year probability of default is 1-N(d_2)=0

8 year

r_8=2.68%, The strike price is 5.9B*$e^{r_8 * 8}$=7.31B, then we get



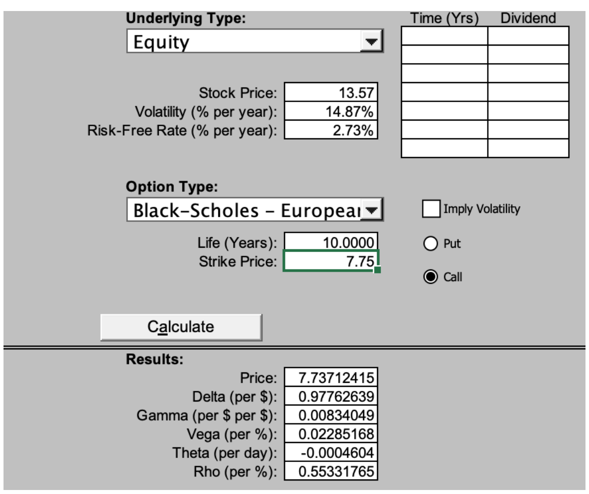
Thus, by using the result that the call option price=7.7077B, we can calculate the asset volatility $\sigma_v = \sigma_s S\partial V/V\partial S$=0.1487*7.7077*0.986/13.57=8.33%.

Similar to year 1, we get $d_1 = 3.6530$, $d_2 = 3.4173$,

Then we get the 5 year probability of default is 1-N(d_2)=0.00032

10 Year

r_8=2.73%, The strike price is 5.9B*$e^{r_{10} * 10}$=7.752B, then we get



Thus, by using the result that the call option price=7.7371B, we can calculate the asset volatility $\sigma_v = \sigma_s S\partial V/V\partial S$=0.1487*7.7371*0.9776/13.57=8.29%.

Similar to year 1, we get $d_1 = 3.3083$, $d_2 = 3.0461$,

Then we get the 5 year probability of default is 1-N(d_2)=0.00116

CreditMetric-type Model

Assumption: Assuming only 2 possible credit states: solvency and default, and the company's recovery rate R=50%.

Computing Company's Credit Spread

Given company's bond, which matures at 2023 April 18 with 3.725% coupon paying semi annually. The closing price at 2022/4/14 is 100.52.

https://markets.businessinsider.com/bonds/riocan_real_estate_inv_trustcd-debts_201313-23-bond-2023-ca766910aw33

Since P = $\sum_i p_i e^{-r(t_i)t_i}$, then $100.52 = 1.8625e^{-r*0.5} + 101.8625e^{-r}$, we get the company's 1year yield rate r=3.16%. Hence the credit spread is $h_i = r - r_1$=3.16%-2.13%=1.03%

Computing Probability of Default

Since $V = Ne^{-r}q + R * Ne^{-r}(1 - q)$, then

100.52=$(1.8625e^{-0.0213/2} + 101.8625e^{-0.0213})$q + 0.5$(1.8625e^{-0.0213/2} + 101.8625e^{-0.0213})$(1-q)

Solving it and we get q=0.9795.

Hence the probability of default is 1-q=0.0205.

Results

year	1	2	3	4	5	8	10
Merton	0	0	0	0	0	0.00032	0.00116
CreditMetric	0.0205	0.0406	0.0602	0.0795	0.0984	0.1527	0.1871