Finance 513 - Spring 2019 *Professor Johnson*
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Questions about Tilray Convertible Bond

The date is October 4, 2018. Tilray Corporation (symbol TLRY) was one of the hottest IPO stocks of the year. Now they are offering a new convertible bond to investors. This case asks you to consider the valuation of the bonds, and the experience of investors who bought it. The Compass site includes links to articles about Tilray and the bond issuance, as well as a copy of the bond indenture (the legal contract between the company and the trustee).

The bonds pay a 5% coupon, mature in 5 years (10/1/2023), and are convertible at bondholders' option into 0.59735 shares of TLRY per $ 100 face value. Assume for your analysis that Tilray defaults on the bonds if and only if the stock price hits 0 prior to maturity, in which case bondholders recover nothing. Also assume that Tilray will call the bonds (which will force investors to convert them) after 10/1/2021 if the stock is at a price of $ 250 or higher. (The bonds cannot be called prior to 10/1/2021.) Finally assume that Tilray will not pay a dividend between now and the date of the bond maturity.
Prepare a brief report answering the following questions.

- **Question 1.** Are the bonds a good deal? You work for a hedge fund, and Merrill Lynch is offering you bonds at par (face value) and the stock is trading for $145.50. If you want to sell the stock, you will have to pay a fee of y =3% to borrow shares, but you face no other transactions costs. Assume the riskless rate, r =2.4%, is constant.

  To answer this question, suppose that, Tilray's stock obeys the CEV diffusion proce8ss:

$$\frac{dS}{S} = \mu\ dt + \frac{\omega}{\sqrt{S}}\ dW^S$$

  where $\omega = 8.4$. Of course, under the risk-neutral measure, the drift μ is replaced by $(r - y)$. Value the bonds using one of two methods.

  The implicit finite difference method (IFD). This algorithm is described in the sheet on the Compass site. To implement it, you work backwards from maturity over a finite grid of stock prices, using the partial differential equation to tell you how to evaluate the solution at each step.

  The Monte Carlo method (MC). As described in class, you can simulate dS forward drawing random shocks dW. You will need to draw at least 20000 paths, and at each step, discount the cash-flows from the bond at the riskless rate. Then average the cumulative discounted payoffs over all your paths.

  For both methods, you need to choose a time step. Use $\Delta t = 1/52$ (one week). Report the model's theoretical valuation of the bonds. With either method, be sure to include some sensitivity checking to make sure that your solutions are not sensitive to any of your implementation assumptions. (For IFD, check whether your solutions are sensitive to the size of your stock price grid. For MC, check that you have drawn enough paths such that the average is stable.)

- **Question 2.** Are there important real-world considerations that your valuation in Question 1 omitted to consider, that might make you think the thoeretical valuation does not tell the whole story? If so, list the issues that you can think of, and explain how each one might affect the valuation. In particular, which considerations might make the bond *more* valuable than the model thinks, and which might make the bond *less* valuable?

- **Question 3.** Now compute the initial hedge ratio for the bonds: how many shares would you sell if you bought $ 100 face value? (If you used IFD, you can just compute the numerical first difference on your stock price grid. If you used MC, you have to run the valuation again assuming a different stock price – for example 144.5 – and then compute how much this changes the theoretical value.)

- **Question 4.** By 1/31/2019, TLRY stock had fallen to 78.00, and the bonds has fallen to 83% of face value. What are the bonds theoretically worth now? Suppose that you bought $ 10 million of bonds at the issuance date and you delta hedged them (and did not subsequently adjust the hedge). How much money did you make or lose? How do you interpret the market's current valuation of the bonds?

- **Question 5.** From your answer to Question 3, we can conclude that your inital model did <u>not</u> do a good job of telling you how many shares to sell in order to off-set the market risk of changes in the bond price. Does this mean that your model was wrong? How could we modify the model so that it would be more helpful to a dealer or intermediary who is not trying to do arbitrage but only wants to have a safe (low variance) position?