15.997 Practice of Finance: Advanced Corporate Risk Management
Spring 2009

Problem Set #4.

The Impact of Debt on Mine Operation & Valuation

This assignment builds on Problem Set #3. All the parameters are exactly as given in Problem Set #3. We assume that the mine can be abandoned as discussed in question (5) of Problem Set #3. You have already valued the mine to answer question (5), and we take that answer as correct. But Problem Set #3 implicitly values the mine assuming that it is 100% equity financed. We will change that assumption here and repeat the valuation exercise.

(1) Assume that the mine is financed in part with debt. The outstanding debt contract has annual annuity bond payments of 5,000,000 dollars due each period starting the first period:

a) Assume that the mine is operated according to the strategy you solved for in problem (5) of Problem Set #3: i.e. it is abandoned at the nodes specified in (5)-(b), and kept open and operating otherwise. Assume that the debt receives its payments so long as the mine is open and operating, but that when the mine is abandoned, the debt is worthless. What is the value of the debt? Find the value of the debt at all points in the tree, i.e. at all contingent copper prices through the life of the tree.

b) What is the expected rate of return on the debt at each of the nodes in the tree? Note that this is the same thing as asking what is the discount rate on the debt at each node of the tree.

c) Assume that the equity receives the difference between the operating cash flow from the mine and the payments on the debt. What is the equity cash flow at each node? Note that if the payment on the debt is more than the operating cash flow, then the equity cash flow may be negative. This means that the equity holder must put cash into the firm to keep operating. Assume that the equity holder does put in equity cash as described, so that the mine is abandoned only at the nodes specified in (5)-(b) of Problem Set #3.

d) What is the value of the equity? Find the value of the equity at all points in the tree, i.e. at all contingent copper prices through the life of the tree.

e) What is the total enterprise value (TEV), i.e. the value of debt plus equity? Find the TEV at all nodes of the tree. How does this compare to your solution to (5)-(a) of Problem Set #3?

f) Are there any points in the tree when the value of equity is negative? What does that mean? Is the TEV positive or negative at those nodes? What does it mean when the equity value is negative but the TEV is positive? How does the negative equity value fit with the assumption that the mine is abandoned at the nodes specified in (5)-(b) from Problem Set #3?

(2) Resolve the problem without assuming the answer to (5)-(b) from Problem Set #3. Instead, the levered equity owner chooses to abandon the mine: i.e. revise in order to maximize the value of levered equity.
   a) Revalue the equity and find the abandonment policy at each node.
   b) Revalue the debt at each node, and calculate the TEV at each node.
   c) What happened to the value of debt? What happened to the value of equity? What happened to the TEV?

(3) Assume now that a mine is financed with equity and with a copper-price linked debt contract. There are annual copper price contingent bond payments of 100,000 pounds of copper due each period starting the first period.
   a) Determine the cash flow obligation at each node.
   b) Redo question (1) for this bond.
   c) Redo question (2) for this bond.
   d) Compare the value of debt for this commodity bond with the value of debt for the straight bond. Compare the equity values in the two cases. Compare the TEV in the two cases.