

SESSION 5: Bonds and Options

Risky debt

Q1: the Merton Model

Your new boss has heard of a different way to value debt: a technique based on option valuation techniques. He would love to impress one of his new clients whom your boss heard criticizing the company in public.

The client has a small company active in the biotech sector. His company just made an IPO and the 100 000 shares currently trade at 30€. The company is registered in Tongoland where it has all its activities. As a consequence it pays no taxes and the risk free rate is worth 3%. The sector in which the company is active is known for its volatility. Each year the value of the company may be multiplied or divided by a factor four!

The company wishes to change its capital structure and borrow to buy back some of its equity. This move is expected to have no impact on the market value of the company as there are no taxes in Tongoland. Your client has contacted your boss to discuss the possibility of issuing a zero coupon maturing in three years to cover the expansion costs (amount to be reimbursed at maturity: 1 000 000€). He is ready to issue the bond if he receives 300 000€.

- (a) What is the value of the bond if one uses a binomial tree with a one year step?
- (b) Should your boss take the offer?
- (c) What is the risk premium of the company?
- (d) Broadly speaking which kind of rating could they expect with such a figure?

Q2: Merton in continuous time (RWJ 22.27)

Consider a firm that is financed by both debt and equity. The firm is worth \$ 1 million today and currently has 700 zero-coupon bonds outstanding that mature in six months. Each bond has a face value of \$ 1000. The firm pays no dividends. The annual variance of the firm's continuously compounded asset returns is 0.16, and Treasury bills that mature in six months yield a continuously compounded interest rate of 8 percent per annum. The beta asset of this company is 1 and the market risk premium is 6%.

- (a) Use the Black-Scholes model to calculate the values of firm's debt and equity.

- (b) Compute debt's yield and spread.
- (c) Break up the debt value into put value and risk-free debt.
- (d) What's the risk neutral default probability of this company and the delta of its equity?
- (e) Break up the debt value in face value, loss if no recovery, and expected recovery given default.
- (f) Compute the beta debt, the beta equity and the WACC of the company.

Convertible bonds

Q3: Dr Zoubowsky (this exercise was prepared by A. Farber)

A successful psychiatrist, Dr Zoubowsky had specialized in stress management. A substantial number of his clients were executives required to work long hours. They came to him to alleviate their stress. But the client lying today on his couch was different. Mr D. was CFO (Chief Financial Officer) of company X. (all names are disguised). In his first visit, he had explained his problem as follow:

"Doctor, I can't sleep anymore. I keep asking myself the same question: to call or not to call? I have become so nervous and irritable that my wife sent me to you for advice"

As Dr Zoubowsky didn't understand what Mr D was talking about, he asked for additional details. After several visits, he had assembled the following information.

Some years ago Company X had issued a callable zero coupon convertible bond. This bond would mature in June 2009, in two years from now. The face value of the bond issue was €100,000,000 divided into 1,000,000 individual bonds, each with a face value of €100. Each bond could be converted into one share (the conversion ratio was equal to 1 and the conversion price equal to €100). The convertible issue was callable by company X in June 2007 and June 2008 at a call price of €70. Company X had 6,000,000 shares outstanding and it did not intend to pay dividends during the next two years. The risk free interest rate was 4%.

Mr D's anxiety was due to the decision that he would have to take in the coming days: whether or not to call the bonds. "You have to realize, Doctor, that the value of our company is very volatile. The current market value of the company (the value of both the equity and the convertible bonds) is €360,000,000. Each year, it can increase by 50% or drop by 33,33%."

Dr Zoubowsky knew that Freud wouldn't be helpful in this case. However, he had previously treated another patient who couldn't sleep either but for a totally different reason. This client had become addicted to the Brealey-Myers' textbook

(Principle of Corporate Finance) and spent his night reading it. He came to see Dr Zoubowsky when his wife threatened to file for a divorce.

During a rainy week-end, Dr Zoubowsky read the chapters in Brealey Myers dealing with options and convertible bonds. He decided to help his client to analyze the problem using a binomial tree with one step per year. He wrote down the question that might lead to a decision.

- (a) What are the possible values of the company, of the convertible issue and of the equity at maturity (in June 2009)?
- (b) What are the possible values of the convertible issue in June 2008 if the issue was non callable? Would bondholders convert before maturity?
- (c) Should company X call the bonds in June 2008? How would bondholders react to a call decision?
- (d) What decision should Mr D take in June 2007?

Callable bonds

Q4: Freshwater

A week ago you realized a project valuation analysis using an option pricing methodology to assess Freshwater's new R&D partnership. Freshwater's new CFO, Alan, has been highly impressed by your financial skills and would like to work with you on a new financing project.

Freshwater wants to increase its production capacity. For the time being the company is unable to finance on equity so the decision has been made to finance the project by issuing debt.

However the board meeting organised to validate the decision has been very chaotic as some board members are convinced that the 1Y interest rate is going to drop while other members thought the rate would remain flat.

At the end, it was decided Freshwater should issue a callable bond in order to be able to refinance it if the rate decrease materialises.

Alan's mission is to organise the issue and convince investors to buy the bond. However he doesn't have a clue about how such a bond works and how it is valued. Your job is to help him to figure out how it works.

The callable bond has got the following features:

- Maturity 2Y
- Amount: € 100 million
- Coupon rate: 4.5%
- Callable in year 1 @ € 101

The current 1Y rate is 4% and its volatility is 35%.

On the market you can observe the market price of the following on-the-run bond:
Bond 006: 2Y remaining – 6% Coupon – Price € 104.01

The issuer's profile is identical to Freshwater so you assume you can use these data as benchmark.

Start by constructing the binomial interest rate tree. As you know you have to take a guess for the first node. Let's try 2.50% for instance. Are you lucky?

- (a) What would be the value of an option-free bond taking into account your interest rate binomial tree?
- (b) What is the value of the callable bond?
- (c) What is the value of the embedded call option?

Alan is very impressed by your approach and is now much more comfortable with the callable bond. Before you leave he asks you the following questions:

- (d) Why is the value produced by a binomial model referred to as an 'arbitrage free model'?
- (e) What would happen to the value of the callable bond if the expected volatility was higher?