NTNU Trondheim
Norwegian University of
Science and Technology

Faculty of Social Sciences
and Technology Management
Department of Industrial Economics
and Technology Management

Contact person for the exam:
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EXAM IN COURSE TIØ4146
FINANCE for SCIENCE and TECHNOLOGY STUDENTS
December 7^{th}, 2011
Time: 09.00 - 13.00
deadline for examination results: week 2 or 3

Aid A: All calculators allowed
All printed and written material allowed

Problem 1 (weight 15%)

In 1978 Leonard Koppett published a model to predict whether the US stock market would finish higher or lower than the year before. The input data for the model were first recorded in 1967 and are available each year by the end of January, so the prediction is for 11 months. The model predicted correctly for the 11 historical years when it was published, and also for all subsequent years through 1997, except for 1990, so 18 out of 19 years.

a) Do the results of Koppett's model contradict the Efficient Market Hypothesis (EMH)? Make additional assumptions if necessary.

Koppett's model was very simple: if the Super Bowl was won by a team that originally came from the National Football League the market would go up, if it was won by a team from the American Football League it would go down. The model is also known as the Super Bowl Indicator. Koppett was a sports journalist and the model was published in Sporting News of February 11 1978.

b) Does this information lead you to a different conclusion than under a)? Explain why.

An article in 'Byens Næringsliv', a local business newspaper, of 25 October 2011 announced the establishment of a new mutual fund which has its offices in Trondheim. The fund will be actively managed and its portfolio selection strategy is to include companies that 'earn money today, not in an unpredictable future'.

c) What does the Efficient Market Hypothesis predict about the excess returns of portfolios that consist of companies that earn money today?

Problem 2 (weight 35%)

Thomasson is a large electronics conglomerate, active in most major markets. As a large, internationally diversified company it has an asset beta of 0.8 and it can borrow cheaply at 6.5%. It is considering to diversify into the telecom industry, where it is not yet active. The project under evaluation would require an investment of €350 000 and generate a net annual after tax cash flow of €50 000 in perpetuity. The plan is to finance the project with a fixed, perpetual loan of 80% of the investment sum from Thomasson's bank. The project has sufficient debt capacity to support such a loan and the annual interest rate would be 9%. For the remaining part of the investment the company would use its retained earnings.

Thomasson's analysts collected the following financial data on the telecom industry. It has an average return on equity of 20% and the average interest rate on its debt is 7%. The average debt-to-equity ratio in the industry is $\frac{1}{4}$. All debt is fixed and permanent. The corporate tax rate is 35%. On the financial market the return on government bonds is 6% per year and the market risk premium is 6%.

a) Calculate the Weighted Average Cost of Capital (WACC) that Thomasson should use for the project and use this WACC to calculate whether Thomasson should go ahead with the project or not. Show the calculations that support your answer and make additional assumptions if necessary.

Problem 3 (weight 40%)

On a financial market risk free debt is available at a yearly interest rate of 5%. Stock X is traded at a price of 100. The stock pays no dividends and has a volatility of 50%, measured as annual standard deviation. European call and put options on stock X with exercise prices of 90, 100 and 110 are also traded. The options mature 2 weeks from now (or in 0.04 year of 250 trading days). Calls with exercise prices of 90 and 110 cost 10.86 and 0.99, puts with the same two exercise prices cost 0.68 and 10.77.

a) Calculate the prices of the at-the-money call and put on X. Use calculations to support your answer and make additional assumptions if necessary.

Stock X will announce its annual earnings 2 weeks from now. Investor B, who lives opposite X's main office, thinks the announcement will contain little news, because she did not see people nervously walk in and out of X's main office.

b) Describe an option position that has limited downside risk, relative to what it costs to set up the position, and profits from investor B's insight that the earnings announcement contains little news. Calculate how much it costs to set up the position and what its maximal profit at maturity is. Use calculations to support your answer and make additional assumptions if necessary.

Problem 4 (weight 10%)

The trade-off theory of capital structure is named after an economic trade-off that produces an optimal capital structure at less than 100% debt.

a) What is traded off against what in the trade-off theory?

b) When is optimal capital structure reached? Be precise in your answer.

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Problem 1 (weight 15%)

a) Being correct in 18 out of 19 years is an exceptionally high score and can only be attributed to chance under extremely rare circumstances. So with the information for question a) Koppett's model has predictive ability that clearly contradicts the EMH.

b) The information for question b) makes it clear that the predictive ability, however improbable, must be spurious. There is no reason why the football association to which the Super Bowl winner originally belonged should have any relation with stock market movements. Although the probability of being correct by chance in 18 out of 19 years is extremely low, the number of more or less random sequences from sports, traffic, the weather, etc. is so large that there always is a possibility to find a match. Koppett intended the model as a joke, was surprised it received positive response and was relieved when its predictions finally were wrong, after 19 years. Still, the Superbowl indicator was mentioned in the Wall Street Journal as late as 2011.

c) The current profitability (and the future profitability, for that matter) is already reflected in the current prices, according to the EMH. Selecting stocks on that basis cannot, on average, produce positive excess returns in efficient markets.

Problem 2 (weight 35%)

To calculate the Weighted Average Cost of Capital (WACC) for the project we have to use the riskiness (and the corresponding opportunity cost of capital=r_a) of the new industry and the capital structure of the project. The opportunity cost of capital can be calculated in different ways:

1. Using the expression for r_a when debt is fixed and permanent: $r_a = r_d(1-\tau)\frac{D}{V-\tau D} + r_e\frac{E}{V-\tau D} = .07 \times (1-.35) \times \frac{.2}{1-.35\times.2} + .2 \times \frac{.8}{1-.35\times.2} = 0.182$. This can also be done in terms of βs, where the βs are obtained by running the CAPM in reverse.

2. We can also run the formula for r_e i reverse: $r_e = r_a + (r_a - r_d)(1-\tau)\frac{D}{E}$; $.2 = r_a + (r_a - .07) \times (1-.35)\frac{.2}{.8}$, $r_a = 0.182$

3. We can first calculate the WACC in the telecom industry: $r_e\frac{E}{V} + r_d(1-\tau)\frac{D}{V} = .2 \times .8 + .07(1-.35) \times .2 = 0.169$ and then use the MM formula to calculate r_a: $WACC = r_a(1-\tau L)$; $.169 = r_a(1-.35\frac{.2}{1})$, $r_a = 0.182$

4. Finally, the WACC $= r_a\frac{V_a}{V} = r_e\frac{E}{V} + r_d(1-\tau)\frac{D}{V}$; and $V = V_a + \tau D$ or $V_a = V - \tau D$ so $r_a\frac{1-.35\times.2}{1} = .2 \times .8 + .07(1-.35) \times .2$, $r_a = 0.182$

The WACC for the project can also be calculated in different ways:

1. Using the MM formula: $WACC = r_a(1-\tau L)$; $WACC = .182 \times (1 - .35 \times \frac{.8}{1}) = 0.131$

2. Calculating the project r_e (using project r_d): $r_e = r_a + (r_a - r_d)(1-\tau)\frac{D}{E} = .182 + (.182 - .09) \times (1-.35)\frac{.8}{.2} = 0.421$ and then calculate the project WACC: $r_e\frac{E}{V} + r_d(1-\tau)\frac{D}{V} = .421 \times .2 + .09 \times (1-.35) \times .8 = 0.131$

With this WACC the value of the perpetual cash flow is $50000/.131 = 381679$. The NPV is $381679 - 350000 = 31679$, Thomasson should go ahead with the project.

Oppgave 3 (vekt 40%)

a) We use the Black and Scholes formula to calculate the values of the at-the-money options. The five determinants are: $S_0 = 100$, $X = 100$, $r = .05$, $\sigma = .5$ and $T = 0.04$.

$$d_1 = \frac{\ln(S_0/X) + (r + \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}} = \frac{\ln(100/100) + (.05 + .5.5^2)0.04}{.5\sqrt{0.04}} = 0.07$$

$$d_2 = d_1 - \sigma\sqrt{T} = 0.07 - .5\sqrt{0.04} = -0.03$$

The areas under the normal curve for the values of d_1 and d_2 are NormalDist(0.07) = 0.5279, and NormalDist$(-0.03) = 0.488$. The call option price is:

$$O_{c,0} = 100 \times 0.5279 - 100e^{-.05\times.04} \times 0.488 = 4.09$$

For the put we need $N(-d_2) =$ NormalDist$(0.03) = 0.512$ and $N(-d_1) =$ NormalDist$(-0.07) = 0.472$, so the option price is

$$\begin{aligned} O_{p,0} &= Xe^{-rT}N(-d_2) - S_0N(-d_1) \\ &= 100e^{-.05\times.04} \times 0.512 - 100 \times 0.472 = 3.90 \end{aligned}$$

Using the put-call parity gives the same result:

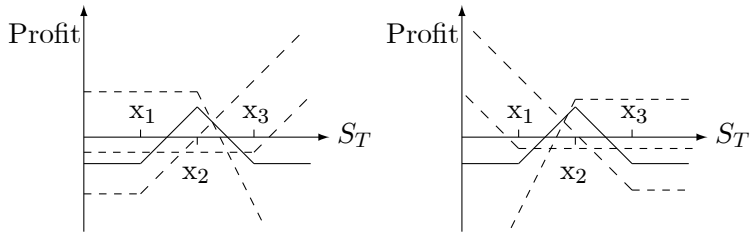
$$\begin{aligned} put &= call + PV(X) - share \\ put &= 4.09 + 100e^{-.05\times.04} - 100 = 3.89 \end{aligned}$$

b) Little news means little movement in X's stock price, i.e. low volatility. Option positions that profit from low volatility are short straddles and butterfly spreads. Only the latter has limited downside risk; butterfly spreads are depicted below. They can be constructed with puts or calls: buying one with a low exercise price, selling two with a medium exercise price and buying one with a high exercise price. The initial investment is calculated in Table 1.

Table 1: Butterflies, initial investments

		with calls		with puts	
X	Position	O_c	2×3	O_p	2×5
90	buy 1	10.86	-10.86	0.68	-0.68
100	sell 2	4.09	8.18	3.89	7.78
110	buy 1	0.99	-0.99	10.77	-10.77
Total			-3.67		-3.67

The maximum payoff at maturity is 10, from the call with X=90 or the put with X=110, so the maximum profit is 10 minus the future value of the sum of the option premia: $10 - 3.67e^{.05\times.04} = 6.3227$. Since $e^{.05\times.04} \approx 1$ ignoring this term gives no reduction in score. Other option positions are also positions are also possible; they are all accepted as long they satify the requirements in the question.



(a) Using calls (b) Using puts

Figure 1: Profit diagrams for a butterfly spread

Oppgave 4 (vekt 10%)

a) In the trade-off theory the expected tax advantage of debt is traded off against expected costs of financial distress

b) Optimal capital structure is reached when the marginal expected tax advantage equals the marginal expected costs of financial distress.