NTNU Trondheim
Norwegian University of
Science and Technology

Faculty of Economics
Department of Industrial Economics
and Technology Management

Contact person for the exam:
Name: D. van der Wijst
Phone: 73593511

EXAM IN COURSE TIØ4146
FINANCE for SCIENCE and TECHNOLOGY STUDENTS
12 May 2022 Time: 09.00 - 13.00

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

Problem 1 (weight 20%)

In a well known article[1], American researchers investigate the returns of various investment strategies. They use a large database of quarterly data of US firms over a period of 10 years. Their method is to construct different portfolios and analyse the portfolio returns. Two of these portfolios are described below. The first portfolio contains only the firms that are in the lowest decile (i.e. the lowest 10%) of Price/Earnings ratios (share price/earnings per share). The second portfolio contains only the firms that are in the lowest decile of Price/Book ratios (market value/book value of net tangible assets). All portfolios are rebalanced (i.e. the deciles are recalculated and the portfolios are adjusted) every quarter and transaction costs are included in the calculations of the returns. The researchers estimate the following regression model for each portfolio: $r_{pt} - r_{f\,t} = \widehat{\alpha}_p + \widehat{\beta}_p(r_{mt} - r_{f\,t}) + \epsilon_{pt}$, where r_p = portfolio return, r_f = risk free interest rate, $\widehat{\alpha}$ and $\widehat{\beta}$ are estimated coefficients, r_m = return on the market portfolio, ϵ = an error term and p, t are indices for portfolio and time. The estimated regression coefficients of these portfolios are in Table 1; their standard errors are in parentheses below the coefficients.

Table 1: Regression estimates

Portfolio:	$\widehat{\alpha}$	$\widehat{\beta}$
Lowest Price/Earnings	0.022	1.029
	(0.005)*	(0.056)*
Lowest Price/Book	0.010	1.076
	(0.005)	(0.060)*

* means significantly $\neq 0$

a) Which form of market efficiency is tested in this study?

b) Do any of the results in Table 1 contradict the Efficient Market Hypothesis (EMH)? If so, explain which specific result(s) and why. If not, explain why not.

[1] Zsuzsanna Fluck, Burton G. Malkiel, and Richard E. Quandt, The predictability of stock returns: a cross-sectional simulation, The review of economics and statistics, 1997-05-01, Vol.79 (2), p.176-183.

Problem 2 (weight 30%)

Pentus produces engines for small boats. It has a modest market share, the bulk of the market is covered by the five big brands. But Pentus is successful in its own corner of the market, particularly since the introduction of its popular Mark8 engine. Financially, Pentus is successful too. Its total book value is NOK 452 million, NOK 252 of which is debt. The company pays, on average, 7.5% interest on its debt. Its 5 million outstanding shares now trade at NOK 6.96 and give a return of 15.5%. Pentus uses its financial policies to strengthen its corporate image of dependability and reliability, so it does not adjust its outstanding debt contracts to changing stock valuations. Because the growth possibilities in engines are limited, Pentus considers expanding into the very different market of electronics for maritime navigation and communication. Its 'new business' team made contacts with electronics producers that can provide the components that Pentus will assemble into high quality equipment. The Pentelus project, as they call it, requires an immediate and irreversible investment of NOK 70 million. Unlike engines, maritime electronics have a very short life cycle. The Pentelus project will generate an expected after tax cash flow of NOK 27.5 million per year during 3 years, starting 1 year after the investment. Pentus plans to finance 60% of the investment with a loan. Its bank is willing to provide such a loan against an interest rate of 8.5%. The loan's principal amount will be paid back in three equal amounts after each of the following three years. The remaining part of the investment will be financed with equity from internal sources as retained earnings. The 'new business' team collected the following data of firms that are active in maritime electronics. On average, the firms in this industry are financed with equal parts of debt and equity. The average interest rate on their debt is 7% and the average equity beta is 1.2. The maritime electronics industry is very volatile, and it is common practice not to adjust outstanding debt contracts to changing stock valuations. On financial markets, the risk free interest rate is 5% and the return on the market portfolio is 14.5%. The corporate tax rate is 35% and personal taxes can be ignored.

a) Should Pentus invest in the Pentelus project or not? Show calculations to support your answer and make additional assumptions if necessary.

Problem 3 (weight 30%)

Nærmerøe is a successful Swedish airline that operates a route network between small airports in the Nordic countries. It has gradually expanded its fleet and recently made the step from turbo-prop to jet engined planes. Purchasing agreements of aeroplanes often include options to buy more aeroplanes and from its previous purchases Nærmerøe has one option on an aircraft left. The option gives Nærmerøe the right to buy a regional airliner for its own use (reselling is not allowed) against a price of SEK 580 million (SEK means Swedish kronor). Today's market price is considerably higher. Aircraft technology continually improves, so the option contract stipulates that the purchasing price increases by 10% per year. The option expires two years from now, but it can be exercised at any time before that. Nærmerøe would use the aircraft to expand its network. Calculations show that this network expansion is currently expected to generate future cash flows with a present value of SEK 550 million. However, this value is very uncertain. It can go up with 20% per year if Nærmerøe's business formula is successful in the already crowded market. On the other hand, the values of the cash flows can go down with 16.7% per year if Nærmerøe's formula fails. Analysts of the airline industry are optimistic and estimate the probability of success for Nærmerøe at 75%.

a) What is the value today of the option to expand the network by buying the aircraft and when should the option be exercised? Use a two-period binomial model and

assume a risk free interest rate of 4% per year. Show calculations to support your answer and make additional assumptions if necessary.

Problem 4 (weight 20%)

Question 4a) and 4b)

Some researchers collect information by sending questionnaires to Chief Financial Officers (CFOs). One such study[2] asked CFOs directly whether their firms have a target debt-equity ratio. A very large majority of CFOs answered that they had some form of a target debt-equity ratio.

a) What does this result says about the trade-off theory of capital structure?

- contradicts the trade-off theory
- does not test the trade-off theory
- is in line with the predictions of the trade-off theory

b) What does this result says about the pecking order theory of capital structure?

- contradicts the pecking order theory
- does not test the pecking order theory
- is in line with the predictions of the pecking order theory

Question 4c)

The trade-off theory of capital structure describes the optimal capital structure for any firm as the level of debt that:

- minimizes the present value of the costs of financial distress
- maximizes the present value of the interest tax advantage
- equates the marginal value of the expected interest tax advantage to the marginal value of the expected costs of financial distress
- equates the total value of the expected interest tax advantage to the total value of the expected costs of financial distress

Question 4d)

The pecking order theory of capital structure describes the optimal capital structure for any firm as the level of debt that:

- puts the firm at the top of the pecking order
- puts the firm at the bottom of the pecking order
- minimizes the degree of information asymmetry
- none of the above, it does not describe optimal capital structure

[2] John R. Graham and Campbell R. Harvey, The theory and practice of corporate finance: evidence from the field, Journal of Financial Economics Volume 60, Issues 2–3, May 2001, Pages 187-243

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Problem 1 (weight 20%)

a) In addition to market data (price per share, total market value), the researchers also use accounting data (earnings, book values) to construct their portfolios. Such data are public information and, hence, this study tests the semi-strong form of market efficiency.

b) The estimated regression equation corresponds to that of Jensen's alpha. The alpha coefficient tests whether portfolios systematically earn abnormal returns (i.e. returns in excess of the market risk premium). As the authors put it: it tests whether the returns are justified by the riskiness of the portfolio. Alphas significantly > 0 contradict the Efficient Market Hypothesis (EMH). This is the case with the first portfolio of low P/E firms, not with the other portfolio. Hence, only the alpha coefficient of this portfolio (of 0.022) contradicts the semi-strong form of the EMH. Significant beta coefficients do not contradict market efficiency.

Problem 2 (weight 30%)

The description of the problem makes clear that the project has a short life (3 years) and that its debt is predetermined, so that capital structure is likely to change over time. Hence, APV is the only practical method to evaluate the investment. The first step is to calculate the OCC from the data of the maritime electronics industry. The average debt/equity ratio is $0.5/0.5 = 1$, the cost of debt is given as 7% and the average equity is beta is 1.2. Using the CAPM, this gives a cost of equity of $0.05+1.2(0.145-0.05) = 0.164$ or 16.4%. Since debt is predetermined we can unlever with the formula:

$$\begin{aligned} r_a &= r_d(1-\tau)\frac{D}{V-\tau D} + r_e\frac{E}{V-\tau D} \\ &= 0.07(1-.35)\frac{0.5}{1-.35\times 0.5} + 0.164\frac{0.5}{1-.35\times 0.5} = 0.127 \end{aligned}$$

This can also be done in terms of βs: the β of debt follows from the CAPM: $0.07 = 0.05 + \beta_d(0.145-0.05) \Rightarrow \beta_d = 0.21.\beta_a$ then becomes:

$$\beta_a = 0.21(1-.35)\frac{0.5}{1-.35\times 0.5} + 1.2\frac{0.5}{1-.35\times 0.5} = 0.81$$

and the CAPM gives: $r_a = 0.05 + 0.81(0.145 - 0.05) = 0.127$. We can also use the formula for r_e in reverse:

$$\begin{aligned} r_e &= r_a + (r_a - r_d)(1-\tau)\frac{D}{E} \\ 0.164 &= r_a + (r_a - .07)(1-.35)\frac{0.5}{0.5} \Rightarrow r_a = 0.127 \end{aligned}$$

Alternatively, we can calculate the industry WACC:

$$WACC = 0.07(1-.35)0.5 + 0.164 \times 0.5 = 0.10475$$

and then use the MM formula in reverse:

$$0.10475 = r_a\left(1 - 0.53\frac{0.5}{1}\right) \Rightarrow r_a = 0.127$$

With this OCC we can calculate the base case present value:

$$\frac{27.5}{1.127} + \frac{27.5}{1.127^2} + \frac{27.5}{1.127^3} = 65.264$$

The next step is to calculate the present value of the tax advantages of debt (no other side-effects are mentioned in the text). We have to calculate the tax savings for each year separately because the loan is paid back gradually over the project's life time. The initial loan is 60% of 70 million, so 42 million. After each year, $42/3 = 14$ is paid back. The tax saving = loan $\times$ interest rate $\times$ tax rate, so the tax savings for:

the first year is: $42 \times 0.085 \times 0.35 = 1.2495$

the second year is $28 \times 0.085 \times 0.35 = 0.833$

the third year is $14 \times 0.085 \times 0.35 = 0.4165$

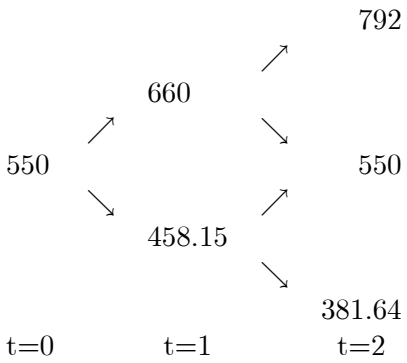
The loan is predetermined (not rebalanced), so the tax advantage must be discounted at the cost of debt:

$$\frac{1.2495}{1.085} + \frac{0.833}{1.085^2} + \frac{0.4165}{1.085^3} = 2.1853$$

The APV then becomes: $-70 + 65.264 + 2.1853 = -2.55$ This is < 0, so Pentus should not invest in the Pentelus project.

Problem 3 (weight 30%)

We begin by setting up the value tree for the cash flow values:



Value process for cash flows

The parameters of the binomial process are given: $u = 1.2,\ d = 0.833$ and $r = 1.04$, so we can calculate the equivalent martingale probabilities:

$$p = \frac{r-d}{u-d} = \frac{1.04 - 0.833}{1.20 - 0.833} = 0.564$$

The exercise price of the option increases with 10% per year from SEK 580 million today to $1.1 \times 580 = 638$ next year and to $1.1 \times 638 = 701.8$ after two years. We start at the end of the tree and calculate the option values at maturity, then move to the beginning of the tree and compare at each relevant node the values 'dead' and 'alive'. The exercise price after two years is SEK 701.8 million, so it is obvious that the option only ends in-the-money in the upper node of t=2 in the tree. Its value there is

$$\max[0, 792 - 701.8] = 90.2$$

The value of the option alive in the upper node at t=1 is

$$\frac{0.564 \times 90.2 + 0.436 \times 0}{1.04} = 48.92$$

We have to compare this with the value dead, which is:

$$\max[0, 660 - 638] = 22$$

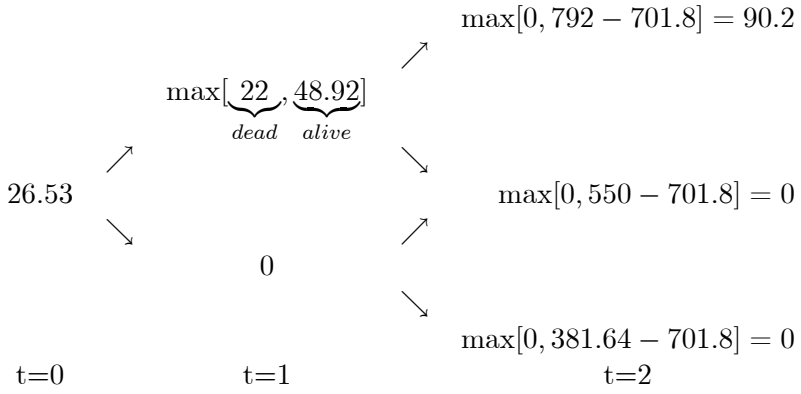
So the option is worth more alive than dead. In the lower node at t=1 the option value, both dead and alive, is zero. The present (t=0) value of the option then becomes:

$$\frac{0.564 \times 48.92 + 0.436 \times 0}{1.04} = 26.53$$

This is higher than the value dead, which is:

$$\max[0, 550 - 580] = 0$$

So the value of the option is SEK 26.53 million and it should be exercised in the upper node at maturity (t=2). The calculations are summarized in the lattice below.



Value process for cash flows

In principle, it is also possible to price the options by constructing replicating portfolios, but that is a very roundabout way in this case.

Problem 4 (weight 20%)

Question 4a) and 4b)

The trade-off theory leads to an optimal capital structure to which firms try to return after a disturbance. This gives the firm a target capital structure, so the finding is in line with the predictions of the trade-off theory. The pecking order theory, on the other hand, does not lead to an optimal capital structure. So when CFOs says they have a target capital structure, they do not choose capital structures following the pecking order theory. Hence, the finding contradicts the pecking order theory.

Question 4c)

In the marginalist tradition, the trade-off theory describes optimal capital structure as the point where the last marginal unit of debt produces the same amounts of marginal expected tax advantage and marginal expected costs of financial distress. At this point, any increase or decrease in units of debt will decrease firm value, so optimal capital structure is reached. Hence, the third answer is correct.

Question 4d)

The pecking order theory does not lead to an optimal capital structure, so the fourth answer is correct.