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
29 November 2021 Time: 09.00 - 13.00

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

Problem 1 (weight 20%)

Yin et al.[1] investigate the stock price reactions to profit warnings issued by a sample of firms listed on the Hong Kong Stock Exchange. Profit warnings are announcements issued by publicly traded companies, prior to the issuance of their formal financial reports, to warn investors that their earnings will differ from previously expected levels. The researchers collected all such announcements made during the period from July 2007 to July 2012. The statements of profit warnings are obtained from the website of the Hong Kong Stock Exchange. Daily closing prices of the issuing firms and the Hang Seng index were also collected. The final sample constitutes a total of 1723 profit warnings, of which 1238 contain negative news and 485 contain positive news about firms' earnings prospects. The researchers use the market model and the standard event study methodology to estimate the abnormal returns following profit warnings. They report Cumulative Average Abnormal Returns (CAAR) for the event day and several time windows after that. Some of their results are in Table 1 below.

Table 1: CAAR (in %)

Window (days)	Negative warnings	Positive warnings
0	-3.46*	4.16*
1 to 4	0.55	-1.43*
1 to 10	1.25*	-2.82*

* 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.

Problem 2 (weight 30%)

Aker Problems ASA is active in the oil and gas industry, where it delivers complex energy projects. It sees its digital technology and problem solving culture as its main

[1] S. Yin, K. Mazouz, A. Benamraoui, and B. Saadouni, "Stock price reaction to profit warnings: the role of time-varying betas", Review of Quantitative Finance and Accounting, vol. 50, no. 1, pages 67–93, 2018.

competitive advantages. It likes to present itself as a main provider of renewable energy solutions, but most of its earnings come from its fixed and floating solutions for subsea oil and gas production. Its current book value is NOK 60 billion, with equal proportions of debt and equity. The company pays, on average, 7% interest on its debt. Aker's financial policy is to keep its debt contracts stable, it does not adjust the outstanding amounts to changing stock valuations. Its stock price has been rising steadily over the years and its 75 million outstanding shares now trade at NOK 800 on Oslo børs and give a return of 15%. To strengthen its emphasis on renewable energy solutions Aker is considering starting a modern lithium-ion battery factory in the north of the country. In that region electricity prices are low and ice-free harbour facilities guarantee an uninterrupted supply of raw materials. But other production factors, like skilled labour, are relatively scarce. The AccuRate project, as Aker calls it, requires an investment of NOK 100 million and will generate an expected perpetual after tax cash flow of NOK 12.5 million per year. Aker plans to finance 60% of the investment with a perpetual loan. Its bank is willing to provide such a loan against an interest rate of 9%, which is rather high. The rest will be financed with equity from internal sources as retained earnings. The AccuRate project will compete with the lithium-ion battery factory of the famous entrepreneur Eli Tusk, currently the only such factory in this part of Europe. As all of Tusk's enterprises, his battery factory is aggressively financed with a large proportion debt. Tusk has no problems finding investors who are willing to provide debt. The outstanding debt of his battery factory has an estimated market value of NOK 172.5 million and he pays 9.5% interest on it. Tusk does not adjust the outstanding debt amounts to changing stock valuations. His shares in the battery factory are doing well too: the 10 million outstanding shares hit a new price record and they currently trade at NOK 5.75 to give 17.5% return. 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 28% and personal taxes can be ignored.

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

Problem 3 (weight 30%)

Data Solutions ASA rents out general purpose computer equipment to medium-sized companies in emergency situations, e.g. after a fire or a hacker attack. The standard rent contract is for a quarter (i.e. three months) and the current market price is €135000 per quarter. However, the price is very volatile, it depends, among other things, on the supply of hardware and the intensity of hacker attacks. In financial terms this means that after every quarter the rent either goes up with 25% or down with 20%. So far Data Solutions was very successful with its quick, standard solution, but now it wants to introduce more flexibility. Hence, it is considering making its rent contracts more attractive by offering its clients the possibility to extend the rent with one more quarter at the same price after the first quarter has passed.

a) If the risk free interest rate is 6% per year, what is the value today of the possibility to extend the rent with one quarter at the same price?

Data Solutions is also considering another possibility: to make the standard rent contract for two quarters at the same price (now: €135000 per quarter) and include the possibility for clients to terminate the contract after one quarter.

b) If the risk free interest rate is 6% per year, what is the value today of the possibility to terminate the two quarter rent contract after one quarter?

Problem 4 (weight 20%)

In a recent article, Harris and Roark[2] empirically analyse corporate capital structure using a large sample of firms (they use more than 180 000 observations). In one of their regressions, they relate the debt ratio of the firms in their sample to variables suggested by the trade-off theory of capital structure. Their main results are in Table 2 below.

Table 2: Estimates from regression analysis

Explanatory variable	Coefficient
market-to-book ratio	−0.0092*
asset tangibility	0.2219*
profitability	−0.4877*
firm size	0.0431*
cash flow volatility	0.1032*
R^2	0.2530

* means significantly $\neq 0$

The variable to be explained is the debt ratio of the firms, calculated as the total value of debt divided by the market value of assets. The market-to-book ratio is the market value of assets divided by the book value of total assets. Asset tangibility is the ratio of net property, plant and equipment to the book value of total assets. Profitability is operating income before depreciation. Firm size is the log of firm assets, deflated to 2015 dollars. Cash flow volatility is the standard deviation of industry cash flows over the previous 5 years.

a) For each of the five explanatory variables in Table 2 indicate whether the estimation result:

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

[2] Christopher Harris and Scott Roark, "Cash flow risk and capital structure decisions", Finance Research Letters, Volume 29, June 2019, pages 393-397.

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Problem 1 (weight 20%)

a) Yin et al. investigate the stock price reactions to profit warnings. Such warnings are public information, they are announced on the website of the stock exchange. Hence, this study tests semi-strong form market efficiency.

b) The significant CAAR in the event window (of -3.46 and 4.16) do not test market efficiency. The significant post-event CAAR (of 1.25 in the window 1 to 10 for negative warnings and of -1.43 and -2.82 in the windows 1 to 4 and 1 to 10 for positive warnings) contradict market efficiency in the semi-strong form. They show the pattern of overreaction followed by a correction. The researchers do not report pre-event CAAR.

Problem 2 (weight 30%)

The problem description makes clear that the AccuRate project (battery production) is in another line of business than Aker's main activities (oil and gas production). So the opportunity cost of capital has to be calculated from other battery producers and Eli Tusk's factory is the only choice. We also notice that both Aker's and Tusk's debt are predetermined (not rebalanced). We start by calculating the market value of Tusk's battery factory's equity: 10 million shares at NOK 5.75 per share gives NOK 57.5 million. The market value of debt is 172.5 million, so the total value is $57.5 + 172.5 = 230$ million NOK. The returns and tax rate are given, so we can unlever with the formula:

$$\begin{aligned} r_a &= r_d(1-\tau)\frac{D}{V-\tau D} + r_e\frac{E}{V-\tau D} \\ &= 0.095(1-.28)\frac{172.5}{230-.28\times 172.5} + 0.175\frac{57.5}{230-.28\times 172.5} = 0.12 \end{aligned}$$

Alternatively, we can use the formula for r_e in reverse:

$$\begin{aligned} r_e &= r_a + (r_a - r_d)(1-\tau)\frac{D}{E} \\ 0.175 &= r_a + (r_a - .095)(1-.28)\frac{172.5}{57.5} \Rightarrow r_a = 0.12 \end{aligned}$$

or calculate the WACC of Tusk's battery factory:

$$r' = 0.095(1-.28)\frac{172.5}{230} + 0.175\frac{57.5}{230} = 0.095$$

and then solve the MM formula for the unknown r_a :

$$0.095 = r_a\left(1 - 0.28\frac{172.5}{230}\right) \Rightarrow r_a = 0.12$$

With this OCC we can calculate the cost of equity for the AccuRate project:

$$\begin{aligned} r_e &= r_a + (r_a - r_d)(1-\tau)\frac{D}{E} \\ r_e &= .12 + (.12 - .09)(1 - .28)\frac{60}{40} = 0.1524 \end{aligned}$$

The project's WACC is:

$$r' = 0.09(1 - .28)\frac{60}{100} + 0.1524\frac{40}{100} = 0.10$$

Alternatively, we can use the MM formula:

$$\begin{aligned} r' &= r_a(1 - \tau L) \\ r' &= 0.12\left(1 - .28\frac{60}{100}\right) = 0.10 \end{aligned}$$

With this WACC the value of the perpetual cash flow is:

$$\frac{12.5}{0.1} = 125$$

so the NPV is $125 - 100 = 25$ million NOK, Aker should go ahead with the project.

APV can also be used. The base case present value is $12.5/.12 = 104.17$ and the tax advantage is $\tau D = .28 \times 60 = 16.8$, so APV $104.17 + 16.8 - 100 = 20.97$. The conclusion is the same: Aker should go ahead with the project.

This is not required for the exam, but a more precise APV can be obtained by defining capital structure in project market values in stead of the investment amount. This involves solving the following simultaneous equations:

$$\begin{aligned} B &= 104.17 \\ D &= 0.6 \times APV \\ TA &= .28 \times D \\ APV &= B + TA \end{aligned}$$

where B= base case value, D=debt and TA is tax advantage. The computer easily finds this solution: $APV = 125.2,\ B = 104.17,\ TA = 21.034,\ D = 75.123$, which corresponds to the NPV calculated with the WACC. Notice that debt (75.123) is 60% of the project's market value (125.2).

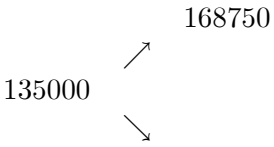
Problem 3 (weight 30%)

question a)

The possibility to extend the rent with one quarter is a real call option with the rent contract as underlying value. The market price of rent contracts follows a binomial process with an up factor of 1.25 and a down factor of 0.8. Given the current market price of €135000 per quarter, we can set up the binomial tree for rent prices (one step of a quarter is enough):

The parameters of the binomial process are:

$$\begin{aligned} u &= 1.25,\ d = 0.8 \text{ and } r = e^{.25\times.06} = 1.0151, \text{ so} \\ p &= \frac{1.0151 - 0.8}{1.25 - 0.8} = 0.478 \text{ and } 1 - p = 0.522 \end{aligned}$$



Quarterly rent prices

Note that the interest rate is re-scaled from an annual to a quarterly value. (Using discrete discounting r= $\sqrt[4]{1.06} = 1.0147$ is also possible.) The option to extend will only be exercised at t=1 if it is profitable to do so, the pay-offs in the end nodes are:

$\max[0, 168750 - 135000] = 33750$

$\max[0, 108000 - 135000] = 0$

and they have a value today of:

$$\frac{0.478 \times 33750 + 0.522 \times 0}{1.0151} = 15893$$

So the option the extend the rent contract with one month at the current price of €135000 has a value of €15893.

question b)

The possibility to terminate a two-quarter rent contract after 1 quarter is a put option; its payoff at maturity is either zero or the positive difference between the contract price of €135000 and the market rent:

$\max[0, 135000 - 168750] = 0$

$\max[0, 135000 - 108000] = 27000$

The value today is:

$$\frac{0.478 \times 0 + 0.522 \times 27000}{1.0151} = 13884$$

So the option the terminate the two-month rent contract after one month has a value of €13884.

alternative calculations

If the Black and Scholes model is used, the binomial u and d parameters have to be converted into continuous time annual standard deviation: $1.25 = e^{\sigma\sqrt{0.25}} \Rightarrow \sigma = 0.4463$ (alternatively: $0.8 = e^{-x\sqrt{0.25}} \Rightarrow \sigma = 0.4463$). The five determinants of B&S option prices are then: $S_0 = X = 135,\ \sigma = 0.4463,\ T = 0.25,\ r = 0.06.$

$$\begin{aligned} d_1 &= \frac{\ln(S_0/X) + (r + \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}} \\ &= \frac{\ln(135/135) + (.06 + 0.5 \times .4463^2)0.25}{.4463\sqrt{0.25}} = 0.1788 \end{aligned}$$

$$d_2 = d_1 - \sigma\sqrt{T} = 0.1788 - .4463\sqrt{0.25} = -0.04435$$

NormalDist$(0.1788) = 0.57095$ and NormalDist$(-0.04435) = 0.48231$

$$\begin{aligned} O_{c,0} &= S_0 N(d_1) - \left(X e^{-rT}\right) N(d_2) \\ &= 135 \times 0.57095 - 135 \times e^{-0.06 \times 0.25} \times 0.48231 = 12.936 \end{aligned}$$

and

NormalDist$(-0.1788) = 0.42905$ and NormalDist$(0.04435) = 0.51769$

$$\begin{aligned} O_{p,0} &= Xe^{-rT}N(-d_2) - S_0N(-d_1) \\ &= 135 \times e^{-0.06\times 0.25} \times 0.51769 - 135 \times 0.42905 = 10.926 \end{aligned}$$

It is also possible to calculate the option values from their replicating portfolios in the binomial model, so for the call in question a)

$$\Delta = \frac{O_u - O_d}{(u-d)S} = \frac{33750 - 0}{(1.25 - 0.8)135000} = 0.55556$$

and

$$D = \frac{uO_d - dO_u}{(u-d)r} = \frac{1.25 \times 0 - 0.8 \times 33750}{(1.25 - 0.8)1.0151} = -59107$$

which gives an option value of

$$O_c = 0.55556 \times 135000 - 59107 = 15894$$

And for the put in question b):

$$\Delta = \frac{O_u - O_d}{(u-d)S} = \frac{0 - 27000}{(1.25 - 0.8)135000} = -0.44444$$

and

$$D = \frac{uO_d - dO_u}{(u-d)r} = \frac{1.25 \times 27000 - 0.8 \times 0}{(1.25 - 0.8)1.0151} = 73884$$

which gives an option value of

$$O_p = -0.44444 \times 135000 + 73884 = 13885$$

Finally, it is also possible to calculate the values of the rents over the second quarter with and without the options and deduce the option values from their differences. For question a), the the present value of the rent over the second quarter excluding the option to extend is, of course:

$$\frac{0.478 \times 168750 + 0.522 \times 108000}{1.0151} = 135\,000$$

and the value including the option to extend is

$$\frac{0.478 \times 135000 + 0.522 \times 108000}{1.0151} = 119110$$

so the option value is:

$$135000 - 119110 = 15890$$

Similarly, for the put in question b) the present value of the rent over the second quarter excluding the option to terminate is

$$\frac{0.478 \times 135000 + 0.522 \times 135000}{1.0151} = 132990$$

and the value including the option to terminate is

$$\frac{0.478 \times 135000 + 0.522 \times 108000}{1.0151} = 119110$$

so the value of the option to terminate is

$$132990 - 119110 = 13880$$

Problem 4 (weight 20%)

The estimation results of the market-to-book ratio (−), asset tangibility (+) and firm size (+) are in line with the predictions of the trade-off theory. The estimation results of profitability (−) and cash flow volatility (+) contradict the trade-off theory.