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
1 June 2021 Time: 09.00 - 13.00

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

Problem 1 (weight 20%)

The performance of mutual funds is a topic of undiminished importance, both from an academic and a practical point of view. A recent academic study[1] analyses the results of different types of funds in a European country. The study uses monthly returns over the period February 2007–March 2015 for 37 equity funds and 21 hedge funds. Fund performance is measured by Jensen's alpha, i.e. the intercept of a regression model. Two regression models are used: one represents the Capital Asset Price Model (CAPM, as in equation (3.12) in the book) and the other is the three-factor model of Fama and French (FF, as in equation (3.19) in the book). Regressions are run for the gross excess fund returns (returns in excess of the risk-free interest rate, before expenses) and net excess returns (calculated by subtracting the total expense ratio from the gross return for each fund). The estimates of the intercepts (alphas) are reproduced in Table 1 below; t-statistics are printed in parentheses under the coefficients.

Table 1: Regression estimates of mutual funds

	Jensen's alphas and (t(α))			
	CAPM		FF 3-factor model	
	Gross	Net	Gross	Net
Equity funds	0.197	−0.842	0.093	−1.017
(t-statistic)	(**1.961**)	(**−8.354**)	(0.973)	(**−10.552**)
Hedge funds	0.006	−1.09	0.006	−1.09
(t-statistic)	(0.081)	(**−15.303**)	(0.084)	(**−15.396**)

t-values significantly $\neq 0$ are printed **in bold**

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.

Problem 2 (weight 30%)

TechTalk is a Nordic software house, specialized in educational software. It has a small but stable market position in the industry, which is dominated by a few American

[1] Maher Asal, Testing for the presence of skill in Swedish mutual fund performance: Evidence from a bootstrap analysis, Journal of Economics and Business, Vol. 88, November–December 2016, Pages 22-35.

tech giants. The past couple of years have been very successful for TechTalk and this has boosted its share price to €75 per share. It has 1 million shares outstanding. However, the software industry is very risky and TechTalk is no exception: it has an equity β of 1.8, and it pays a comparatively high interest rate on its debt, viz. 7%. To provide an element of stability, TechTalk does not adjust its capital structure to changing market valuations. Its has a total book value of €100 million, 55% of which is equity and 45 % is debt. TechTalk considers extending its product range with software for videoconferencing. This type of software is in great demand since the COVID19 pandemic, and TechTalk sees an opportunity for a good project. Technically, the project can be realized by adapting one its existing software products; this requires an immediate and irreversible capital expenditure of €45 million. The project under consideration would generate after tax cash flows of €15 million per year during 4 years, starting 1 year after investment. TechTalk's management thinks the project is comparatively safe, because it is in the same line of business and can be sold to the same customers as its existing products. So its wants to finance the investment with a loan of €25 million. The bank is willing to provide such a loan against an interest rate of 8.5% per year. The loan has to be paid back in two amounts: €15 million after 2 years and €10 million after 4 years. The rest of the investment, €20 million, will be financed with retained earnings. 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 TechTalk invest in this project or not? Show calculations to support your answer and make additional assumptions if necessary.

Problem 3 (weight 30%)

On a financial market similar to Oslobørs, the shares of ZX co. are traded at a price of €75. ZX co. is among the most volatile shares on the market, its annual standard deviation is 40%. However, ZX co. is popular among certain investors because it has a reputation of paying dividends regularly. The next dividend, already announced on the website of the stock exchange, will be paid three months from now. It is a cash dividend of €12.50 per share. Options are also traded on the financial market. One of those options is a European put written on shares ZX co. with a time to maturity of 6 months and an exercise price of €70. The annual risk free interest rate is 5%.

a) What is the value today of this put option? Show calculations to support your answer and make additional assumptions if necessary.

b) Suppose a bank has sold 100 of these options. What position must the bank take in shares ZX co. to hedge its obligations from selling these options? Be precise in your description of the position.

Problem 4 (weight 20%)

Many papers analyse the capital structure of firms from an empirical point of view. One such paper[2] investigates the pecking order theory, particularly the effect of the financing deficit on capital structure of firms in Asia. The financing deficit DEF is defined as:

$$DEF = DIV + I + \Delta W - Cfl$$

[2] Dar-Hsin Chen, Chun-Da Chen, Jianguo Chen, and Yu-Fang Huang, Panel data analyses of the pecking order theory and the market timing theory of capital structure in Taiwan, International Review of Economics & Finance, Volume 27, 2013, Pages 1-13.

where DIV is the cash dividend payment, I is the net investment, ΔW is the net increase in working capital and Cfl is the operating cash flow after interest and taxes. In two regressions, the researchers relate net debt issued (ΔD) and net equity issued (ΔE) to the financing deficit: $\Delta D = \alpha_1 + \beta_1 DEF + \varepsilon_1$ and $\Delta E = \alpha_2 + \beta_2 DEF + \varepsilon_2$, where $\alpha_{1,2}$ and $\beta_{1,2}$ are estimated coefficients and $\varepsilon_{1,2}$ are error terms[3]. Their estimation results are: $\beta_1 = 0.309$ and $\beta_2 = 0.675$, and both coefficients are highly significant.

a) Do these estimation results support or reject the pecking order theory?
support
reject
do not test the pecking order theory

Next, the researchers run two regressions that relate the debt ratio of the firms in their sample to variables suggested by the trade-off theory of capital structure: asset tangibility, market-to-book ratio, log sales and profitability. The first regression only includes these four variables. The second regression also includes the financing deficit divided by the book value of assets, a variable suggested by the pecking order theory. The estimation results of both regressions are in Table 2 below and all coefficients are significantly $\neq 0$.

Table 2: Estimates from regression analysis

Explanatory variable	Coefficient	Coefficient
Tangibility	0.237	0.283
Market-to-book ratio	−0.088	−0.056
Log sales	0.040	0.058
Profitability	−0.635	−0.366
DEF/total assets		0.648

b) Is the coefficient of the cumulative financing deficit in Table 2 in line with predictions of the pecking order theory?
in line
not in line
does not test the pecking order theory

c) Can you conclude from the results in Table 2 that one of the two theories is (much) more supported than the other by the results of this study?
pecking order more supported than trade-off theory
trade-off theory more supported than pecking order theory
both theories are supported
neither theory is supported

[3] All amounts are scaled (divided) by net asset value.

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
1 June 2021 Solutions

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

Problem 1 (weight 20%)

a) By analysing fund performance, this study tests strong form market efficiency. The models and knowledge that funds use to make investment decisions are private information.

b) The intercepts of the regressions represent the value management has added to the fund above what could be justified by the funds' risk, according to the CAPM or the FF 3-factor model. A significantly positive intercept (Jensen's alpha) is viewed as outperformance, and a significantly negative intercept is viewed as underperformance. The intercepts in the regressions of gross returns test whether, on average, managers have any skill. This tests a rather strict form of market efficiency, i.e. whether excess returns can be obtained, adjusting for risk but not for the costs. The intercepts in the regressions of net returns tell us whether managers have sufficient skill to generate returns that at least cover the costs that funds impose on investors. This tests the usual, less strict form of market efficiency, i.e. whether excess returns can be obtained adjusting for risk and for the costs. This appears not to be the case: all intercepts in the regressions of the net returns are significantly negative and underperformance does not contradict the EMH. Only the intercept in the CAPM regression for the gross returns of the equity funds (of 0.197) is significantly positive, so only this result contradicts the rather strict form of the EMH. The other 'gross' intercepts are insignificant, as the EMH predicts. Since students are free to choose the strict or less strict form of market efficiency, both answers ('yes, the gross returns of the equity funds (of 0.197) contradict' and 'no contradiction because all intercepts in the regressions of the net returns are significantly negative') are correct. Notice that the results in the table are averages, individual funds can deviate, both positively and negatively.

Problem 2 (weight 30%)

From the problem description we notice that the project has a short life (4 years) and that its debt is predetermined, so that capital structure changes over time. This makes APV the preferred method to evaluate the investment. We start by calculating the OCC from TechTalk's data, since the project is in the same line of business. The market value of its equity is 1 million shares at €75 per share, so €75 million. No market value of debt is given, so we have to use the book value of €45 million. The total value is, thus, €120

million. The cost of debt is given as 7% and the cost of equity can be calculated with the CAPM: $r_e = 0.05 + 1.8(0.145 - .05) = 0.221$ or 22.1%. Because TechTalk does not adjust its capital structure to changing market valuations, its debt is predetermined and we can unlever with the formula:

$$\begin{aligned} r_a &= r_d(1-\tau)\frac{D}{V-\tau D} + r_e\frac{E}{V-\tau D} \\ &= 0.07(1-.35)\frac{45}{120-.35\times 45} + 0.221\frac{75}{120-.35\times 45} = 0.17863 \end{aligned}$$

The more general formula

$$r_a = r_e\frac{E}{V_a} + r_d\frac{D-PV(TS)}{V_a}$$

can also be used, but that amounts to the same thing.

We can also use the formula for r_e in reverse:

$$\begin{aligned} r_e &= r_a + (r_a - r_d)(1-\tau)\frac{D}{E} \\ 0.221 &= r_a + (r_a - .07)(1-.35)\frac{45}{75} \Rightarrow r_a = 0.17863 \end{aligned}$$

It is even possible to first calculate TechTalk's WACC:

$$r' = 0.07(1-.35)\frac{45}{120} + 0.221\frac{75}{120} = 0.155$$

and then solve the MM formula for the unknown r_a :

$$0.155 = r_a\left(1 - 0.35\frac{45}{120}\right) \Rightarrow r_a = 0.178$$

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

$$\frac{15}{1.17863} + \frac{15}{1.17863^2} + \frac{15}{1.17863^3} + \frac{15}{1.17863^4} = 40.459$$

The text mentions no other side-effects than the (implicit) tax savings. Since the amount of debt varies over time we have to calculate the tax savings for each year separately. Recall that tax savings = loan × interest rate × tax rate

tax savings for the first 2 years: $25 \times 0.085 \times 0.35 = 0.74375$

tax savings for the second 2 years: $10 \times 0.085 \times 0.35 = 0.2975$

The proper discount rate for the tax advantage is the cost of debt, since the loan is predetermined:

$$\frac{0.74375}{1.085} + \frac{0.74375}{1.085^2} + \frac{0.2975}{1.085^3} + \frac{0.2975}{1.085^4} = 1.7648$$

The APV then becomes: $-45 + 40.459 + 1.7648 = -2.7762$. This is < 0, so TechTalk should not invest in this project.

Problem 3 (weight 30%)

a) We start by calculating the PV of the dividend: $12.5e^{-0.05\times 0.25} = 12.345$ We subtract that from the stock price today: $75 - 12.345. = 62.66$. We then have the five determinants in the Black and Scholes formula: $S_0 = 62.66$, $X = 70$, $r = .05$, $\sigma = .4$ and $T = 0.5$.

$$d_1 = \frac{\ln(S_0/X) + (r + \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}} = \frac{\ln(62.66/70) + (.05 + .5\times .4^2).5}{.4\sqrt{0.5}} = -0.16183$$

$$d_2 = d_1 - \sigma\sqrt{T} = -0.16183 - .4\sqrt{0.5} = -0.44467$$

The formula for a put is:

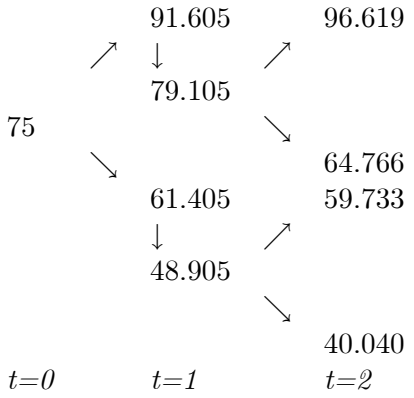
$$O_{p,0} = Xe^{-rT}N(-d_2) - S_0N(-d_1)$$

The areas under the normal curve for the values of $-d_1$ and $-d_2$ are NormalDist(0.16183) = 0.56428 and NormalDist(0.44467) = 0.67172. The option price is:

$$O_{p,0} = Xe^{-rT}N(-d_2) - S_0N(-d_1) = 70e^{-0.05\times0.5}0.67172 - 62.66\times0.56428 = 10.502$$

or €10.50.

The binomial model can also be used; 2 time steps of 3 months are logical choice. The up- and down factors then become: $u = e^{.4\times\sqrt{.25}} = 1.2214$ and $d = e^{-.4\times\sqrt{.25}} = 0.81873$. The interest rate factor is $e^{.05\times.25} = 1.0126$ so the equivalent martingale probability is $p = (1.0126 - 0.81873)/(1.2214 - 0.81873) = 0.481$ and $1 - p = 1 - 0.481 = 0.519$ This gives the following binomial tree:



Lattice 1 Value ZX co. stock

The option prices at maturity then are:
$\max[0, 70 - 96.619] = 0.0$
$\max[0, 70 - 64.766] = 5.234$
$\max[0, 70 - 59.733] = 10.267$
$\max[0, 70 - 40.040] = 29.96$
The t=1 prices are:
$\frac{0.481\times0+0.519\times5.234}{1.0126} = 2.683$ and $\frac{0.481\times10.267+0.519\times29.96}{1.0126} = 20.233$
so the value of the option today is:
$\frac{0.481\times2.683+0.519\times20.233}{1.0126} = 11.65$

b) The option delta of a put is: $\Delta_p = N(d_1) - 1$. Since $N(d_1)$ = NormalDist(−0.16183) = 0.43572, the delta of the put is $0.43572 - 1 = -0.56428$. So the bank needs to short sell 56 shares ZX co. to hedge its obligations from selling the options. The intuition is that a short put loses value if the price of the underlying share decreases. To hedge this, you need a position that increases in value if the share price decreases, i.e. short shares.
In the binomial model the option delta is $(2.683 - 20.233)/(79.105 - 48.905) = -0.581$

Problem 4 (weight 20%)

a) If the pecking order theory holds, then external funding is dominated by debt issues. If the borrowing possibilities are exhausted, the pecking order theory accommodates

some equity issues, but the equity component is still much less important then the debt issues. This is not supported in this study: the opposite is actually observed. The net equity issues are at a higher level than net debt issues. Hence, the pecking order theory is rejected.

b) The pecking order predicts that if external financing is needed, debt is at the top of the pecking order. The financing deficit reflects the need for external financing, so the positive coefficient of this variable in Table 2 is in line with predictions of the pecking order theory.

c) If capital structures were chosen according to the trade-off theory, the coefficient of profitability would be positive and the coefficient of the financing deficit would be insignificant. We see that the coefficient of profitability is negative and the coefficient of the financing deficit is significant. On the other hand, if capital structures were chosen according to the pecking order theory, then the coefficient of profitability would be negative, the coefficient of the financing deficit would be significantly positive and the variables representing the trade-off theory would be insignificant. The conclusion must be that both theories are supported by the results of this study. The same conclusion is reached on page 156 of the book, that discusses a similar study with the same results.