NTNU Trondheim
Norwegian University of Science and Technology

Faculty of Economics
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

17 December 2018
Time: 15.00 - 19.00

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

Problem 1 (weight 30%)

Gerritsen[1] analyses the profitability of buy and sell recommendations issued by technical analysts. He employs a dataset of 5017 stock and stock index recommendations related to the Dutch stock market, recorded in the period November 2003 to December 2010. He finds that the signs of these recommendations (i.e. buy or sell) are consistent with various technical trading rules (such as moving average crossovers and break-outs from support and resistance levels). To analyse the profitability of the recommendations he uses event study methodology, and he reports the following cumulative average abnormal returns (caar) in 5-day periods (weeks) around the publication date of the recommendation.

	Stock recommendations		Index recommendations	
Period	buy	sell	buy	sell
day -4 to 0	2.04%*	-2.59%*	0.78%*	-0.97%*
day 1 to 5	-0.01%	-0.11%	-0.32%*	0.15%
day 6 to 10	-0.13%	0.24%	-0.03%	0.27%
day 11 to 15	-0.04%	0.18%	-0.16%	0.18%
day 16 to 20	-0.10%	0.34%*	0.16%	0.27%

* means significantly different from 0

The cumulative average abnormal returns in the table are cumulative over the week mentioned in the row entry, but not over the whole period of 5 weeks. Gerritsen includes the event day in the pre-event window because it is not known at what time of the day the recommendation is published (before, during or after trading hours).

a) Which form of market efficiency is tested by Gerritsen and do any of his results in the table contradict the Efficient Market Hypothesis (EMH)? If so, explain which result(s) and why.

Problem 2 (weight 30%)

Aqua is a European aluminium smelter with a 100 years of industrial history. Its main value driver is access to cheap energy, guaranteed by a contract with its government. As a large, reputable company it has good relations with its bank and it can borrow cheaply

[1] Dirk F. Gerritsen, Are chartists artists? The determinants and profitability of recommendations based on technical analysis, International Review of Financial Analysis, Volume 47, October 2016, pp 179-196

against 7% interest. The book value of its outstanding debt is €150 million, while the book value of its equity is €175 million. Its growing supplies to the automotive industry made the company successful in the past and its 20 million outstanding shares have been increasing in price to the present level of €15. This gives the shares a return of 15%. However, the future looks less bright. The automotive industry is shrinking and the USA imposed an import levy on aluminium. Hence, Aqua wants to take up another energy intensive production with long term possibilities and it is considering starting fertilizer production. Setting up a fertilizer production line requires an investment of €50 million and it will generate a perpetual after tax cash flow of €5 million per year, starting one year after the investment. Aqua plans to finance the investment with a perpetual loan of a fixed amount of €37.5 million, and the bank is willing to supply such a loan against an interest rate of 8%. The rest will be financed with equity from retained earnings. Aqua collected the following financial information by carefully studying financial market data. Presently, there are two big fertilizer companies, TARA and BAFS, that are representative of the fertilizer industry. TARA is financed with 55% debt, which has a beta of 0.35. Its equity beta is 2. BAFS is a bit more conservatively financed, with 50% debt. Its debt has a beta of 0.1 and its equity beta is 1.5. Both companies have very long term loans, which can be considered fixed (predetermined) and perpetual. In financial markets, the risk free interest rate is 5%, the return of the market portfolio is 12% and the corporate tax rate is 40%. Personal taxes can be ignored.

a) Should Aqua take on fertilizer production or not? Show calculations to support your answer and make additional assumptions if necessary.

Problem 3 (weight 30%)

In a financial market, shares of ZX Co. are traded at a price of €55. ZX Co. is a rather volatile share, its annual volatility is 35%. European put options on the share are also traded. Puts with an exercise price of €50 trade at €0.43 and puts with an exercise price of €60 trade at €5.40. Both options have a time to maturity of a bit less than a month. The yearly risk free interest rate is 5%.

a) Calculate the price of at-the-money puts on shares of ZX Co. Use the Black and Scholes formula and a time to maturity of 0.08 years (corresponding to a bit less than a month).

An investor buys 2 of these at-the-money put options on shares ZX Co. At the same time she sells a put option with an exercise price of 50, and she also sells a put option with an exercise price of 60. All options are on the same share ZX Co. and have the same time to maturity of a bit less than a month.

b) What is the maximum profit this investor can obtain from this option position at maturity and at which share prices is the maximum obtained?

Problem 4 (weight 10%)

In a column in The Guardian of 17 July 2018, Mrs. C.S. Onwurah, a British member of parliament for the labour party, made the following complaint about the behaviour of a bank toward a manufacturer: "His [i.e. the manufacturer's] high-street bank was initially supportive when he requested a loan for new manufacturing equipment, which would significantly boost productivity. Once the bank realised that the equipment would not be something they could sell on should he go bankrupt, their interest drained away entirely."

a) Briefly explain the bank's behaviour using one of the capital structure theories.

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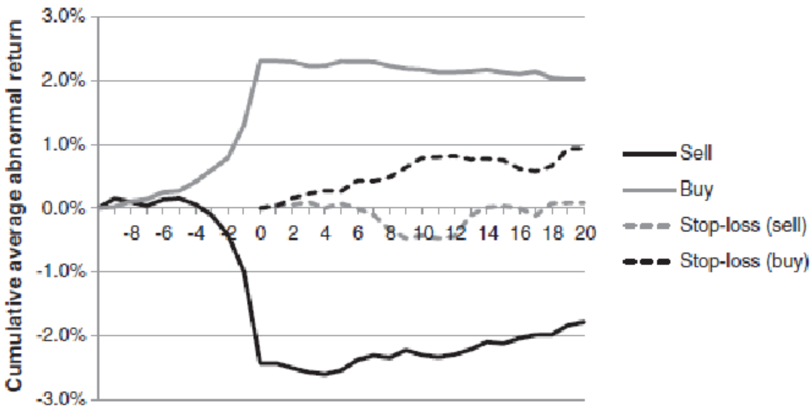
Problem 1 (weight 30%)

Gerritsen analyses the profitability of buy and sell recommendations issued by technical analysts (or chartists). Technical analysis primarily uses perceived patterns in plotted past prices to predict future prices, so tests of technical analyses are tests of weak form market efficiency. Occasionally, technical analysts use additional information, like surveys of investor sentiment. If such information is mentioned, it can be argued that the test concerns semi-strong market efficiency. Gerritsen's results do not contradict the EMH. The pre-event caar (including the event day) do not test market efficiency, so their significance does not reject the EMH. They show that technical analysts base their recommendations on recent developments in prices. As the author puts it: 'they indicate that technical analysts are primarily capable of predicting the past'. The post-event caar are small, mostly insignificant and the two that are significant have the wrong sign: positive after a sell recommendation and negative after a buy recommendation. So following the advice does not give positive excess returns, but rather the contrary. Hence, the recommendations do not contradict weak form market efficiency. The author provides the following graph to underline his conclusion (the stop-loss recommendations are not included in the question).



Notice that Gerritsen tests the profitability of buy and sell recommendations, and not the stock market reaction to the 'news' of a recommendation by technical analysts. The distinction is relevant, because underreaction to news can contradict market efficiency but underperforming investment strategies can not.

Problem 2 (weight 30%)

As always, the relevant data refer to the project and the industry it is in. The background data on aluminium smelting are irrelevant. The stock market data allow us to calculate the asset beta and, hence, the opportunity cost of capital in the fertilizer industry. For TARA, $\beta_e = 2$, $\beta_d = 0.35$ and $D/V = 0.55$. Since debt is predetermined and perpetual, we use the formulas corresponding to the Modigliani-Miller analyses:

$$\beta_a = \beta_d(1-\tau)\frac{D}{V-\tau D} + \beta_e \frac{E}{V-\tau D}$$

so for TARA

$$\beta_a = 0.35(1-.4)\frac{.55}{1-.4\times .55} + 2\frac{.45}{1-.4\times .55} = 1.3019$$

and for BAFS

$$\beta_a = 0.1(1-.4)\frac{.5}{1-.4\times .5} + 1.5\frac{.5}{1-.4\times .5} = 0.975$$

The average of these two is $(1.3019 + 0.975)/2 = 1.1385$. It is also possible to use the formula for β_e in reverse, e.g. for TARA:

$$\begin{aligned} \beta_e &= \beta_a + (1-\tau)(\beta_a - \beta_d)\frac{D}{E} \\ 2 &= \beta_a + (1-0.4)(\beta_a - 0.35)\frac{0.55}{0.45} \Rightarrow \beta_a = 1.3019 \end{aligned}$$

Using the CAPM we find the OCC to be:

$$r_a = 0.05 + 1.1385(0.12 - 0.05) = 0.1297$$

or 12.97%. It is also possible to to calculate r_a for TARA and BAFS and then take the average. More generally, the average of TARA and BAFS can be calculated at different points in the process. The cost of equity for the project can then be calculated as:

$$\begin{aligned} r_e &= r + (1-\tau)(r - r_d)\frac{D}{E} \\ r_e &= 0.1297 + (1-0.4)(0.1297 - 0.08)\frac{37.5}{12.5} = 0.21916 \end{aligned}$$

The WACC for the project then is

$$\begin{aligned} WACC &= r_e\frac{E}{V} + r_d(1-\tau)\frac{D}{V} \\ WACC &= 0.219\frac{12.5}{50} + 0.08(1-0.4)\frac{37.5}{50} = 0.091 \end{aligned}$$

We can also use the Modigliani-Miller formula to directly calculate the WACC:

$$\begin{aligned} r_a\left(1 - \tau\frac{D}{V}\right) &= r' \\ 0.1297\left(1 - 0.4\frac{37.5}{50}\right) &= 0.091 \end{aligned}$$

This WACC gives the cash flow a present value of $5/0.091 = 54.945$ and the project a NPV of $54.945 - 50 = 4.945 > 0$ so the project should be accepted.

APV can also be used. The base case PV is $5/0.1297 = 38.551$. The PV of the tax savings are τD or $0.4 \times 37.5 = 15$, so the APV is $38.551 + 15 = 53.551$, which leads to the same conclusion: the project should be accepted.

Problem 3 (weight 30%)

a) We use the Black and Scholes formula to calculate the value of at-the-money puts. Its five determinants are:
$S_0 = 55$, $X = 55$, $r = 0.05$, $\sigma = 0.35$ and $T = 0.08$

$$\begin{aligned} d_1 &= \frac{\ln(S_0/X) + (r + \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}} \\ &= \frac{\ln(55/55) + (0.05 + 0.5 \times 0.35^2)0.08}{0.35\sqrt{0.08}} = 0.0899 \end{aligned}$$

and

$$d_2 = d_1 - \sigma\sqrt{T} = 0.0899 - 0.35\sqrt{0.08} = -0.0091$$

NormalDist$(-0.0899) = 0.46418$ and
NormalDist$(0.0091) = 0.50363$ so that the put value is:

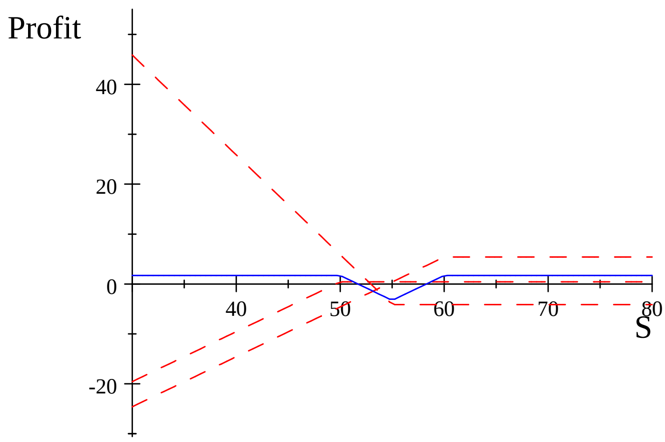
$$\begin{aligned} O_{p,0} &= Xe^{-rT}N(-d_2) - S_0N(-d_1) \\ O_{p,0} &= 55 \times e^{-0.05\times0.08} \times 0.50363 - 55 \times 0.46418 = 2.06 \end{aligned}$$

So the put price is €2.06.

b) The position described in the question is known as a short butterfly and it is a bet on large price movements. To calculate the profit at maturity we start by calculating the sum of the option premiums: $0.43 - (2 \times 2.06) + 5.40 =$€1.71. Its future value is $1.71 \times e^{0.08\times0.05} = 1.7169$ or €1.72. It may help to calculate the profit from the position for different stock prices at maturity, as is done in the table.

S_T	1 short $X = 50$	2 long $X = 55$	1 short $X = 60$	Option premiums	Total
45	−5	20	−15	1.72	1.72
50	0	10	−10	1.72	1.72
52.5	0	5	−7.5	1.72	−0.78
55	0	0	−5	1.72	−3.28
57.5	0	0	−2.5	1.72	−0.78
60	0	0	0	1.72	1.72
65	0	0	0	1.72	1.72

Alternatively, we can plot the profits of the different options (dashed lines) and the combined position (solid line) against the stock price at maturity:



Profit at maturity of a short butterfly

We see that the maximum profit is €1.72 and it is obtained when, at maturity, the stock price is €50 and lower or €60 and higher.

Problem 4 (weight 10%)

Mrs. Unwurah unwittingly gives a perfect illustration of one of the implications of the trade-off theory. General purpose assets can easily be redeployed by other companies and lose little value in a bankruptcy. In terms of the trade-off theory, they have low bankruptcy costs and such assets can carry much debt. By contrast, firm-specific assets have limited or no value to other firms. Such assets have high bankruptcy costs and can carry little debt. This accurately describes the behaviour of the bank.