ES52064 Financial markets

Indicative answers to seminar problems

The problems provided as part of this module are designed to apply the theories learned to practical and realistic scenarios, allowing students to apply their knowledge and practice their ability to explain real-world events using economic theories in plain English. Seminars are dedicated to discussing these problems, but we are not able to discuss all problems due to time constraints. Having additional problems allows students to practice their knowledge in preparation of the assessment; they can compare their solutions with the indicative answers provided and for any additional clarifications attend the office hours.

The below table gives an indication about the problems to be discussed in class for each topic. At times it will be not be possible to discuss each problem and at other times it might be possible to discuss an additional problem if time permits. It is expected that students are prepared to discuss all problems in each seminar.

	Seminar problems
Topic 1	1, 4
Topic 2	5, 7
Topic 3	10, 11
Topic 4	14, 16
Topic 5	17, 20
Topic 6	21, 24
Topic 7	25, 27
Topic 8	29, 30
Topic 9	34, 35
Topic 10	38, 40

The difficulty of problems will vary, as the difficulty of questions in the exam will vary, to allow for an assessment of the degree to which the learning outcomes have been met and the final mark to reflect the standards achieved. The questions discussed in the seminar will therefore be a mix of more easy and more difficult questions. Furthermore, some problems will require the application of more than one model for a complete answer, but these are not necessarily more difficult than problems requiring the use of only a single model.

Topic 1

Problem 1

Tillmann Uhrmacher did sell his shares in Avancia plc a few days ago and has now noticed that the price has increased by nearly 15% since his sale. Looking at the reason for the increase in the price he discovers that it was due to information being made public by the company on agreeing a joint venture with a company in Malendia, a market they had sought to enter for a long time and which is projected to increase their profits significantly. Malendia is a large country with a young and increasingly wealthy population, but its financial system is significantly underdeveloped and has no established stock market or tradition of investments into stock markets. Tillmann Uhrmacher is surprised that the announcement caught even the most knowledgeable traders by surprise as press comments showed. Upon investigating the case further, he finds that a day prior to him selling his shares, a brief note was published in the print edition of a local newspaper at the location of the new joint venture, mentioning the arrival of a delegation from Avancia plc for negotiations with a local company.

Why was this information not picked up by traders at the time?

Indicative answer: *The information was available publicly, but it was in a location and format that make it difficult for traders to pick up such information. With Malendia having no stock market nor a tradition of stock investments, trying to gather relevant information from local newspapers is unlikely to beneficial. Inhabitants in the area who would have picked up the information, would not have used it as they do not invest into the stock market. Thus from the perspective of traders outside Malendia, the costs of collecting this information would be very high as the newspapers might be difficult to obtain and are unlikely to yield and meaningful information. Local people would not trader and hence despite them having information, this information would not be acted upon, avoiding the stock to reflect this information.*

Problem 2

Lech Szobomir is occasionally investing small amounts of his savings into local stocks, unlike his friend Mariusz Zawenski who has become a part-time trader. Lech Szobomir

has not much experience and his knowledge about the stock market is very limited; he struggles to interpret financial information as this is not his professional background. Whenever he decides to invest into the stock market, he follows some tips from his friend Mariusz Zawenski. In some of their discussions, Mariusz Zawenski tells his friend repeatedly that he should follow the financial press more and then he could make more profits and improve on his salary. Lech Szobomir replies that there is no point in doing so as he just does not understand it. Unlike Mariusz Zawenski, he only has a small amount to invest and his friend's knowledge is far superior to his own.

Is it rational for Lech Szobomir to not seek additional information about stocks, while for Mariusz Zawenski it is?

Indicative answer: *There are a two main differences between the two friends. Firstly, Mariusz Zawenski invests significantly larger amounts into the stock market; secondly, Mariusz Zawenski knows well how to interpret the information he obtains, while his friend does not. The costs of following the financial press, in terms of subscriptions costs as well as the time required will be too high to benefit him. The small amounts he can invest will limit the profits he can make from investing, and his lack of knowledge will not reduce the risks he faces from investing significantly, also limiting the benefits. As the condition for a trader to become informed was* $C \leq \frac{(V^*-P)^2\sigma_S^2}{2z\sigma_\varepsilon^2\sigma_V^2}$*, he faces a small amount* $V^* - P$ *and a high value of* σ_ε^2*, the noise in the information. This parameter constellation makes obtaining information not profitable. In contrast to that, Mariusz Zawenski will have a higher value of* $V^* - P$ *as he invests more and his knowledge will reduce* σ_ε^2*, fulfilling this condition. Hence their respective decisions may well be rational.*

Problem 3

Grammatica Bank manages the wealth that a friend inherited three years ago from a relative as he has no knowledge of investment strategies. Every quarter the bank provides him with a report in which they outline the investments they have made, on what basis they made their decisions, and how the investments performed. In their most recent report, they claim that their investment strategy has yielded him a return of 2.7% p.a. above the market return and 3.4% p.a. above the benchmark return, which is adjusted for the risk the bank has taken for these investments; the volatility of the investments was 24% p.a. The report also contains general information on the market itself, which yielded a return of 2.9% and a volatility of 8% in the last quarter, compared to yields on government bonds of 1.4% p.a.

a. Looking at these figures you immediately claim that the bank underperformed by 2.4% p.a. How did you obtain this result?

b. How do you explain the difference in the bank claiming a return of 3.4% above the benchmark, while your assessment shows the bank underperforms by 2.4%?

Indicative answer:

a. *Given the information provided, we need to look at the net selectivity of the bank.*
Annualize all variables: The variables are given in a mix of quarterly and annual formats, we first annualise all data.
Market return: $\mu_M = 0.029 \times 4 = 0.116$
Market volatility: $\sigma_M = 0.08\sqrt{4} = 0.16$
Variables given annually: Risk-free rate: $r = 0.014$
investment volatility: $\sigma_i = 0.24$
excess return over market: $\mu_i - mu_M = 0.027 \Rightarrow$ *Investment return:* $\mu_i = 0.027 + 0.116 = 0.143$
excess return over benchmark: $\mu_i - \widehat{\mu}_i = 0.034$
Determining the risk of the investment: $\widehat{\mu}_i = r + \beta_i (\mu_M - r) = 0.014 + \beta_i (0.116 - 0.014) = 0.014 + 0.102\beta_i$
Inserting this into the excess return over benchmark, we have $0.143 - 0.014 - 0.102\beta_i = 0.034 \Rightarrow \beta_i = \frac{0.095}{0.102} = 0.9314$
Equivalent systematic risk for idiosyncratic risk: $\beta_i^* = \frac{\sigma_i}{\sigma_M} = \frac{0.24}{0.16} = 1.5$
Benchmark adjusted for full risk: $\mu_i^* = r + \beta_i^* (\mu_M - r) = 0.014 + 1.5 (0.116 - 0.014) = 0.167$
Conclusions: The benchmark return is 16.7%, but the investment return is 14.3%, giving the claimed underperformance.

b. *The banks claims that it outperforms the benchmark by 3.4% as they take only into account the systematic risk. However, the banks has taken on significant idiosyncratic risk as the* $\beta_i^* = 1.5$ *shows; taking this additional risk into account in the same way systematic risk is taken into account yields the underperformance of the investment.*

Problem 4

An investment has yielded a return of 17% and the volatility has been 32%, compared to a return of a broad market index of 13%, which had a volatility of 22%. Your investment had a correlation with this market index of 0.85 and you could have invested into government bonds yielding 3%.

a. Evaluate your performance relative to the market using two risk measures, one taking into account all risks and the other taking into account systematic risk only.

b. Explain the differences (if any) between the results of the two performance measures.

c. Which performance measure would you choose?

Indicative answer:

a. *We use the Sharpe ratio and Jensen's* α
Variables known: Risk-free rate $r = 0.03$, *investment return* $\mu_i = 0.17$, *investment risk* $\sigma_i = 0.32$, *market return* $\mu_M = 0.13$, *market risk* $\sigma_M = 0.22$, *correlation with market* $\rho = 0.85$
Sharpe ratio: Investment: $SR_i = \frac{\mu_i - r}{\sigma_i} = \frac{0.17-0.03}{0.32} = 0.4375$
Market: $SR_M = \frac{\mu_M - r}{\sigma_M} = \frac{0.13-0.03}{0.22} = 0.4545$
$\Rightarrow$ *The market has a higher Sharpe ratio and performs better than the investment*
Jensen's α*: We first need to obtain the* β_i *of the investment as this is not given:*
$\beta_i = \frac{\sigma_{iM}}{\sigma_M^2} = \frac{\sigma_i \sigma_M \rho}{\sigma_M^2} = \frac{\sigma_i \rho}{\sigma_M} = \frac{0.32 \times 0.85}{0.22} = 1.2364$
Then we get the CAPM return as $\widehat{\mu}_i = r + \beta_i (\mu_M - r) = 0.03 + 1.2365 (0.13 - 0.03) = 0.1537$
Jensen'a alpha: $\alpha_i = \mu_i - \widehat{\mu}_i = 0.17 - 0.1537 = 0.0163$
$\Rightarrow$ *As the Jensen's* α *of the market is zero, the investment outperforms the market*

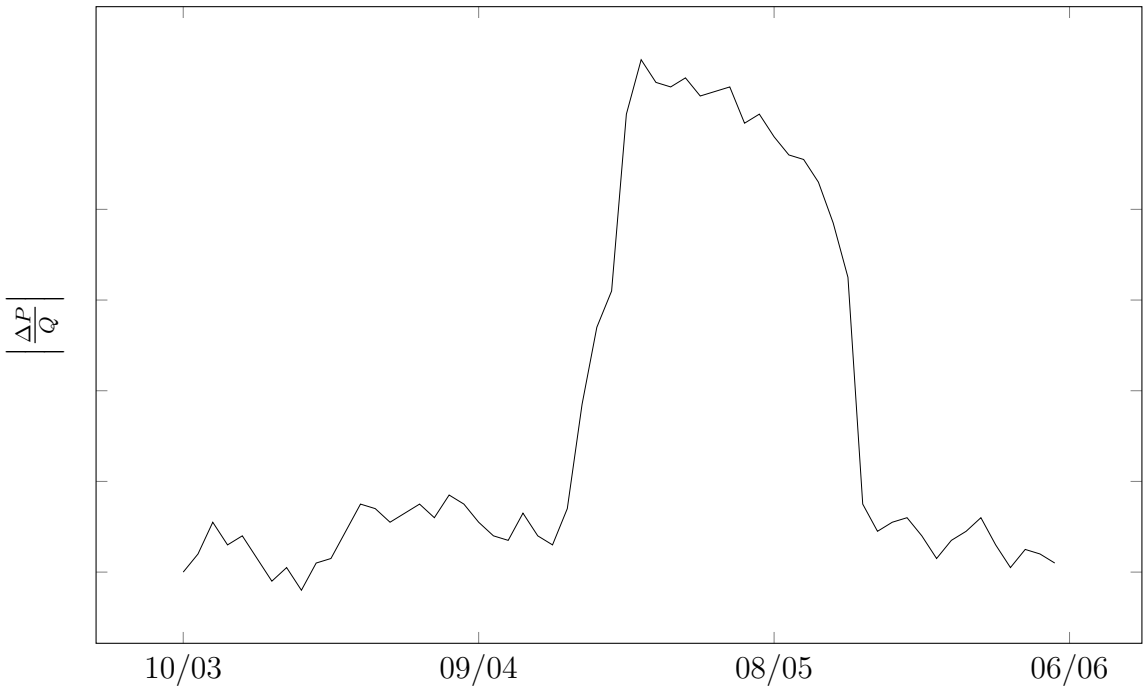
b. *The reason for the different results, the Sharpe ratio implying that the investment underperformed, while Jensen's* α *implies that the investment outperforms the market, is the different risks that are used. The investment has significantly more total risk than the market as evidenced from the volatility of 32%, compared to 22% for the market; the systematic risk as measured by the* β_i *is only slightly higher at 1.2364, compared to the market of 1. The difference therefore arises from the fact that the investment has taken on significant idiosyncratic risk, which is not taken into account by Jensen's* α*, but the Sharpe ratio will consider this unsystematic risk.*

c. *Which performance measure is preferable will depend on the appropriate risk measure. If the investment is part of a wider investment that is well diversified, unsystematic risk will be eliminated when seen in combination with other investments and can therefore be ignored, favouring Jensen's* α*. If the there are no further investments and the investors are concerned about the total risks they are exposed to, then the Sharpe ration would be preferable.*

Topic 2

Problem 5

The below graphic shows the absolute value of the ratio of the price change of a stock, ΔP, and the trade size, Q, for each trading day during a 60 day time period.



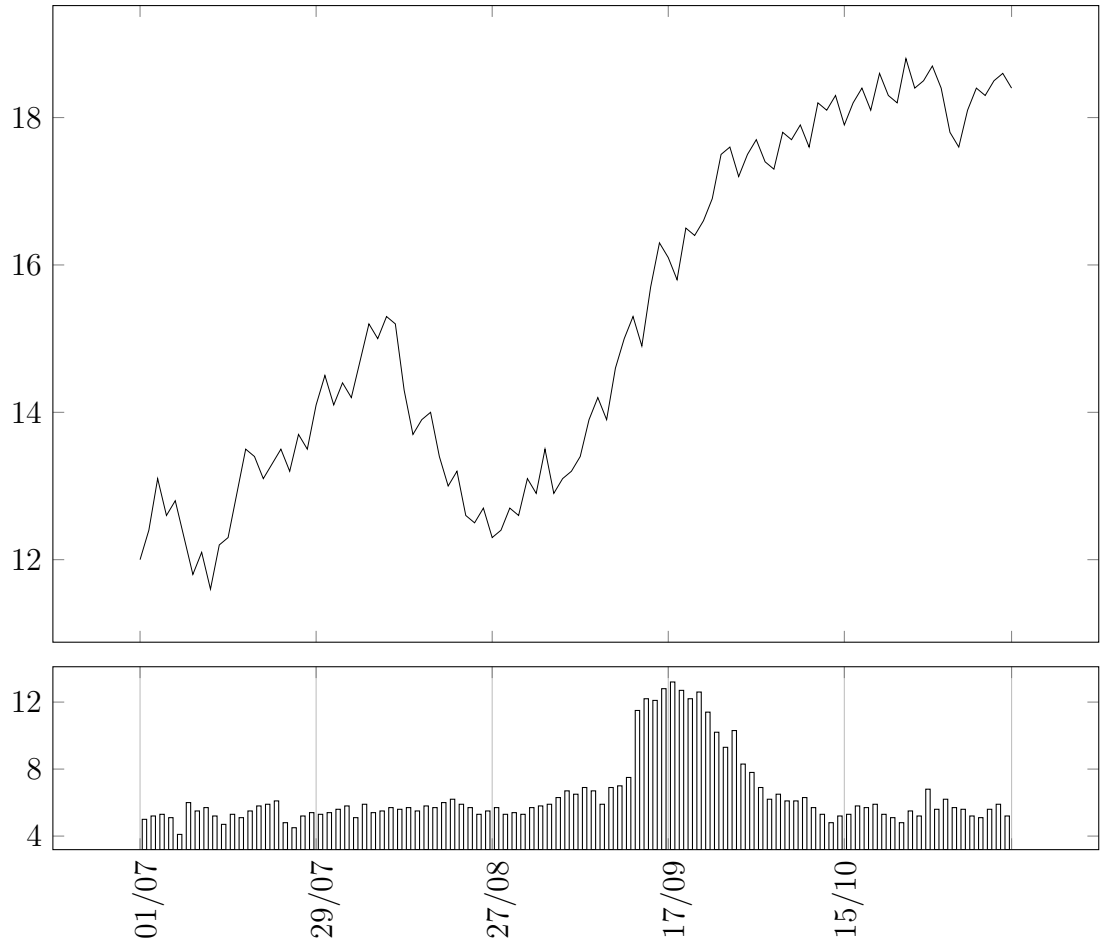
How can you explain this graph?

Indicative answer: *The ratio* $\left|\frac{\Delta P}{Q}\right|$ *can be interpreted as the inverse of the liquidity of a stock. Hence in mid-April the liquidity suddenly drops and then slowly improves until in mid-May it reverts to its original value. This development suggests that in mid-April information was available to some traders, who then used their informational advantage and other traders seeking to learn from their trading behaviour adjusted the price, causing the stock price to move more for a given trade size than before. As this information was slowly incorporated into the price, the degree of asymmetric information reduced and consequently the liquidity improved. There would have been less trading by informed traders due to the lower informational advantage and trades would be more likely to be from noise traders, making the adjustment of prices smaller. The sudden increase in liquidity in mid-May can be attributed to the public*

revelation of the information, which eliminates the informational advantage informed traders have and the liquidity would fall back to normal levels.

Problem 6

You are given the following chart of a stock, where the top panel shows the daily closing stock price and the bottom panel the daily trading volume (in million shares) over 100 trading days.



What information can you extract from this graph? Focus in particular on the rise and fall of the stock price in July/August and then the increase during September and explain any differences you might observe.

Indicative answer: *Combining the information from stock price movements and the trading volume, we observe that the rise in the stock price during July and its*

subsequent fall were accompanied by average trading volume; this suggests that the increase in the stock price was not accompanied by much information being present in the market. Subsequently the stock price back to its original value, given there was no information backing up the rise in the stock price. The rise of the stock price in September was accompanied by significantly higher than usual trading volume, suggesting that this rise was information driven. The fact that the price subsequently remained at that level supports this view. In addition, we see that the trading volume initially did not increase as the price increased, suggesting that the information was initially either not widespread or very uncertain; only during the latter half of the rise in the stock price did the information become more widespread or more precise. The trading volume then tapers off slowly, suggesting that the informational advantage of informed traders has reduced as the information spread more and more widely.

Problem 7

The Ammaya Stock exchange investigates its trading rules with the aim of improving the quality of the market for all investors and attracting new investors. As part of its investigation it hears of retail investors complaining that the market often moves considerably when they submit even modest orders, making buying and selling stocks unnecessarily expensive; furthermore the prices seem to be not very informative, it looks like that very few informed traders are present in the market who ensure that stock prices reflect the current market consensus. As a possible barrier to a better market quality the stock exchange identifies its arcane rule that traders may only submit 5 orders for shares during each trading day. It suggests to abolish this rule and expects the market quality to improve.

Would this measure of allowing traders to submit as many orders as they like improve the market quality?

Indicative answer: *Allowing more frequent trades would enable informed traders to better make us of their informational advantage by tradi9ng more often on their information. This has the consequence that prices adjust more quickly to any information they might have as the more frequent trading more clearly reveals the information through repeated trade imbalances in the same direction, which are less likely to occur than one large imbalance. This, however, comes at the price of reduced market liquidity as information becomes available. The larger price adjustments will lead to a lower liquidity of the market and therefore retail investors will see themselves confronted with prices moving even more when submitting their orders. It is only once a sizeable part of the information has been included into the price that the liquidity of the market will improve with more trades as the result of lower asymmetric information between traders. It is therefore that more frequent trading opportunities will improve market*

efficiency, but will reduce market liquidity after information has become available, before market efficiency will improve after a while. The change of the rules will have positive and negative effects and the stock exchange needs to balance the more efficient market and long-term improvement in liquidity against the short-term deterioration of liquidity.

Problem 8

Enzio Frabrici observes that the trading volume of a stock he follows closely has increased significantly in recent days. In discussion with his colleague Natalya Klimatova he claims that this will be due to a large number of traders having obtained some sort of information that he has not been able to uncover. Natalya Klimatova doubts that this is the case as she knows that both of them would have heard about this information as they are quite well connected. Instead, she suggests, it probably will be that a small group of traders has obtained some very specific piece of information that has eluded them and most other traders.

Who is right in their assessment of the cause of the higher trading volume?

Indicative answer: *Only using trading volume it is impossible to distinguish the two cases that have been put forward. A higher trading volume is typically associated with a more information being available in the market. This additional information content can be in the quantity of information, that is the number of informed traders, or in terms of the quality of the information, its precision. Without additional information it is not possible to separate these two causes, or any combination of them.*

Topic 3

Problem 9

In recent months, the bond market of Ulanda has seen significant volatility, which was uncharacteristic for this usually very calm market. The volatility was fuelled by expectations of interest rate rises by the central bank, which then did not materialise during a number of meetings of its monetary policy committee, including some emergency meetings due to the volatility of the bond market. A public debate has begun about this episode of high volatility and how to prevent a reoccurrence in the future. A leading commentator on economic affairs of the popular newspaper Ulanda Star, Christian Mbewe, blames 'out-of-control speculators' for the instability of the bond market and suggests that such speculation should be banned to protect genuine investors.

Would such a ban on speculation, however enforced, be beneficial?

Indicative answer: *We can reasonably assume that the speculation was de-stabilising as the volatility of the bond markets was much higher than it usually is. Such destabilising speculation is overall welfare reducing, however, investors nevertheless benefit. It will be speculators who make losses by selling too low and buying too high and these losses are exceeding the benefits investors obtain. Investors can benefit by trading with speculators and they would sell at high prices and buy at low prices, giving them profits. Hence, banning destabilising speculation would increase overall welfare, but would nevertheless reduce the benefits to investors. In addition it needs to be considered that stabilising speculation is welfare enhancing and investors also benefit. A ban on speculation would eliminate these welfare gains. How the overall welfare gains are affected by a ban on speculation would depend on the frequency in which stabilising and destabilising speculation occurs, but in all cases investors would be worse off. Therefore if the sole aim is to improve the welfare of investors, a ban on speculation would be counterproductive.*

Problem 10

Jongil Kim has come across a local newspaper report that suggests Steinman plc will soon announce a major breakthrough in the development of a new drug. This information seems not to have been shared widely in the market and the market is overall neutral about the prospects of the company, although some traders have started a selling off of the shares due to the delay in announcing any major developments from their research department. To the surprise of his colleagues, Jongil Kim does not start buying shares in Steinmann plc, but instead joins the selling off of shares with other investors. He is called irrational for selling rather than buying shares.

Is there a rational explanation for his behaviour?

Indicative answer: *Jongil Kim is clearly ignoring his own information by selling shares when the information suggests he should be buying. Such a behaviour can be rational as other traders are herding to sell shares and him being the only, or one of a small number of informed traders, will unlikely turn the market around with his limited demand. Theredore the price will continue to fall and he would be able to make profits by selling shares rather than buying them. Once the stock price has reached its bottom, he could start purchasing shares at an even lower price and increase his profits. It therefore is rational to ignore his information and join the herding behaviour of other traders.*

Problem 11

The market in a number of smaller stocks at the Pollinta Stock Exchange has been characterised as a casino by many experienced market observers. It seems that in many of the small stocks that are listed, traders catch on to spurious bandwagons which seem to have no relation to the value of the stocks, only to abandon this bandwagon and jump on another one, often reversing past price trends. The rationale given for the bandwagons are dismissed by most market professionals as being without merit, but they seem not to be able to break any such trends. As a consequence of the behaviour of quite a large fraction of traders in these stocks, the stock prices have seen large swings from time of high valuations to time of low valuation, and back again, without any relationship to their fundamental values.

a. How do you explain the characteristics of the market in these stocks and why do traders participate?

b. Would measures to curb the influence of these traders be beneficial?

Indicative answer:

a. *The market is characterised by herding. Investors will coordinate their trad8ing decisions by following irrelevant information, the bandwagon without merit, and thereby induce a price trend from which they can benefit as long as they can close their position before the trend reverses. For example if buying in a rising market a trader would benefit from the price rise by being able to sell at a higher price later on; or the market trend is falling, traders can sell the stock and repurchase it later at a lower price, in both cases making a profit. Those traders that are still engaged in the market as its trend reverses will make losses, however, which can be substantial. The fact that quite a large fraction of traders engages in such behaviour implies that informed traders are not able to conduct large enough trades to counter these spurious trends.*

b. *Herding in this style can be seen a destabilising speculation as it induces excess volatility. While it is not informed speculation as originally intended, the motivations for speculators are irrelevant for the assessment of its consequences. Overall the welfare from such destabilising speculation reduces, but it will be overall the speculators themselves who suffer losses, while investors, or here informed market professionals, could benefit by taking opposite positions. Curbing such trading behaviour would therefore increase overall welfare, but the professional investors would lose.*

Problem 12

You compare the properties of markets in small and not well known stocks with that of larger and widely held stocks. One observation you make is that smaller stocks are much more subject to large price swings than larger stocks. In larger stocks, price trends are much less common and frequently reversed after brief periods of time, while for small stocks these price trends can last for a considerable time and are much more frequently observed. You also observe that information on small stocks is made public much less frequently than for larger stocks, which benefit from more disclosures by the companies themselves but also information provided by the financial press. Finally, large stocks seem to attract a higher proportion of professional investors following these stocks' information closely.

How can you explain that small stocks are more frequently seeing price trends and that these price trends are lasting longer than for large stocks?

Indicative answer: *Smaller stocks are more often subject to herding than larger stocks. This will be because there are typically less informed traders than in larger stocks, simply due to the size of possible investments that can be made; furthermore*

smaller stocks have less information disclosure, so it will take longer until new information is becoming public knowledge. It is in the mean time that the large number of uninformed traders can override the demand of informed traders and induce the price trend by following some arbitrary signal as a coordination device; in larger stocks the larger fraction of informed traders makes this more difficult to achieve. Secondly, price trends in smaller stocks can be sustained for longer as it will only be broken by information becoming public, which happens less frequently than with larger stocks. This has also the consequence of making herding more profitable as the likelihood of price trends being broken and herding traders making a loss is much reduced. This then makes the emergence of price trends more likely.

Topic 4

Problem 13

As a long-time stock market investor you are well used to stock markets exhibiting bubbles from time to time, have become adapt at recognising them, and take measures to not suffer losses from the bubble bursting unexpectedly. You have recently expanded your investments to stocks listed overseas and have gained a good understanding of these markets. As your investment strategies often involve taking loans to make additional investments to exploit any market inefficiencies you have discovered, you are sensitive also to the interest charged on your loans. As the interest rates in your overseas market is lower than in your home market you have started taking out loans overseas, denominated in a foreign currency. Even though you belief that your currency is currently slight undervalued, you calculate that even a correction of this undervaluation will not wipe out the lower interest you are charged. To your surprise you observe over the coming weeks and months that the undervaluation of your currency increases ever more, making the repayment of your loan more and more expensive. A friend who is more familiar with the foreign exchange market explain to you that it is just a bubble and will correct itself sometime soon. You are confused how a bubble like this can be sustained; all bubbles you have experienced in stock markets had led to an overvaluation of the stocks, never an undervaluation, while here your currency is undervalued.

How can you explain that an undervaluation of the currency can be a bubble?

Indicative answer: *Given the limited liability of stocks, negative stock prices are not possible, and as bubbles are grown ever further unless they burst, they cannot grow beyond the fundamental value for negative bubbles in stock markets. As there is a fixed time when this bubble bursts, backwards induction causes the bubble to burst in the previous time period, which then induces a burst of the bubble in the time period before that, and so on, implying that negative bubbles cannot emerge in stock markets. In exchange markets there is not limit on the exchange rate. Seen from the perspective of the foreign country, it is a positive bubble of their exchange rate and this knows potentially no bounds and can grown to any level before it bursts. Hence in exchange rates we can see positive or negative bubbles, like in the case here.*

Problem 14

The Financial Regulatory Agency (FRA) is, amongst other duties, responsible for the orderly functioning of the stock exchange. The stock market has recently seen a large influx of investments that has seen prices increase and while the prospects of companies are looking well, many investors start to become nervous about the high valuation stocks currently have. Many investors have started to consider the risks of stock prices falling back and the number of put options contracts agreed in the market has increased significantly. The FRA suggests to limit the sale of put options as a measure to stabilise the market.

What is the rationale behind the suggestion of the FRA?

Indicative answer: *With investors purchasing put options, the sellers of these put options, often banks and large institutional investors, will hedge their exposure by replicating the payoff profile of put options; this will lead to a negative demand, which can cause a non-monotonous demand function ('backward sloping') if such demand is sufficiently high. The FRA might well think that the demand is so high that this situation might soon emerge. If the hedging demand is that high, it can lead to a stock market crash due to the non-monotonous demand function and the equilibrium price jumping downward suddenly to its new equilibrium. This can happen with the advent of even slight negative news and requires that the strike prices for the put options are similar. The latter is likely the case as investors started to purchase put options at the same time and will most likely choose a strike price near the then stock price. By limiting the same of put options, seeks to avoid the a non-monotonous demand curve to emerge as the hedging demand is will be lower. If the demand is below a threshold no stock market crash occurs, aiding the stability of the stock market.*

Problem 15

The price of Atalanta plc has recently seen a significant increase without any new information becoming available or meaningful rumours being spread. More and more new traders have been investing into Atalanta plc and as the price was rising, many seasoned investors have warned that the stock is significantly overpriced, but to no avail. In light of the warnings, however, more and more traders become concerned about the rise in the price and fear they are investing into a bubble that may burst anytime. For this reason, many traders hedge their position and seek to avoid losses from a sudden drop in the stock price.

Can a sudden drop in the stock price of Atalanta plc be prevented by hedging?

Indicative answer: *Firstly, the developments in the stock price by Atalanta plc has all the signs of herding being its main cause. Inexperienced new traders are entering market and causing the stock price to rise, which suggests herding as there is not information suggesting that the value of Atalanta plc has increased. The increasing price rises suggest that the stock has entered a bubble. Such bubbles can burst without any apparent reason and the lack of increasing demand by inexperienced traders can lead to such a situation. Traders seem to be aware of this risk and seek to hedge their investments, but this will induce non-monotonous demand curves if the hedging demand is large enough. This situation can then lead to a crash of the stock price if any negative news arrives in the market. Thus the hedging of their position adds another source of a sudden drop of the stock price; it can either be the result of the herding stopping, causing the bubble to burst, or new information could cause a change of equilibrium causing a stock crash.*

Problem 16

Stock prices have been rising steadily over months with more and more traders buying stocks, while existing traders cash in their profits by selling up. The recent traders are aware that the stock price has been increasing recently and many traders have hedged their positions at the level they entered the market. Hedging demand has therefore increased significantly in the last months.

Does the high hedging demand increase the likelihood of a stock market crash?

Indicative answer: *In order for a stock market crash to be induced by high hedging demand, the hedging demand must have similar strike prices. Here traders have hedged their positions based on the price at which they entered the market and as the price has been steadily increasing over time with new traders entering, the strike price will be spread out over a wider range. This make it unlikely that the hedging demand will induce a non-monotonous demand curve and hence a stock market crash seems unlikely for this reason.*

Topic 5

Problem 17

You are holding a portfolio worth £100,000 consisting two stocks, Arifa and Belusa, with weights of $\frac{2}{3}$ and $\frac{1}{3}$, respectively. Arifa stocks have shown an annual return of 10% and an annual volatility of 25%, while Belusa has an annual return of 14% and an annual volatility of 35%; their correlation you found to be 0.74. You seek to avoid losses exceeding £10,000 over any 10-day time period, but are willing to accept larger losses in 1% of cases.

a. How would you have to change your portfolio to achieve this aim?

b. Is the change you seek in part a. realistically achievable?

Indicative answer:

a. *The information on the expected returns are not needed.*
Relevant information: $\sigma_1 = 0.25$, $\sigma_2 = 0.35$, $\rho = 0.74$, $V = 100,000$, $\omega_1 = \frac{2}{3}$, $\omega_2 = \frac{1}{3}$, $\alpha = 2.33$ *as we need to determine the 99% Value-at-Risk*
Current Value-at-Risk: $\sigma_P = \omega_1^2 + \sigma_1^2 + \omega_2 + \sigma_2^2 + 2\omega_1\omega_2\sigma_1\sigma_2\rho = \left(\frac{2}{3}\right)^2 0.25^2 + \left(\frac{1}{3}\right)^2 0.35^2 + 2\frac{2}{3}\frac{1}{3}0.25 \times 0.35 \times 0.74 = 0.0702$, *giving a standard deviation* $\sigma_P = 0.2650$
Variances are expressed annually, but we require them for 10 days, hence we adjust them using $\Delta T = \frac{10}{250}$, *where the denominator accounts for the trading days per year, where common numbers to use are 250, 252, 255, or 260, depending on the market considered.* $VaR = \alpha\sigma_P\sqrt{\Delta T}V = 2.33 \times 0.2650 \times \frac{1}{5} \times 100,000 = 12,349$
Covariances with the portfolio: For the covariance of an asset with the portfolio we use for two assets: $\sigma_{1P} = Cov(R_1, R_P) = Cov(R_1, \omega_1 R_1 + \omega_2 R_2) = \omega_1 Cov(R_1, R_1) + \omega_2 Cov(R_1, R_2) = \omega_1\sigma_1^2 + \omega_2\sigma_1\sigma_2\rho$
$\sigma_{2P} = Cov(R_2, R_P) = Cov(R_2, \omega_1 R_1 + \omega_2 R_2) = \omega_2 Cov(R_2, R_2) + \omega_1 Cov(R_1, R_2) = \omega_2\sigma_2^2 + \omega_1\sigma_1\sigma_2\rho$
$\sigma_{1P} = \frac{2}{3}0.25^2 + \frac{1}{3}0.25 \times 0.35 \times 0.74 = 0.0633$
$\sigma_{2P} = \frac{1}{3}0.35^2 + \frac{1}{3}0.25 \times 0.35 \times 0.74 = 0.0840$
$\beta_1 = \frac{\sigma_{1P}}{\sigma_P^2} = \frac{0.0633}{0.0702} = 0.9010$
$\beta_2 = \frac{\sigma_{2P}}{\sigma_P^2} = \frac{0.0840}{0.0702} = 1.1966$
Determination of the weight changes:
$\Delta VaR = (\Delta\omega_1\beta_1 + \Delta\omega_2\beta_2)\, VaR = \Delta\omega_1 (\beta_1 - \beta_2)\, VaR$, *where we used that*

$\Delta\omega_1 + \Delta\omega_2 = 0$
$-2,349 = \Delta\omega_1 (0.9010 - 1.1966) 12,349 \Rightarrow \Delta\omega_1 = 0.6435$
New weights: $\omega_1 = \frac{2}{3} + 0.6435 = 1.3102$, $\omega_2 = \frac{1}{3} - 0.6435 = -0.3102$

b. The adjustment in the portfolio would involve a large negative weight for Belusa, which can be interpreted as a short position. Such a large short position of nearly a third of the overall portfolio is generally not achievable. We can therefore conclude that the new portfolio cannot be realistically achieved.

Problem 18

For the investments into Arifa and Belusa in problem 17, you want to ensure that the value of your investment never falls by more than 5% below its current value. In addition to the investment into the portfolio, you have the ability to invest into a government bond yielding 4% p.a.

Using Constant Proportion Portfolio Insurance, how much of your initial wealth of £100,000 would you invest into the risky portfolio and the government bond, respectively?

Indicative answer: *We can use the results from the solution to problem 17. The maximal reasonable loss on the portfolio can be identified by the Value-at-Risk* $VaR = 12,349$ *on an investment of* $V_0 = 100,000$*, giving* $\gamma = \frac{12,349}{100,000} = 0.1235$*. From this follow that the multiplier is given by* $m = \frac{1}{\gamma} - \frac{1}{0.1235} = 8.097$.
Variables given in problem: Insurance threshold $\alpha = 0.95$*, risk-free rate* $r = 0.04$*, time length* $T - t = \frac{10}{250}$
Initial cushion: $C_0 = V_0 \left(1 - \alpha e^{-r(T-t)}\right) = 100,000 \left(1 - 0.95 e^{-0.04 \frac{10}{250}}\right) = 5,151.88$
Initial investment into risky portfolio: $mC_0 = 8.097 \times 5,151.88 = 41,714.77$
Initial floor: $B_0 = V_0 - mC_0 = 100,000 - 41,714.77 = 58,285.23$
The initial portfolio would consist of investing just below 42% of the total investment into the risky portfolio and 58% into the risk-free government bond.

Problem 19

Catherine Johansson is managing a portfolio of stocks on behalf of her client, Simon Holder, which was originally invested into government bonds yielding 4% p.a.; she

will review the portfolio again in a month's time. The investment portfolio under her management has been valued at \$10m and she has determined that her investments give a 95% Value-at-Risk of \$2.4m over a month. She advises her client that even if the market turned completely against them, he would at least have a portfolio worth \$7.6m in a month time.

a. Is her assurance to Simon Holder correct?

b. Which method would you suggest to ensure that Simon Holder holds a portfolio worth at least \$7.6m in a month's time?

c. How would your approach differ from that of Catherine Johansson?

Indicative answer: *turned completely against them, he would at least have a portfolio worth \$7.6m in a month time.*

a. *This is not correct, the portfolio will not lose more than \$2.4m in the coming month with a probability of 95%. This implies that with a probability of 5% the loss will be higher and the portfolio will therefor be worth less.*

b. *The value can be guaranteed using Constant Proportion Portfolio Insurance.*
The maximal reasonable loss on the portfolio can be identified by the Value-at-Risk $VaR = 2.4m$ *on an investment of* $V_0 = 10m$*, giving* $\gamma = \frac{2.4}{10} = 0.24$*. From this follow that the multiplier is given by* $m = \frac{1}{\gamma} - \frac{1}{0.1235} = 4.1667$.
Variables given in problem: Insurance threshold $\alpha = 0.76$*, risk-free rate* $r = 0.04$*, time length* $T - t = \frac{1}{12}$
Initial cushion: $C_0 = V_0 \left(1 - \alpha e^{-r(T-t)}\right) = 10 \left(1 - 0.76 e^{-0.04 \frac{1}{12}}\right) = 2.4253$
Initial investment into risky portfolio: $mC_0 = 4.1667 \times 2.4253 = 10.1055$
Initial floor: $B_0 = V_0 - mC_0 = 10 - 10.1055 = -0.1055$
The initial portfolio would consist of investing just above 100% of the total investment into the risky portfolio she has currently chosen and take a small loan of \$105,500.

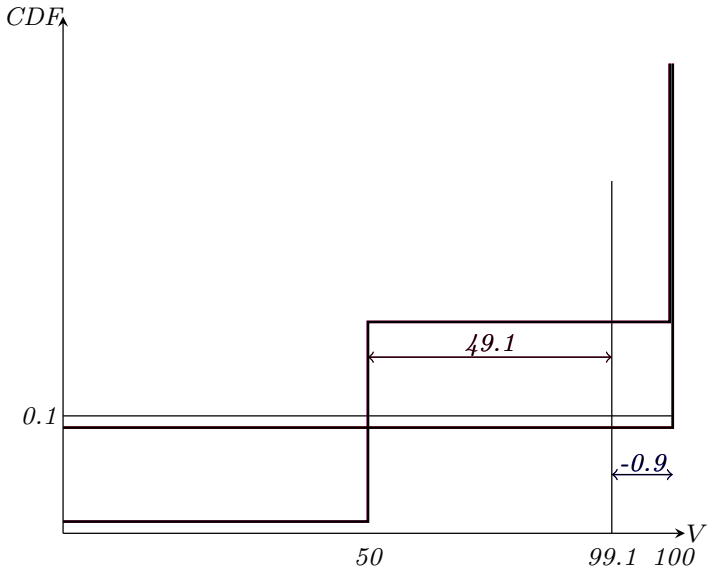
c. *The difference is that with Constant Proportion Portfolio Insurance the allocation between the risky assets and the risk-free government bonds is constantly reviewed. While the initial allocation is virtually the same, the allocation into the risky assets will reduce if the portfolio suffers any losses to limit the risk of any more losses. With Catherine Johansson's approach no adjustments would be made during this time and therefore losses can exceed the threshold.*

Problem 20

Sami Mattikaiinen manages a trading desk at Lapland Bank and has been assessing a breach of the Value-at-Risk limit of one of the traders under his management. While the breach was a minor exceedence of the maximum risk the trader was allowed to take, neither he nor his trader understand how it came about. The breach occurred as the trader was selling parts of a corporate bond holding and replaced it with a bond of comparable qualities, but with the issuer in a different industry. The total amount invested did even reduce slightly and the risks associated with the new bond was not higher than with the bond he partially sold.

How can you explain the breach of the risk limit in these circumstances?

Indicative answer: *Value-at-risk at times does not take into account diversification properly. In some situations it can be the case that diversifying a portfolio will increase the Value-at-Risk. In particular with credit risk it is often a case of being repaid the bond in full or not receiving much of a repayment at all. He might have been in a situation comparable to this from the lecture:*



If the probability of default of the bonds was close to the Value-at-risk threshold of c, then diversification can actually increase the risk of the portfolio when diversifying.

Topic 6

Problem 21

The shares of Trafalgar plc. trade at 431p and you are seeking information whether it is advisable to invest into this company. When collecting information about the company you establish that it has paid a dividend of 13p during the last year, having grown its dividend by 4% each year in the past and you believe that the company will able to maintain this growth for the foreseeable future. You have further determined the volatility of the shares as 22% p.a. and its correlation with a broad market index is 0.82. This market index is expected to increase by 8% p.a. and has shown a variance of 0.04 and treasury bills yield 3.5% p.a.

a. Would you recommend to purchase shares of Trafalgar plc.?

b. Would your answer change if the dividend were to grow at 5% each year?

c. How do you explain that such a small difference between the growth rates affects your results significantly?

Indicative answer:

a. *Identification of parameters: Dividend:* $D_t = 13$, *growth rate:* $g = 0.04$, *risk-free rate:* $r = 0.035$, *Stock variance:* $\sigma^2 = 0.22^2 = 0.0484$, *market variance:* $\sigma_M^2 = 0.04$, *market return:* $\mu_M = 0.08$, *Correlation with market:* $\rho = 0.82$
Determining expected stock return: Use the CAPM: $\mu_i = r + \beta_i(\mu_M - r)$, $\beta_i = \frac{\sigma_{iM}}{\sigma_M^2} = \frac{\sqrt{\sigma^2}\sqrt{\sigma_M^2}\rho}{\sigma_M^2} = \frac{0.03608}{0.04} = 0.902 \Rightarrow \mu_i = 0.035 + 0.902(0.08 - 0.035) = 0.07559$
Stock value: $P_t = \frac{1+g}{\mu_i - r} D_t = \frac{1+0.04}{0.07559-0.04} 13 = 380$
Final result: As the current stock price exceeds its value, the stock is not a good investment and buying it is not recommended.

b. *Change required: All results from part a. can be reused as only the growth rate of dividends changes to* $g = 0.05$.
Stock value: $P_t = \frac{1+g}{\mu_i - r} D_t = \frac{1+0.05}{0.07559-0.05} 13 = 528$
Final result: As the current stock price is below its value, the stock is a good investment and buying it is recommended.

c. *The value of the stock increases by nearly 40% when increasing the expected growth rate of dividends from 4% to 5%. The reason is that while the growth rate of dividends is only slightly higher, the cumulative effect is substantial. This is*

especially true if the growth rate g is close to the discount rate μ_i as in this case future dividends are growing at nearly the same rate as the discount rate, making their present value remain nearly constant year after year, adding substantial value to the stock.

Problem 22

Jones & Co. seek to expand their business and have drawn up three possible avenues for investment:

- Expanding their current business in the domestic market would require an investment of £100m and they expect to generate profits giving a return on investment of 11% each year for the foreseeable future. Having discussed this investment with their bank, the bank has agreed to grant a loan of £60m at a loan rate of 8% p.a.
- They could expand in an overseas market, investing £70m, which would generate an initial return on investment of 7%, but their profits are expected to grow by 4% every year. Their bank would provide a loan of £35m at a loan rate of 9% p.a.
- The final investment opportunity would be to diversify their business by expanding into new markets, which would require an investment of £110m, to which the bank would lend £65m at a loan rate of 9.5% p.a. The investment is expected to yield a return of 11.5% p.a. for the foreseeable future.

For these investments they are able to raise up to £100m in equity.

If Jones & Co. face equity costs of 12% p.a., what would be your advice on their investments?

Indicative answer: *The investments need to be evaluated using Net Present Value. and then the optimal combination of investments chosen.*
Weighted Average Cost of Capital: Cost of equity: $\mu = 0.12$
Investment 1: Investment: $I_1 = 100$*, debt:* $D_1 = 60$*, equity:* $E_1 = I_1 - D_1 = 100 - 60 = 40$*, loan rate:* $r_L^1 = 0.08 \Rightarrow R_1 = \mu\frac{E_1}{D_1+E_1} + r_L^1\frac{D_1}{D_1+E_1} = 0.12\frac{40}{60+40} + 0.08\frac{60}{60+40} = 0.096$
Investment 2: Investment: $I_2 = 170$*, debt:* $D_2 = 35$*, equity:* $E_2 = I_2 - D_2 = 70 - 35 = 35$*, loan rate:* $r_L^2 = 0.09 \Rightarrow R_2 = \mu\frac{E_2}{D_2+E_2} + r_L^2\frac{D_2}{D_2+E_2} = 0.12\frac{35}{35+35} + 0.09\frac{35}{35+35} = 0.105$
Investment 3: Investment: $I_3 = 110$*, debt:* $D_3 = 65$*, equity:* $E_3 = I_3 - D_3 = 110 - 65 = 45$*, loan rate:* $r_L^3 = 0.095 \Rightarrow R_3 = \mu\frac{E_3}{D_3+E_3} + r_L^3\frac{D_3}{D_3+E_3} = 0.12\frac{65}{65+45} + 0.095\frac{45}{65+45} = 0.1098$
Net Present Values: Profits: $\Pi_1 = 0.11 \times 100 = 11 \Rightarrow NPV_1 = \frac{\Pi_1}{R_1} - I_1 = \frac{11}{0.096} - 100 =$

14.58
Profits: Growth rate of profits: $g = 0.04$, *Initial profits:* $\Pi_2 = 0.07 \times 70 = 4.9 \Rightarrow NPV_2 = \frac{1+g}{R_1-g}\Pi_2 - I_2 = \frac{1+0.04}{0.105-0.04}4.9 - 70 = 8.40$
Profits: $\Pi_3 = 0.115 \times 110 = 12.65 \Rightarrow NPV_3 = \frac{\Pi_3}{R_3} - I_3 = \frac{12.65}{0.1098} - 110 = 5.21$
Assessment of individual investments: All investments have positive Net Present Value and all investments should be made.
Choice of investments: The company cannot finance all investments as it cannot raise sufficient equity. The maximum that can be raised is £100m and the investments require equity of £40m, ££35m, and £45m, respectively. We can therefore at most make two of these investments and should choose those two that give the highest Net Present Value when combined. In this case this is investment 1 and investment 2.
Final result: Jones & Co. should expand their current business in their domestic market and expand overseas.

Problem 23

You observe that after an increase in the stock price the next price change of the stock is more likely to be positive than negative. After a decrease in the stock price, you find that the next price change is more likely to be positive than negative. You conclude that the market cannot be efficient as whatever the last observation of the price change, the price is more likely to increase than decrease.

a. Is your conclusion correct, assuming you have performed appropriate statistical test supporting your observation?

b. If instead, you observed that after a decrease in the stock price the next price change is more likely to be negative than positive, would your conclusion hold?

Indicative answer:

a. You cannot make this conclusion. Market efficiency implies that the returns of stocks are uncorrelated over time, it makes no claims about the signs of any stock movements. The average return of a stock is positive, hence it will be more likely to observe positive price changes than negative price changes, as in this case. What is relevant is the correlation of returns, thus any variations around this trend of the stock price. Thus from your observations you cannot conclude that the market is inefficient, but you can also not conclude that it is efficient.

b. Your observation suggests serial correlation as after a positive return, positive returns are more likely and after a negative return another negative return is

more likely. Therefore we have a positive serial correlation, which contradicts the implications of efficient markets and, provided statistical tests show a sufficiently high level of significance, you can conclude that the market in this stock is not efficient.

Problem 24

You have two companies that compete in the same market, facing comparable competitive forces. Despite them being so similar, the profits of the listed company Pillmeyer AG has grown at a rate of 4% p.a., while Hertig KG, which is privately owned, has only grown at 3% p.a. With the current owners of Hertig KG seeking to sell their company, they need to determine its value to be able to set an appropriate price. As Pillmeyer AG is listed on the stock exchange, they know that its value is €117m and according to their latest annual report they generated profits of €4.5m. Internal numbers show that Hertig KG showed profits of €1.7m.

What is the value of Hertig KG?

Indicative answer:
Identifying the problem: To value Hertig KG we need to have information on the current profits $D_2 = 1.7$, the growth rate of these profits, $g_2 = 0.03$, and the discount rate of future profits, the expected return on the equity of the company. This information s not given. As both companies are identical and subject to the same market forces, it is reasonable to assume that the expected returns on both companies are identical. We would thus turn to Pillmeyer AG and use their expected return, but this is also not given. However, we can derive this expected return.
Obtaining the expected return: For Pillmeyer AG we have $P_1 = \frac{1+g_1}{\mu_1 - g_1} D_1 \Rightarrow 117 = \frac{1+0.04}{\mu_1 - 0.04} 4.5 \Rightarrow \mu_1 = 0.08$, assuming that the expected returns for both companies are identical, we have $\mu_1 = \mu_2 = 0.08$.
Value of Hertig KG: $P_2 = \frac{1+g_2}{\mu_2 - g_2} D_2 = \frac{1+0.03}{0.08-0.03} 1.7 = 35.02$
Final result: The value of Hertig KG is €35.02m.

Topic 7

Problem 25

You observe the following term structure on government bonds:

Maturity (years)	1	2	3	4	5	6	7	8	9	10
Yield (% p.a.)	3.24	3.31	3.57	3.82	4.13	4.41	4.93	5.02	5.52	5.97
Maturity (years)	11	12	13	14	15	16	17	18	19	20
Yield (% p.a.)	6.08	6.12	5.86	5.68	5.52	5.35	5.27	5.22	5.20	5.19

a. What is the expected yield of a 3-year bond in 4 years' time?

b. How do you explain the change of the yield the 3-year bond experiences, given your answer to part a.?

c. In how many years' time do you expect short-term yields to decline?

d. In how many years' time do you expected the yield 5-year bonds to decline?

Indicative answer:

a. *Determining the relevant bonds: The bond in question matures in 7 years time, hence we need to choose the return on the 7-year bond:* $(1+0.0493)^7$. *This return needs to be equal to that of a 4-year bond bought now,* $(1+0.0382)^4$, *followed by a 3-year bond, whose yield is unknown:* $(1+r)^3$
Solution: $(1+0.0493)^7 = (1+0.0382)^4 (1+r)^3 \Rightarrow r = 0.0643$
Final result: The bond in question is expected to have a yield of 6.43%.

b. *The yield of 3-year bonds is expected to increase from 3.57% to 6.43%, this is due to the yield curve being increasing, implying that investors expected yields to increase over time.*

c. *An increasing yield curve implies that yields are expected to rise, while a decreasing yield curve implies that they are expected to decrease. The yield curve obtains a negative slope after 12 years, hence we would expect short term yield to decrease again in 12 years time.*

d. *The slope of the yield curve over a time period of 5 years becomes negative after 10 years. Hence yields on 5-year bonds are expected to fall in 10 years time.*

Problem 26

A bank has obtained deposits to the amount of \$50m from a wealthy individual and agreed to pay interest of 5.5% p.a. for a period of 2 years, while the current level of interest rates for all maturities is 5.25%. It can grant loans at the current level of interest to companies with repayments to be scheduled in 5 years. In order to completely eliminate any interest rate risk, how much loans do they need to provide to companies?

Indicative answer: *We need to employ a duration-based hedge. For this, we need to obtain the duration of bonds, which in turn requires the 'bond' value. We derive these first for a nominal value of 100. The coupon payment are then the interest rate agreed multiplied by the nominal value.* Identification of parameters: $C_1 = 0.055 \times 100 = 5.5$, $r_1 = 0.0525$, $T_1 = 2$, $C_2 = 0.0525 \times 100 = 5.25$, $r_2 = 0.0525$, $T_2 = 5$
'Bond' values: *Deposits:* $B_1 = \frac{5.5}{1+0.0525} + \frac{5.5}{(1+0.025)^2} + \frac{100}{(1+0.025)^2} = 100.46$
Loans: $B_2 = \frac{5.25}{1+0.0525} + \frac{5.25}{(1+0.025)^2} + \frac{5.25}{(1+0.025)^3} + \frac{5.25}{(1+0.025)^4} + \frac{5.25}{(1+0.025)^5} + \frac{100}{(1+0.025)^5} = 100.00$
Duration: $D_1 = \frac{\sum_{\tau=1}^{T_1} \tau \frac{C_1}{(1+r_1)^\tau} + T_1 \frac{100}{(1+r_1)^{T_1}}}{B_1} = \frac{\frac{5.5}{1+0.0525} + 2\frac{5.5}{(1+0.0525)^2} + 2\frac{100}{(1+0.0525)^2}}{100.45} = 1.9481$
$D_2 = \frac{\sum_{\tau=1}^{T_2} \tau \frac{C_2}{(1+r_2)^\tau} + T_2 \frac{100}{(1+r_2)^{T_2}}}{B_2} = \frac{\frac{5.25}{1+0.0525} + 2\frac{5.25}{(1+0.0525)^2} + 3\frac{5.25}{(1+0.0525)^2} + 4\frac{5.25}{(1+0.0525)^2} + 5\frac{5.25}{(1+0.0525)^2} + 5\frac{100}{(1+0.0525)^5}}{100} = 4.5470$
Weight of loans: $\omega_2 = \frac{D_1}{D_1 - D_2} = -0.7496$
Final result: *As deposits are liabilities to banks loans are assets, having different signs, doe snot imply a short position in loans. The total amount of loans that need to be given is then* $-0.7496 \times 50 = 37.4793$. *The total value of loans that need to be given is \$37.4793m. The amount of loans given is less than the deposits obtains as the loans have longer durations and are therefore more sensitive to interest rate changes.*

Problem 27

As an intern at Khalili Bank in the country of Avar, you are asked to provide a brief statement for a client meeting on the likely economic conditions in the next few years. You have only recently moved to Avar and are very much unaware of the economic situation. However, you observe that the yield curve has an inverse hump shape, i. e. it initially decreases and from year 4 onwards increases again.

What would be your conclusions?

Indicative answer: *The yield curve gives an indication about the future development of interest rates. The initially decreasing yield curve suggests that short-term*

interest rates are falling and in 4 years time they will start to increase again. This indicates that over the next four years the market expects the central bank to lower interest rates before than increasing them. Applying basic macroeconomic theory, this suggests economic growth is slowing down or a recession is entered from which Avar will emerge in approximately four years.

Problem 28

A pension fund has long-term liabilities due to commitments of future pension payments. It determines the value of these commitments by discounting at the currently prevailing interest rate for 25-year government bonds. Until pension payments have to be made, the pension fund has invested a considerable part of their reserves into Treasury Bills and comparable short-term debt instruments. They valued the instant access these investments guaranteed, without being too much affected by changing interest rates. The yields on long-term bonds have been falling recently and the pension fund made considerable losses as a consequence.

a. Why does the pension fund suffer losses as long-term interest rates fall?

b. How can the pension fund reduce the risk of losses from future decreases in the long-term interest rate?

Indicative answer:

a. A lower discount rate, here the interest rate of the long-term bonds, increases the value of the 'bond'. The 'bond' in this case is a liability of the pension fund, hence the value of their liabilities increase. This is not matched by a comparable increase in the value of assets; they are short-term bonds and as such will have shorter duration, so even if short-term interest rates were falling, the increase in the value of assets would be smaller. Hence, the value of liabilities will increase more than the value of assets, akin to debt increasing without the value of assets increasing. Thus overall the net-value of the pension fund will decrease, causing it make losses.

b. If matching the duration of assets to the duration of liabilities, increases in the value of liabilities will be much better matched by an increase in the value of assets, reducing losses. Therefore, the pension fund should commence investing their reserves into long-term bonds rather than short-term bonds.

Topic 8

Problem 29

Helgo Holdings plc is a property company that holds a large number of residential and commercial properties, all partially mortgaged by banks or pledged against a bond they have issued. Recent rises in the interest rate on mortgages combined with a saturated market for commercial property has made the company much less profitable than it used to be. In order to conduct maintenance work on their properties, they have traditionally relied on unsecured loans. As one of the few companies on which credit default swaps are traded, you have seen a significant increase in the CDS spread over the last few months from 0.0225 to 0.0312.

a. One of the bonds issued by Helgo Holdings plc, maturing in 11 years, is featuring a coupon of 6.75% and trades at 94.38% of its face value when government bonds of the same time to maturity yield 5% p.a. A few months ago before the CDS spread increased, you had assessed the probability of default of Helgo Holdings plc as 3% per year, in line with the wider market consensus, and using this probability of default had obtained a value for this bond of 88.91% of its face value. How can you explain this difference between the price at which the bond is traded and your calculation of its value?

b. Re-evaluating Helgo Holdings plc after the rise of the CDS spread, you assess the probability of default to have risen to 3.5% per year. How do you reconcile this change in your assessment of the default rate with the CDS spread? Provide an economic explanation for this change.

Indicative answer:

a. When using the CDS spread as the basis of the calculation for the value of the bond, we obtain $B = \sum_{t=1}^{T} Ce^{-(r+s)t} + 1e^{-(r+s)T} = \sum_{t=1}^{11} 0.0675e^{-(0.05+0.0225)t} + e^{-(0.05+0.0225)11} = 0.9438$*, hence the bond is priced in line with the CDS spread. You had estimated the probability of default as 0.03, hence will have done* $\widehat{B} = \sum_{t=1}^{T} Ce^{-(r+h)t} + 1e^{-(r+h)T} = \sum_{t=1}^{11} 0.0675e^{-(0.05+0.03)t} + e^{-(0.05+0.03)11} = 0.8891$*. The difference is that you have not considered the recovery rate, which is given from* $s = h\,(1-R) \Rightarrow R = \frac{h-s}{h} = \frac{0.03-0.0225}{0.03} = 0.25$*. Omitting this recovery rate accounts for the differences in the values calculated.*

b. The not only does the default rate change, but also the recovery rate changes. Before the rise in the CDs spread from part (a) the recovery rate was 0.25, after

the rise in the CDS spread and y9our re-evaluation of the default this changes to $R = \frac{h-s}{h} = \frac{0.035-0.0312}{0.035} = 0.1086$. *The recovery rate has reduced, probabily due to the saturated market for commercial property, which will make it more difficult to sell property in case of default, reducing the amount available to unsecured creditors.*

Problem 30

You compare the yield of the senior tranches of two collaterised debt obligations. Your assessment suggests that the unsecured loans included in both CDOs have approximately the same probabilities of default, but CDO A has a significantly lower yield than CDO B. The only difference you can find is that for CDO A the borrowers whose loans are included into the CDO are spread around the country, while for CDO B the loans included are mostly given to inhabitants of Molton, a large town which is dominated by the mining company Lubrica Ltd. as the main employer.

How do you explain the higher yield of CDO B compared to CDO A?

Indicative answer: *The loans included in CDO A are well diversified by being spread all over the country, thus the correlations between loan defaults should be relatively low. In contrast to that, the loans included in CDO B are given ikna single town, are largely dependent on the prospects of the main employer in that town. Thus the correlation if default will be significantly higher. This will lead to the probability of a large number of losses accumulating in the CDO being relatibely high, increasing the risk of losses to senior tranches.*

Problem 31

Arito Yamasaki observes the trading prices of a senior and a junior tranche of the same collaterised debt obligation. She is initially puzzled by observing that over the last year the yield of the senior tranche has decreased while that of the junior tranche has increased.

How can Arito Yamasaki explain her observation?

Indicative answer: *The yield of the senior tranche decreasing implies that its value has increased, thus the likelihood of losses must have reduced. Similarly, the yield of the junior tranche increasing implies that its value has decreased, thus the likelihood of losses must have increased. This cannot be the result of the result of mainly the default risk of the underlying bonds changing as this would affect senior and junior tranches in the same way. The reason fore the observation is that correlations between defaults have changed. In this case it seems that correlations have reduced over time. If correlations reduce, an extreme outcomes, such as that all bonds default, become less likely and hence senior tranches are less likely to see large losses, increasing their value and reducing their yield. In the other hand, as such extreme events become less likely with lower correlations, it also becomes less likely that no bonds default and junior tranches face no losses. Thus losses for junir tranches are increasing, reducing their value and increasing their yields.*

Problem 32

You have been assigned the task of mentoring a new placement student at your bank, where you are working in structured finance developing securities that meet your clients requirements to transfer risks. As a building block to such securities you explain the concept of a credit default swap to your mentee. When you explain the idea behind its valuation, he is confused by your statement that the CDS spread does not depend on the time to maturity of the underlying bond. He asks for clarification because he has learnt that with options the premium increases with time to maturity, and surely a CDS is similar to an option.

a. How do you respond?

b. In glee your mentee points to the quoted prices of credit default swaps for a company, which shows that the spread for this company is actually increasing for credit default swaps with longer maturities. How do you explain that this is not a contradiction to the statement that the CDS spread does not depend on the time to maturity?

Indicative answer:

a. *A CDS has many features of an option and the pricing is done in a similar way by comparing the payments the issuer of the option (CDS) makes to the purchaser and the premium (spread) paid by the purchaser to the issuer. However, a key difference is that in options the premium is paid in advance for the entire duration of option, while with credit default swaps, the premium is payable in regular*

installments and only until the CDS has to make a payment. This would be equivalent to the option premium only being payable until an option is exercised, assuming an early exercise is possible, such as in American options; however, the option premium is payable until the maturity of the option. Credit default swaps are only payable until exercise, and therefore each payment covers a fixed time period, making the time to maturity of the CDS irrelevant for the spread.

b. *One explanation is that the probability of default of the company is increasing over time. As the CDS spread is fixed at the start of the contract, it will take into account that later defaults might be more likely. A CDS with a shorter time to maturity would not have to take into account the increasing probability of default. Such a situation is likely to occur if a company is seen as being able to meet its obligations in the short run, but there are doubts about this ability in the medium or long term.*

Topic 9

Problem 33

Evaluating the purchasing power partity, you notice that explaining even long-run changes of the exchange rate using differences in inflation between countries does not yield a strong relationship. In passing, a colleague remarks that obviously it does not work if you use as your measure of inflation the consumer or retail price index as this includes all the services that can only be bought locally and taxes are a problem as well.

How can you use these remarks to explain that purchasing power parity seems to not work and what would be a better test of its validity?

Indicative answer: *Purchasing power parity assumes that goods can be traded, however, many 'goods' in modern society are services that cannot be easily traded across countries; the prices of these services are included in any measure of inflation. These services might involve personal care such as hair cuts, medical services, but will also include goods that are subject to local tastes, especially food items, and for which there is no demand in other countries. The inflation measure will therefore be distorted by such goods and services that are non-tradeable or which are not traded due to local preferences. In addition taxes might change and with it the prices of goods will change; this is not a market-driven change will again distort the inflation measure. To effectively test the purchasing power theory it would be best to include only good s that are in demand in all countries whose exchange rates are investigated and to exclude any effects taxes might have on local prices. It might be possible to use a price index of exported goods that in wide demand globally and which are quite homogenous, for example computer components, standardised elements of machinery, and similar.*

Problem 34

The current exchange rate between the Canadian dollar and the Swiss Franc is 0.6405 CHF/CAD. For both countries you have the following term structure of government bond yields:

Time to maturity (years)	1	2	3	4	5	6	7	8
Switzerland (% p.a.)	2.10	2.20	2.25	2.24	2.23	2.22	2.24	2.25
Canada (% p.a.)	1.35	1.97	2.35	2.74	3.81	4.26	4.59	5.02

What are the expected exchange rates for the coming 8 years?

Indicative answer: *We can use the interest rate parity to determine the difference in exchange rates. The foreign country here is Canada as the exchange rate is expressed in Swiss Francs per Canadian Dollar. Using r^* being the yield of Swiss bonds and r the yield of Canadian bonds, we can get the change of exchange rate as $r_t^* - r_t$ for each time period, hence $\Delta e_t = (r_t^* - r_t)\, t$ and the new exchange rate is $e_t = e_0 + \Delta e_t$, where* $e_0 = 0.6405$

Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Δe	*-0.0075*	*-0.0046*	*0.0030*	*0.0200*	*0.0790*	*0.1224*	*0.1645*	*0.2216*
e_t	*0.6330*	*0.6359*	*0.6435*	*0.6605*	*0.7195*	*0.7629*	*0.8050*	*0.8621*

After the initial appreciation of the Swiss Franc against the Canadian Dollar in the first year, the expectation is that the Swiss Franc will then depreciate in after that as the interest rate of the Canadian government bonds are increasing, while the yields on Swiss government banks remains mostly constant.

Problem 35

Conducting monetary policy leads to an initial overshoot of the exchange rate as prices for goods and services in an economy are not adjusting sufficiently fast; but as prices start to adjust, the exchange falls back to its long-term equilibrium. This result is explained with the observation that prices for goods and services in an economy only adjust slowly, but prices in financial markets adjust quickly. However, an economy has not only the exchange rate that can adjust quickly, but also interest rates.

How will interest rates behave during this time of adjustment to the long-term equilibrium?

Indicative answer: *With interest rate parity holding, interest rates will move consistently with the changes in the exchange rate, While the initial change in the exchange rate due to a monetary shock will not affect interest rates, assuming it was not anticipated, the subsequent slow adjustment to the long-run equilibrium is predictable and with the interest rates of other countries given, a slowly depreciating exchange rate will*

see the interest rate staying above the long-term equilibrium, while for slowly appreciating exchange rates, it will stay below its long-term equilibrium.

Problem 36

Constantin Nicolescu works as a foreign exchange trader at Steaua Bank. As he mainly trades currencies of developed countries, the main events that affect exchange rates are monetary policy decisions. While well anticipated decisions by central banks do not solicit much of an immediate reaction in the foreign exchange markets, he observes a persistent adjustment of the exchange rates in the weeks after major policy announcements. Those anticipated policy decisions commonly move the exchange rate and then after the official announcement, this movement is partially reversed over the coming weeks. He attributes this observation to the inefficiency of the foreign exchange market. His colleague Ariana Popescu, on the other hand, claims that it is a sign of destabilising speculation as the result of traders herding and either overestimating the effect of the monetary policy decision or overestimating the monetary policy decision itself.

Can you agree with either of these positions?

Indicative answer: *While neither an inefficient foreign exchange market nor herding can be excluded as being present, their observations are consistent with the need for exchange rates to adjust such that the economy is in a short-run equilibrium. Prices on goods and services are only adjusting slowly, so in order ensure that goods and money markets are clearing, financial markets need to adjust. Interest rate and exchange rates are linked through the interest rate parity and therefore exchange rates adjust such that markets are in equilibrium and with prices on goods and services not adjusting instantly, this adjustment will be quite high. Once the prices on goods and services are adjusting, the exchange rate will revert to its long-term equilibrium. Thus the reversal of the initial exchange rate change and the predictable slow reversal to the long-term equilibrium are not the result of destabilising speculation by traders. However, in the sense of the definition of market efficiency, they represent a market efficiency, although one that is an equilibrium condition.*

Topic 10

Problem 37

The exchange rate of the Beluga Krona relative to the US Dollar has remained stable for a long period of time. The independent central bank did manage to ensure that the exchange rate fluctuated only in a narrow band around 4.2 Beluga Krona per US Dollar. It was a long-term commitment of the government to maintain a stable currency and they presented it as a major achievement of their administration. This policy has been criticised heavily by opposition parties who claim that the overvaluation of the Belugan Krona imposes significant costs on the economy by hurting exports and making imports too cheap for domestic suppliers to compete with. With elections being called and opinion polls forecasting a win for the opposition parties, the central bank suddenly announces that it will not support the currency any longer as this has become unsustainable and imposes too big costs on the economy; in response the exchange rate changes to 6.4 Beluga Krona per US Dollar. The ruling party sees this as a political move in support of the opposition parties.

How can you explain this sudden change in the policy of the central bank?

Indicative answer: *The central bank is independent, which allows us to discount the accusation that their decision was driven by the desire to support the opposition parties. As there is also not much evidence that the economic situation in Beluga has changed significantly, the only explanation remains that the anticipated victory of the opposition parties has driven this decision. The current government was committed to maintaining the current exchange rate and therefore markets expected the exchange rate to remain stable. With the opposition parties likely to take over the government soon and them seemingly not being committed to a stable exchange rate, at least not at the current level, expectations about the exchange rate changed to wards the exchange rate changing. This change in expectations become self-fulfilling. It was the case that Beluga was in a situation where expectations about the future exchange rate were important for the optimal policy of the central bank. The benefits of maintaining a stable exchange rate were higher than bearing the costs of a devaluation as long as the market expected the exchange rate to remain stable. If expectations change towards a depreciation, the benefits of devaluing the currency through lower real debt due to importing inflation will outweigh the costs of this depreciation.*

Problem 38

Armenda and Cosapon are neighbouring countries that share many economic and political characteristics, although Cosapon has recently embarked on a government-initiated investment into green technologies for which substantial amounts were raised through the issue of bonds, mostly held by domestic investors. Both have maintained stable exchange rates against the US Dollar for many years and against each other. Armenda maintained an exchange rate of approximately 14.5 Armenda Shilling per US Dollar and the exchange rate to the Cosapan Dinar was close to 1. As part of an attempt to liberalize their economies, both country's central bank coordinated their decision to abandon the management of the exchange rate and let it float freely against the US Dollar and against each other. On the day after this announcement, the exchange rates are 18.2 Armenda Shilling per US Dollar, 23.7 Cosapan Dinar per US Dollar, and 0.77 Armenda Shilling per Cosapan Dinar.

How do you explain that despite the otherwise similar economic conditions in both countries, the exchange rates to the US Dollar now differ substantially?

Indicative answer: *The reason is in the higher debt of Cosapan due their investment programme. The higher debt burden makes a higher depreciation optimal. It was* $e\,[\Delta e] = \frac{\theta}{\alpha} rB$ *and the higher debt,* B*, will increase the depreciation of Cosapan relative to Armenda. Through purchasing power parity, this higher depreciation will result in higher (imported) inflation, which reduces the real burden of servicing this debt more in Cosapan than in Armenda; given the higher debt level, this would make the benefits of the depreciation comparable.*

Problem 39

Coledum has developed its economy considerably over the last few years and its standard of living has increased substantially. They have seen the development of a domestic industry producing a wide range of consumer goods and have reduced their reliance on exports for economic growth. Many of the investments required for this transformation of their economy have been provided through loans raised internationally, but the debt burden is generally seen as sustainable. Although Coledum is seen as a politically stable country, it is located in a region of the world that is overall seen as politically unstable. This has lead on many occasions in the past to a situation where capital flows have been reduced unexpectedly in response to political instability in neighbouring countries. This has never affected Coledum's economy much as the capital flows would resume once the main uncertainty in the region had subsided. The last such regional crisis was experienced quite a few years ago before the recent development drive. New political turmoil in its two neighbouring countries has again let

to a drastic reduction in capital flows towards Coledum; this time however, Coledum faces an economic crisis, its exchange rate has drastically reduced and its starts to feel the consequences of a currency crisis.

Compared to previous times of political instability in the region, why is Coledum more affected during this time of political instability in the region?

Indicative answer: *Coledum's economy has undergone a transformation and it now consumes a much larger part of its domestic production (μ) while having higher debt (F) and less exports (X). This makes Coledum vulnerable to a currency crisis. The higher foreign debt has to be served using less exports, which would generate the requisite currency, thus relying on capital inflows more to finance payments on their existing debt. Previously this reliance was much less pronounced as the foreign debt was lower and exports higher, allowing Coledum to overcome reductions in capital inflows. This increased reliance on capital inflows has led to multiple possible equilibria being available, one of which is that with a high level of investment and strong currency, but another equilibrium exists in which investments are low and the currency is weak. The reduction in capital inflows has required a reduction in investment, which reduced wealth in Coledum and reduced investments even further, leading to a downward spiral of investments and a depreciating currency.*

Problem 40

Radu Michalski works as consultant for developing countries and advises them on strategies of economic development. He has noticed that countries with very low levels of economic development rarely face economic crises, especially no currency crises, unless they are politically unstable or involved in armed conflicts. The same is true for well developed countries. It is, however, that countries developing and achieving rapidly improving living standards are most often affected by currency crises. He has looked at many such countries and could find no signs of poor economic decisions being taken by governments, central banks, or other agencies that could account for the emergence of such crises. When a crisis occurs and who is affected seems to be random and he could not detect any patterns for the emergence of currency crises.

Is the threat of a currency crisis part of a country developing its economy?

Indicative answer: *Countries developing their economies undergo substantial changes. To raise living standards in their countries consumption will have to increase and as countries develop these will be produced more and more domestically, reducing the reliance on imported high-end goods that are financed by the export of low-end goods or natural resources. Often, the required investments are financed by foreign loans and*

the lack of capital in these countries require investments with high leverage. Combining these aspects, makes countries vulnerable to currency crises which might emerge as the result of random shifts in global capital flows. The higher foreign debt has to be served using less exports than when a country was less developed, which would generate the requisite currency, thus relying on capital inflows more to finance payments on their existing debt. With less development this reliance was much less pronounced as the foreign debt was lower and exports higher, allowing the countries to overcome reductions in capital inflows. This increased reliance on capital inflows has led to multiple possible equilibria being available, one of which is that with a high level of investment and strong currency, but another equilibrium exists in which investments are low and the currency is weak. The reduction in capital inflows requires a reduction in investment, which reduces wealth and reduces investments even further, leading to a downward spiral of investments and a depreciating currency. Once a country has achieved a higher level of development, it will have access to its own domestic capital, reducing its reliance of foreign debt and capital inflows, making a currency crisis less likely. Thus it can be said that vulnerability to currency crises is part of the development of the economy.

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