Assignment 1: Risk and Return

MOEC0550 Empirical Finance (S)

Spring Semester 2021

1 Introduction

The purpose of this assignment is to examine the risk and return relation in the Swiss stock market. To reflect the Swiss stock market, we have chosen the Swiss market index (SMI) as our index of reference. You will find all the necessary information and the data for the empirical part of this assignment in the course element "Assignment 1" on OLAT.

Deadline All deliverables, which are defined more distinctively in Section 2, have to be turned in on OLAT by Friday 19 March 2021 at 21:00 the latest. Ensure that you submit the deliverables before the deadline, since late reports will receive a grade of 1.

2 Deliverables

You hand in your work by uploading it on OLAT with the following two documents attached:

- **R Code:** Turn in the R-Script including all your calculations and relevant comments for the code. The file should be named as followed: "groupname_assignment1.R"
- **Report:** The report provides answers **to the questions** asked in the problem set on a **maximum of five DIN A4 pages** without the cover page nor tables/graphs and should be handed in as a PDF. Please put your tables/graphs in the appendix. Structure the report with subtitles according to the questions in the problem set. Use 11pt font size at least. Please make sure that you note the names and Matrikel-Nr. of all members of your group on the cover page. The file should be named as followed: "groupname_assignment1.pdf"

3 Data

On OLAT you will find five different data sets, each of which contains monthly data from 30. June 1988 to 26. February 2021.

- A1_dataset_01.txt
  This data set contains the historical prices of all stocks that have been part of the SMI over the observation period. In order to approximately replicate the SMI, the values of the stocks that were not in the SMI at a certain point in time have been set to "NA", so that these will not affect the calculations.

- A1_dataset_02.txt
  This data set contains the historical returns of all stocks that have been part of the SMI over the observation period and they are sorted in the way how they should be included in the portfolio for question 2). Once again, the values of the stocks that were not in the SMI at a certain point in time have been set to "NA", so that these will not affect the calculations.

- A1_dataset_03.txt
  This data set contains the interest rates of Swiss government bonds with different maturities from 1 to 30 years. Please note that although the data here is provided on a monthly basis, the interest rates are the annual interest rates.

- A1_dataset_04.txt
  This data set contains the market values for the stocks, which are also contained in the dataset "A1_dataset_01.txt". You should use these market values to calculate the weights in the value-weighted portfolio.

- A1_dataset_05.txt
  This data set contains the consumer price index (CPI) for Switzerland standardised to June 1988 = 100. The CPI measures the change in prices of goods and services which are representative of the private households' consumption in Switzerland. It indicates how much consumers have to increase or to decrease their expenditure to maintain the same volume of consumption, despite the variations in prices.

4 Controls and Hints

Below you find sample solutions for certain values to check your work progress and make sure that you are on the right track:

- Question 1):

Annualized mean return (equal weighted portfolio)	0.077696
Annualized mean return (value weighted portfolio)	0.077211
Final value of the equal weighted portfolio investment(30.06.1988-29.12.2000)	4.228958
Final value of the value weighted portfolio investment(30.06.1988-29.12.2000)	6.135988

- Question 2):

Annualized mean return for the portfolio with 25 constituents	0.083510
Annualized standard deviation for the portfolio with 25 constituents	0.165982
Sharpe Ratio for the portfolio with 25 constituents	0.384109

5 Problems

5.1 Risk and Return

1. Calculate the monthly returns of all the stocks of the dataset: "A1_dataset_01.txt".
2. Calculate the annualized mean return of an equal weighted portfolio, including all the stocks of the dataset. Report the annualized mean return of the equal weighted portfolio. Does it seem reasonable to you?
3. Create a value-weighted portfolio by using the market values of the dataset: "A1_dataset_04.txt". Make sure to calculate the value-weighted portfolio based on each stock's weight as of t-1.
   (a) Novartis, Nestlé, Roche and UBS are known as the big four in Switzerland due to their large market capitalization. For each of the four report the date and value when they reach their maximum weight in the value-weighted portfolio.
   (b) Calculate then the annualized mean return of the value weighted portfolio, including all the stocks of the dataset. Report the annualized mean return of the value weighted portfolio. Does it seem reasonable to you?

4. Let us now assume that we would like to invest 1 CHF, though we are not sure whether the timing of the investment plays a role or not. For this purpose, examine how an investment develops if you would have invested at different starting dates.

   (a) Calculate the final value of a CHF 1 investment for the equal-weighted and value-weighted portfolio for the following investment periods:

      i. 30.06.1988 – 29.12.2000
      ii. 29.12.2000 – 26.02.2021
      iii. 31.07.1998 – 31.12.2012
      iv. 31.05.2007 – 29.12.2017
      v. 31.08.2011 - 31.01.2020

   (b) Is there a difference between the value weighted and equal weighted portfolio? Is this consistent with your expectations? Can you think of possible explanations?

   (c) Investment advisors often suggest that when investing in stocks over a long-term like 15 years then one "cannot lose money." Based on the results from task a) do you agree? Why or why not?

   (d) Now imagine you would have invested right before the financial crisis in 31.05.2007. How long would it take until you would have recovered your loss? Does it differ among the portfolios?

   (e) Now imagine you would have invested right before the corona crisis in 28.02.2020. How long would it take until you would have recovered your loss? Does it differ among the portfolios?

   (f) Report the maximum drawdown for both the equal weighted and value weighted portfolio for the following investment periods:

      i. 30.06.1988 – 29.12.2000
      ii. 29.12.2000 – 31.01.2020
      iii. 28.02.2020 - 26.02.2021

   (g) Do the two portfolios differ and what is the reason for that? Is the maximum drawdown a useful measure in terms of performance evaluation?

5. In class, the concept of inflation and its role as a hidden variable was discussed. Try to adjust for this factor by using "A1_dataset_05.txt", which contains monthly CPI data for Switzerland standardised to June 1988.

   (a) Revisit exercise 5.1.2 and try to adjust for inflation. How do the results differ?

   (b) Calculate the final value of a CHF 1 investment in the value-weighted portfolio for the full (1988-2021) investment period adjusted for inflation. Plot your results against the non-adjusted results. What are your observations?

5.2 Portfolio Construction

1. Evaluate the Sharpe ratio of the first stock of the dataset: "A1_dataset_02.txt" (Swiss Bank I). Calculate the standard deviation and the Sharpe ratio of this stock. In order to calculate the Sharpe ratio, you should use the 1-year Swiss Government bond as a risk-free rate. The Sharpe ratio should be calculated by applying the following formula:

$$SR = \frac{r_p - r_f}{\sigma_p} \tag{1}$$

   Whereas; r_p the mean return of the constructed portfolio (stock in this case) over the whole observation period, r_f the mean riskfree rate over the observation period and σ_p the mean standard deviation of the portfolio (calculated by taking the mean of the rolling standard deviation). The standard deviation should be calculated as the rolling standard deviation over the last 12 periods (months).

2. In sequence add the next two stocks (e.g. with three stocks the portfolio will consist of Swiss Bank I, Julius Baer Group and Zurich Insurance Group N) and report the new standard deviation and the new Sharpe ratio. Repeat this until the portfolio consists of 25 stocks. Now continue by adding 5 stocks each time until the portfolio consists of 60 stocks (i.e., the portfolio will consist of 30, 35 stocks etc). Report the standard deviation and the Sharpe ratio for every newly constructed portfolio.

3. Explain what is happening to the Sharpe ratio as you add more stocks. What is the reason for that?

4. In the limit as N (number of stocks) becomes large will the correlation of your portfolio return with a portfolio consisting of the big four tend to zero? No data work necessary. Explain.

Risk measure

5. Assume that you have decided to invest in a large portfolio of stocks. Is the risk measure used in 5.2 above appropriate?

6. Suggest a risk measure that will approximate the amount of added risk to your portfolio.

7. What assumptions underlie that this is an appropriate risk measure? Do you think these assumptions hold in practice?

5.3 Variance Ratios

1. In the slides the test of Poterba and Summers (1988) was presented. The paper calculates the following ratio:

$$VR(k) = \frac{var(R_t^k)}{k} / \frac{var(R_t^{12})}{12} \tag{2}$$

where:
$var(R_t^{12})$ is the variance of the 1 year return (12 months)
$var(R_{t^k})$ is the variance of a k month return (i.e., 3 years would be 36 months)

Explain how calculating the above ratio is a test of *mean reversion*.

2. The goal of this exercise is to calculate variance ratios for different horizons using returns on the SMI. Use as base the variance of the one year holding period and relate the variances of other holding periods to that. Formally, this implies calculating the following ratio:

$$VR(k) = \frac{var(R_t^k)}{k} / \frac{var(R_t^{12})}{12} \tag{3}$$

where:
$var(R_t^{12})$ is the variance of the 1 year return (12 months)
$var(R_{t^k})$ is the variance of a k month return (i.e., 3 years would be 36 months)

Fill in the following table:

	Annual Standard deviation	1 Month	24 Months	36Months	48 Months
Equal Weighted Return					
Value Weighted Return					

Use the equal-weighted and value-weighted returns that you calculated in Question 5.1

3. Interpretation:
   (a) How does the variance ratio develop over time? What are your explanations for that?
   (b) Are returns in the SMI independent? Only discuss economic significance - there is no need for a statistical test.
   (c) Based on this, what would your recommendation be to an investor that has a four-year horizon?
   (d) Does this imply that the SMI is not "efficient"?

4. Repeat ii and iii but use log returns.
   (a) How do the results differ?
   (b) Why do you think they differ and which set of results are the most appropriate?

5.4

Suggestions for improvement of this exercise?