Mini Real-World Project for TMU

1. Introduction

Beating the market consistently is a holy grail of any money manger. In the context of stocks, the market is the stock market index.

2. Objectives

The main objective of this mini project is to help you acquire the skill to construct and re-balance stock indexes, and to measure their performances.

3. Data

From finance.yahoo.com, I have downloaded 120 daily times series of Japanese stocks that exist since 2000. In addition to prices, you will also have the details of stock split and dividends. These data are contained in a csv file. The filename is xxxx.T.csv, where xxxx is the code (ticker symbol) of the Japanese stock. The data set will be provided to you as a zip file.

4. Requirement A

The sample period is from January 2000 through December 2017. The benchmark index to beat is TOPIX index. You are required to construct 3 indexes.

- Price-weighted index (you must adjust the divisor for stock splits)
- Equally weighted index (you must re-balance in end of March, June, September, December)
- Your smart beta index (you must also re-balance at the quarterly interval)

5. Requirement B

After you have constructed the indexes for the entire sample period, you are to plot the time series of your indexes.

- For each index that you have constructed, obtain monthly index levels from daily index levels by sampling end-of-the-month prices.
- Since TOPIX is the benchmark, you need to obtain TOPIX at the monthly frequency with the same sample period.
- You also need to have the monthly time series of risk-free rate of Japan. According to a **Study Group report**, it should be the uncollateralized overnight call rate $r_{f,t}$ calculated and published by the Bank of Japan. I have downloaded this time series for you.

6. Requirement C

By this time, you should have (18 × 12=) 216 months of data points for each index and TOPIX. Compute the simple returns. Let r_i, $i = 1, 2, \ldots, n$ be the returns, where $n = 215$. The following quantities are to be computed:

1. Average monthly return $\widehat{\mu} = \dfrac{1}{n}\sum_{i=1}^{n} r_i$
2. volatility $\widehat{\sigma} = \sqrt{\dfrac{1}{n-1}\sum_{i=1}^{n}\left(r_i - \widehat{\mu}\right)^2}$
3. t statistic with respect to the null hypothesis $\mu = 0$
$$t_{n-1} = \frac{\widehat{\mu}}{\frac{\widehat{\sigma}}{\sqrt{n}}}$$
4. Excess return with respect to the benchmark return b_i is $e_i = r_i - b_i$, where b_i is the monthly return of TOPIX. The average excess return is $\widehat{e} = \dfrac{1}{n}\sum_{i=1}^{n} e_i$.
5. Tracking error $\widehat{\sigma}_e = \sqrt{\dfrac{1}{n-1}\sum_{i=1}^{n}\left(e_i - \widehat{e}\right)^2}$
6. Information ratio IR $= \dfrac{\widehat{e}}{\widehat{\sigma}_e}$
7. Sharpe's ratio SR $= \dfrac{\widehat{\mu} - \widehat{r}_f}{\widehat{\sigma}}$, where $\widehat{r}_f$ is the average of the monthly risk-free rate $r_{f,t}$
8. M^2, M2, or Modigliani-Modigliani measure
$$\text{M2} = \text{SR} \times \widehat{\sigma}_b + \widehat{r}_f,$$
where $\widehat{\sigma}_b$ is the volatility of the benchmark (TOPIX)
9. Jensen's alpha $\widehat{\alpha}$
Run time series regression inspired by the Capital Asset Pricing Model:
$$r_{p,t} - r_{f,t} = \alpha + \beta\left(r_{m,t} - r_{f,t}\right) + \varepsilon_t$$
10. Beta $\widehat{\beta}$
11. t statistics for $\widehat{\alpha}$ and $\widehat{\beta}$
12. Treynor's ratio TR $= \dfrac{\widehat{\mu} - r_f}{\widehat{\beta}}$
13. Downside volatility
$$\widehat{\sigma}_- = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\min(0, r_i - b_i)^2}$$
14. Sortino's ratio
$$\text{SOR} = \frac{\widehat{\mu} - \widehat{r}_b}{\widehat{\sigma}_-}$$

7. Requirement D

You will need to write a report with no less than 10 pages (A4 size) with spacing and font size similar to this mini real-world project description. In the report, you need to have charts, tables, and description.

The return, volatility, tracking error, information ratio, Sharpe's ratio, M2 ratio, downside volatility, and Sortino's ratio are to be reported in annualized terms.

Obviously, every report must have at least introduction, statement of hypotheses and assumptions, empirical finding, discussion, and conclusion.

Since the calendar time is short, I offer you the flexibility to write your report in either English or Japanese. But the dead line is strictly before June 23 23:59 hours.

8. References

1. **http://breakingdownfinance.com/**
2. **Report on the Identification of a Japanese Yen Risk-Free Rate**, Study Group on Risk-Free Reference Rates, Bank of Japan, December 2016