VBA for finance – ESILV 2019-2020

Asset pricing theory

You will be evaluated on this project. You will work in groups of two students of the same TD group. Before the end of **Monday 23rd December**, you will send by mail to **your TD teacher** your Excel file as well as a short report (no more than 3 pages) containing interpretation answers (particularly for questions 5 to 7). Every project with badly indented code or without comments will be penalized.

This subject follows the subject on momentum factors. Some prerequisites are gathered in section A.

A. Momentum factor

You have to work on the equity dataset attached to this subject. This dataset contains time series corresponding to prices of stocks as well as prices of an index, which is considered as reflecting the market. Besides these time series, we need a time series, on the same dates, corresponding to the momentum factor, as described in the previous tutorial subject (this factor was simply the portfolio you implemented).

Question 1 *– Write a sub displaying in the Excel sheet the momentum factor, depending on the three relevant parameters (rebalancing frequency, rolling window, proportion of the universe to trade). Please, only write in your worksheet the relevant functions/subprograms (not the UserForm described in the previous subject, for example).*

B. Capital asset pricing model

The CAPM (Capital Asset Pricing Model) attempts to explain the expected return of any financial risky asset as a linear function of the market risk premium. The market can be approximated by a large index. Formally we have:

$$r_i = r_{rf} + \beta_i[r_m - r_{rf}] + \varepsilon_i,$$

where :
$E(.)$: The expected value of a random variable
r_i: The return of the risky asset *i*
r_{rf}: The return of the risk-free asset (you can consider it is equal to zero, or, for a higher mark for your project, download a relevant rate from Bloomberg, such as the Schatz for example)
β_i: A coefficient measuring the link between the expected return of the risky asset *i* and the market risk premium.
r_m: The return of the market
ε_i : a residual (considered to be independent of other random variables).

One can obtain the β_i parameters using the ratio of the covariance between r_i and r_m by the variance of r_m.

Question 2 *– Write a sub calculating the β_i of each asset i and displaying it in a table. This code must generate automatically a histogram of the values of the β_i in the universe of stocks considered.*

Question 3 *– Write a sub determining for each stock the proportion of the historical variance that is explained by the market factor. Display the result in your Excel sheet.*

C. Asset pricing theory

The CAPM works quite well as most of the variance of the returns within the equity scope is explained by the market risk premium. Nevertheless, there is a lot of assumptions and limits: linearity, stationarity, existence of a risk-free asset, the only factor that explains the expected return of a risky asset is the market risk premium…

To overcome the last limitation, Ross generalized the CAPM in 1976 by introducing the APT (Asset Pricing Model[1]). In this specification, the expected return of a risky asset is explained by multiple factors, formally we have:

$$r_i = r_{rf} + \sum_{j=1}^{N} b_{ij} F_j + e_i,$$

where :
b_{ij} : A coefficient measuring the link between the expected return of the risky asset *i* and the *j*-th risk premium.
F_j : A risk factor.
e_i : a residual, independent of the factors.

In addition to the market factor, you will then introduce the momentum factor in your model. As any factor, the momentum factor is common to all stocks (it is the portfolio implemented in section A), but each stock has a specific sensitivity to this factor.

Question 4 *– Write a sub determining b_{i1} (the market sensitivity) and b_{i2} (the momentum sensitivity) and displaying them in the same table for each asset i.*

Question 5 *– Write a sub displaying in the table of Question 4 the difference, for each stock i, between β_i and b_{i1} (the sensitivity to the market in both cases). Why may it differ? (hint: study the correlation between the index and our momentum factor)*

Question 6 *– Using a 200-day rolling window, estimate the two-factor model at each date for one equity of your choice. Can you explain why the sensitivities aren't stable over time?*

D. A factor of your own

[1] For more details, see https://www.top1000funds.com/wp-content/uploads/2014/05/The-Arbitrage-Theory-of-Capital-Asset-Pricing.pdf

The asset pricing theory has not to be limited to two factors. You are going to implement a third factor of your choice. The creativity will be an important part of your mark for this section.

Question 7 *– Write a sub displaying the time series of a factor you have imagined. Provide the rationale of this factor in the report.*

Question 8 *– Write a function returning the sensitivity of a given stock to each factor for models combining one, two, or three factors (for example the market factor and your own factor, or the momentum factor only).*

E. Investment decision

You are now ready to implement a decision-aid tool for a portfolio manager. Depending on the choice of the model (all the possible combinations of the three factors, with at least one factor, that is to say 7 models), this model provides you with a forecast of the return of any stock if one makes some assumptions for the expected returns of each factor. We are not interested in this work in how one can predict the returns of the factors; we consider it is an input provided by the user.

Question 9 *– Implement a UserForm which displays the name of the best stock to invest in, along with its expected return. The parameters that the user provides to the UserForm must be the following: choice of the factors to consider, expected return of each factor.*

Some errors may occur if the user does not use the UserForm properly, for example, if the user press the OK button with empty values for the parameters.

Question 10 *– Add a relevant error handling layer to all the subprograms and functions that the UserForm may execute.*