

Solution Sheet on Problem Set 3

**Asset Pricing Models & Portfolio Choice**

Deadline: 30.11.2021

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| **Task** |  | **Points Earned** |
| **Analyzing Beta Sorted Portfolios**  a)  Annualized portfolio statistics  (4 points) |  |  |
| b)  CAPM regression & report of statistics  (8 points) |  |  |
| c)  Plot and interpret returns and betas (8 points) | Intercept (Risk Free Rate): 0.02295  Slope: 0.09839  The security market line distinguishes between Portfolios above and under the line. Portfolios above the line are outperforming the market, whereas Portfolios under the line are underperforming the market. The market portfolio is equal to   = 1. For our dataset, we observe that the assets with a > 1 are underperforming, whereas the < 1 are outperforming the market. Recalling that a > 1 means that the stock’s price swings more wildly (i.e. is more volatile) than the overall market, we can conclude, that the higher do not perform strong enough, compared to the market (i.e. the returns are not high enough, given the higher volatility).  This is in line with our results in part a). Recall the formula for the Sharpe Ratio:  The analysis in part a) gave us a decreasing Sharpe Ratio from to . When we look into the parameters, which are defining the Sharpe Ratio, we see that the Returns are – more or less – increasing from to . However, the volatility (i.e. the Standard Deviation) is increasing much more, in relation to the increasing return. This leads to the decrease in the Sharpe Ratio, which is, eventually, why they are underperforming the market. |  |
| d)  Plot and interpret alphas and betas  (8 points) | We compare how volatile a stock’s price is in comparison to the overall stock market (, x-axis) versus the investment strategy’s ability to beat the market (, y-axis). Also called “excess return” or “abnormal rate of return”.  is created by active investing, where as can be earned through passive investing.  Our plot shows a decreasing relationship for and Meaning, 1 has a – relatively – high abnormal return, while having a low volatility (in comparison with the market).  Based on our dataset, the lower CAPM- have earned higher abnormal returns, while having lower volatility than the market. On the other side, the higher CAPM- have earned clearly lower abnormal returns, while having much higher volatility (again, in comparison with the market). Recall that in CAPM with close to zero, the return should also be close to zero. When are low, the return can be explained by active investing (i.e. high ). On the other side, when are high, returns can be explained by the higher volatility (i.e. higher ), which is a risk premium for pro cyclical assets. |  |
| e) Plot and interpret R squared and betas  (8 points) | Lastly, we compare again our on the x-axis with the Estimated , the measure of how well observed outcomes are replicated by the model, on the y-axis.  Obviously, the higher our , the more accurate the linear relation in our CAPM-Regression. We observe an increase in up to and then a (weaker compared to the increase) decreases in higher . Our dataset basically shows that for high/low Beta, the linear relation between returns and market returns is weaker, compared to medium-. Which means, that our model is less accurate, when we analyze high/low Portfolios. |  |
| f) Build beta-neutral portfolio and plot results vs. market  (6 points) | The required weight for the long position in beta 1 is 2.646.  **Chart, line chart  Description automatically generated** |  |
| g) Performance comparison of beta-neutral portfolio to market  (6 points) | market neutral portfolio mean return: 0.0136  market portfolio mean return: 0.0095  market neutral portfolio sharpe ratio: 0.1251  market portfolio sharpe ratio: 0.1309   |  |  |  | | --- | --- | --- | | **Correlation Matrix** | **returns\_mkt\_neutral** | **market\_return** | | **returns\_mkt\_neutral** | 1.000000 | 0.006087 | | **market\_return** | 0.006087 | 1.000000 |   Per the above correlation matrix the market neutral portfolio is indeed still correlated to the market returns, however only very slightly. Moreover, given we only rebalance the portfolio once and not e.g. every month the low correlation in this case can be considered to be market neutral. |  |
| h) regressions on beta and Fama-French models  (14 points) | **CAPM regression:**  **Table  Description automatically generated**  **Fama-French 3-factor regression:**  **A screenshot of a computer  Description automatically generated with medium confidence**  **Fama-French 5-factor regression**  **Table  Description automatically generated**  In the CAPM regression we get a very high p value for the beta coefficient (and also a non-existent ). Keeping in mind that the portfolio that was used for this regression was specifically created to be market neutral (i.e. beta = 0) this does not surprise and is reasonable.  With the Fama-French 3-factor and 5-factor regression models the excess return of the market portfolio can be better described (adj of 0.329 and 0.380, respectively). It can also be seen that the goodness of fit of the model increases by adding the two additional independent variables of RMW and CMA.  Moreover, irrespective whether the 3-factor or 5-factor model was used, the p values for all independent variables are extremely low, indicating that they are all significant and have an influence on the excess return of the market neutral portfolio.  For both the 3-factor and 5-factor model we get very low constants (alpha) implying that almost all the return can be explained by the 3-factors or 5-factors respectively.  We tested for multicollinearity using the VIF. Given that the VIF is below for 2.4 for all independent variables multicollinearity is not a problem in this case. Considering how the factors are chosen and created this is sensible. |  |
| i) Performance analysis of rebalanced portfolio  (10 points) | **French-Fama 5-factor regression on the monthly rebalanced portfolio:**  **Table  Description automatically generated**  With monthly rebalancing we get a fairly similar outcome vs if we had just done an initial weighting (cf. question 1 h). Some slight shifts in the coefficients of the independent variables can be observed, and the adjusted is slightly lower here.  For further comparison we also plotted the log price development of market neutral portfolio (from 1 f) versus the log price development of the monthly rebalanced market neutral portfolio.Chart, line chart  Description automatically generated |  |
| **Factor Rotation**  a)  Formulate and solve the optimization function  (8 points) | s.t. (i)  🡪 = 4x1 weight vector on risky factor portfolios, = weight on risk-free asset,  = log-return of portfolio of risky factor portfolios and risk-free asset  (ii)  (iii)  🡪 = mean log returns over 2-year time horizon, = variance-covariance matrix  (ii) and (iii) into (i):  s.t.  Lagrange formulization:    FOCs:  (from 14.9) (iv)  (v)  (vi)  Solving for Lambda:  (vii)  (vii) into (iv):    (viii) **🡪 Optimal risky weights**  (viii) into (vi):    (iv) **🡪 Optimal risk-free weight** |  |
| b) Calculate time-varying weights of optimal portfolio  (10 points) | **Time-varying weights of factor model:**    based on the optimization solution:  risky weight vector:  risk-free weight: |  |
| c) Report performance measures and run Fama-French 5-factor regression  (10 points) | **Performance measures:**  Mean Return: 0.45%  Volatility: 0.86%  Sharpe Ratio: 46.3%  **Fama-French 5-factor regression:**  **Ein Bild, das Tisch enthält.  Automatisch generierte Beschreibung**  Based on the regression results, we can conclude that the degree of explanation of the portfolio returns, based on the Fama-French 5-factor model, is very low which can be seen at the R-squared of 6.8% and the p-value of 0.142, while the latter is normally significant when assuming confidence levels between 1-10%. Thus, the model can’t explain most of the variance in the portfolio returns and leads to insignificant and unreliable results. |  |