AI for finance: Project 1

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March 2023

Exercise 1

Collect price information of 'your stock' and stock market (S&P 500 index) from Yahoo Finance for the past 5 years, 15 years, and 30 years. Note that you have price information – not returns – calculate returns before you do anything since the CAPM is all about stock returns. Risk-free returns can be downloaded from `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html` **Comment on your results.**

stock: Sony Group Corporation (SONY)

yahoo finance: `https://it.finance.yahoo.com/quote/SONY?p=SONY&.tsrc=fin-srch`

Average Excess Return and Sharpe-ratio:

	5 Years	15 Years	30 Years
Average Excess Return	1.305	0.852	0.801
Sharpe-ratio	0.154	0.081	0.077

Ordinary Least Square (OLS) regression:

	5 Years	15 Years	30 Years
R-squared	0.426	0.373	0.257
Alpha	0.626	-0.055	0.161
Beta	1.031	1.360	1.209

Beta value of Sony Group Corporation (SONY) from yahoo finance over 5 years is 0.96, which is pretty close to our beta that also takes into account the risk-free rates over the five years. We can also observe how the model during the last 5 years has a R-squared of 0.426 which is nice if we take into account that we run our model using only one factor. So the model can explain around 40% of data and it loses explainability by increasing the number of years. The parameter beta

is always above 1 so SONY did quite good over the years compared to the market.

Exercise 2

Now consider that you are a portfolio manager and you have $1 million to invest, and hence you want to diversify the risk of owning 'your stock'. Pick any number of stocks (10 minimum) you want to create an equally weighted stock portfolio of stocks. Comment on your results

Portfolio Assets: Apple(AAPL) - Adobe(ADBE) - Disney(DIS) - IBM(IBM) - Intel(INTC) - CocaCola(KO) - Microsoft(MSFT) - Motorola(MSI) - Nike(NKE) - Walmart(WMT)

Average Excess Return and Sharpe-ratio:

	5 Years	15 Years	30 Years
Average Excess Return	1.070	1.218	1.225
Sharpe-ratio	0.201	0.253	0.229

By comparing the 5 years results of the portfolio with the single stock of the previous exercise we can see how, even if we a lower average return over the portfolio, the sharpe-ratio is better. This is due to the fact that by using multiple stock we are doing Diversification in a way to reduce the overall Idiosyncratic Risk related to each single asset and keeping only the Systematic Risk

Ordinary Least Square (OLS) regression:

	5 Years	15 Years	30 Years
R-squared	0.897	0.849	0.734
Alpha	0.453	0.589	0.669
Beta	0.938	0.942	1.052

By running the OLS regression with the portfolio the parameter beta is really close to 1. we are replicating the market. this is no surprise since the majority of the stocks i've chosen are also contained in the S&P 500 index.

Exercise 3

How did your portfolio perform during the recent crisis – August 2008 through March 2009?

Average Excess Return and Market Excess Return

	Crisis 2008-2009
Market Average Excess Return	-5.367
Portfolio Average Excess Return	-3.835
Portfolio Sharpe-ratio	-0.440

Ordinary Least Square (OLS) regression:

	Crisis 2008-2009
R-squared	0.921
Alpha	2.015
Beta	1.089

The portfolio during the crisis performed very awful (negative average return and negative sharpe-ratio). It also had a beta of 1.089 so it was replicating the market, but we do not want that because the overall market tends to be very bad during a crisis, we would like to make the beta as small as possible in order to go in the opposite way.

Exercise 4

Now add a risk-free bond to your portfolio. Assume that you are a risk-averse manager, and you want 40% of $1 million invested in risk-free rates and the rest (60%) in the stock portfolio you created in Exercise 3. Did the portfolio perform better than the "stocks" only portfolio during the 2007-2009 crisis?

Ordinary Least Square (OLS) regression:

By putting 40% of the portfolio value in risk-free rates it performed better and we managed to increase the average return and obtain a beta way lower than the previous one (without risk-free rates) which is good since we would like to avoid following the market during a crisis.

	Crisis 2008-2009
Market Average Excess Return	-5.367
Portfolio Average Excess Return	-2.320
Portfolio Sharpe-ratio	-0.444
R-squared	0.921
Alpha	1.192
Beta	0.654

Exercise 5

Now go back to Fama-French website – use the Rm-RF and redo Question 2.

Comparing Fama-French Rm-Rf with Market risk premium (calculated in exercise 2)

30 Years data	Fama-French(Rm-Rf)	Market risk premium
Average Excess Return	1.225	1.225
Sharpe-ratio	0.229	0.229
R-squared	0.730	0.734
Alpha	0.516	0.669
Beta	1.016	1.052

Exercise 6-7

Fama-French talks about different factors for stock/asset returns. Pleases run a multifactor model for the stock and portfolio you have created. The factors are: a) Market; b) SMB; c) HML; d)TERM=difference in yields between 10 year and 3 months U.S. Treasuries; e) CREDIT=difference in yields between BAA and AAA rated U.S. corporate bonds.

By running a multifactor model we are increasing the explainability of our data, resulting in a higher value of the R-squared parameter in both the single stock and portfolio benchmark.

Ordinary Least Square (OLS) regression comparison between single factor model and multifactor model over 30 years

Single stock (SONY)	Monofactor model (market risk)	Multifactor model
R-squared	0.257	0.317
Alpha	0.161	1.082
Beta	1.209	1.143

Weighted portfolio	Monofactor model (market risk)	Multifactor model
R-squared	0.734	0.755
Alpha	0.669	0.660
Beta	1.052	1.015

Exercise 8

Assume, there is only one factor, the market factor. You'd like to hedge the systematic risk/market risk in your portfolio since you expect an economic downturn. One way to achieve the goal is to use futures contracts. Specifically, you may want to use S&P500 futures to hedge. To accomplish this, you need to calculate the optimal hedge ratio since your portfolio may be related to the S&P500 futures differently than it is related to the S&P500 index, and then find the number of futures contract and establish a strategy. How many futures do you need and what is your hedging strategy?

By using derivatives we are hedging the portfolio over the market's loss. we can calculate the number of futures contracts as:

$$N = \beta * \frac{P}{C} \tag{1}$$

Ordinary Least Square (OLS) regression with futures changes

	Years 1997-2023
R-squared	0.768
Beta	1.037

With Beta = Optimal hedge ratio we can apply the formula and find the number of futures contract that we need

$$N = 5.221$$

Since we can buy only an integer number of contract we aim for an under-hedging strategy and take 5 contracts