EFM Week 6 Assignment

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In this assignment, we have just one objective: to test the CAPM. We've also included some simple NumPy questions at the start to get your warmed up. If you have any questions, feel free to email me (zzwang@uchicago.edu) or Allan (zhangallan@uchicago.edu) or Jason (zphang@uchicago.edu).

1 NumPy Exercises

1. Bernoulli Distribution

   a) We want to generate the results of 10,000 coin flips, where $H = 1$ and $T = 0$. Generate a NumPy array of 10,000 random numbers, using **numpy.random.random**. This produces a random draw of real numbers between 0 and 1.

   b) Produce a corresponding sequence of 1's (heads) and 0's (tails) by checking the each element of the array is larger than $p = 0.5$ This is NumPy, so this can be done in a single vector operation! (Your result should be a boolean array of length 10,000).

   c) Calculate the mean and variance of your draws using the relevant NumPy functions. What we have just done is 10,000 draws from something called a Bernoulli distribution with parameter $p = 0.5$, which gives 1 with probability p and 0 with probability p. This distribution has a theoretical mean and variance of:

   $$\text{Mean} = p$$

   $$\text{Variance} = p(1 - p)$$

   Do you get approximately correct mean and variance numbers?

d) Now repeat the above exercise using $p = 0.1$, $p = 0.3$ and $p = 0.9$. Are your numbers still in line with the above formulae?

2. Normal Distribution

a) Now we want to draw n =10,000 standard normal numbers. Do the same as the above, except using **numpy.random.randn**.

b) Calculate the mean and variance. Since this is a standard normal distribution, it should have mean 0 and variance 1.

c) From statistics, we know that

$$\mathbb{E}[aX + b] = a\mathbb{E}[X] + b$$

$$\text{Var}(aX + b) = a^2\text{Var}(X)$$

Where X is our random variable, and a and b are constants.

Now, choose you favorite a and b (say, $a = 3.14$ and $b = 2014$. Multiply your existing array of normal draws by a and add b), and see if your mean and variance chance as predicted.

2 Testing the CAPM

Note: If you are short on time, I would prefer that you spent your time thinking about parts 4 and 5, rather than parts 2 and 3. Thus, if you wish to use it, I have attached python code for a function that takes in a ticker as a string and returns a list of monthly returns, which should greatly speed up parts 2 and 3.

1. Skim through the Quandl Python guide (found here: "https://www.quandl.com/help/python") and download the Quandl Python library.

2. Get monthly adjusted closing prices of (1) the S&P 500 index and (2) all of the stocks in the DJIA 30 (with the exception of Visa) from Jan 1, 2007 to December 31, 2013.

   For your convenience, I have listed all of the tickers (minus VISA) here:

```
stock_list = ["AXP","BA","CAT","CSCO","CVX","DD","DIS","GE","GS","HD","IBM",
"INTC","JNJ","JPM","KO","MCD","MMM","MRK","MSFT","NKE","PFE","PG","T","TRV",
"UNH","UTX","VZ","WMT","XOM","INDEX_GSPC"]
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3. Write a function that takes these adjusted closing prices and gives us the monthly returns of the S&P 500 index as well as each of the 29 specified members of the DJIA 30 over this time period.

4. For each stock i, calculate the $\beta^{i,M}$ and the expected returns of the stock. Recall that $\beta^{i,M}$ of a stock is given by:

$$\beta^{i,M} = \frac{\sigma_{i,M}}{\sigma_M^2},$$

where we use S&P 500 returns (INDEX_GSPC) to represent the market.

5. Plot each stock by plotting $\beta^{i,M}$ on the x-axis and expected return on the y-axis. What would CAPM expect this graph to look like? What does it actually look like?