FTS Real Time System Project: Understanding Risk and Return

Question: How are risk and return typically measured?

When you invest in stocks or bonds or other securities, you have to decide how much you want to invest in each security. This decision requires you to estimate how well you think each security will perform, and how risky each security is. Beyond that, if you invest in more than one security, you may have a reduction of risk due to diversification. In this project, we explore common measures of risk and return, applied to stocks, and using the FTS 30 Stock Case.

Definitions

Let $E(r_i)$ denote the expected return from stock i. This is measured annually, so $E(r_i)$=10% means you expect the stock to return 10% over the year. For example, suppose a stock's current price is 50 and the expected return is 10%. Then, we expect that in one year, the stock price will be 55. It does not have to be 55, it could be more or less, but the expected value of prices in the future is 55.

There are many ways to estimate the expected return; stock analysts use techniques involving historical data, fundamental analysis, and scenario analysis. Values based on the CAPM are provided by the FTS Real Time Client, though you can override them with your own estimates using the "Parameters" menu item.

Modern portfolio theory uses the standard deviation of returns (also called *volatility*) as a measure of risk (or equivalently, the variance).

Expectations versus Realizations

Both the expected return and the volatility reflect expectations about the future. That's natural because when you make the decision to invest, you don't know what will happen in the future and so the decision must be based on estimates of what you think will happen.

What actually happens may or may not correspond to your expectations. For example, if the stock price is 60 at the end of the year instead of 55 as expected, you would have a realized return of 20%. Of course, that is only one observation, and one observation cannot confirm that our expectations were correct. To measure if our expectations were realized, we therefore calculate what happens over a number of observations and see whether on average, we were correct.

Operationally, this means that we calculate the return on each stock and the portfolio over a number of periods (e.g. daily) and then calculate the realized return, the average realized return and the volatility of the return.

Let r_{it} be the realized return on stock i between time t-1 and t, calculated as

$$r_{it} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}$$

Over T periods, we calculate the average of the individual stock returns and the standard deviation of these returns and compare them to the expectations. We can also calculate the realized return of the portfolio and compare it to the individual stocks, as we will do below.

Project

1. To start, buy two stocks. Buy 1 share of each stock. Choose the first stock to have a high volatility and expected return, choose the second to have low volatility and expected return. You can see the volatilities and expected returns in the Index Model (CAPM) analytics:

Edit | US Dollar | Stocks: Index Model (CAPM) | Parameters

Copy Selection
Copy All
Find
Export to Excel

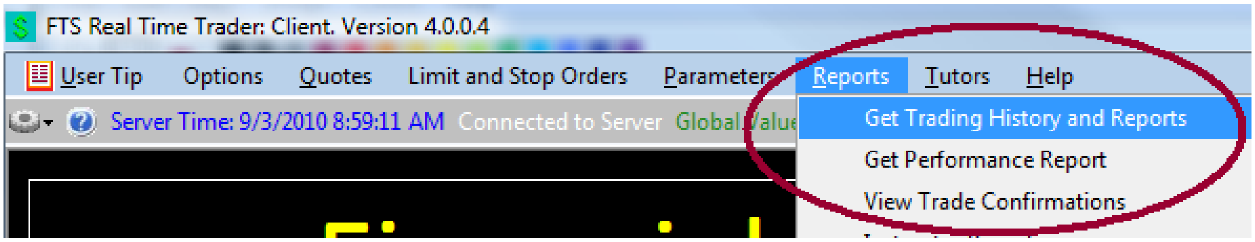
		Value	Beta	Exp Return	Volatility	Sharpe	Treynor	Jensen	M2
		99,255.20	0.9620	0.0804	0.2747	0.1552	0.0443	0.0000	
			1.4889	0.1038	0.4248	0.1553	0.0443	0.0000	
			1.4889	0.1038	0.4248	0.1553	0.0443	0.0000	
			1.0183	0.0829	0.2912	0.1549	0.0443	0.0000	
Benchmark			1.0000	0.0821	0.2853	0.1553	0.0443	0.0000	
Position (Raw)			1.0197	0.0830	0.2301	0.1852	0.0443	0.0000	
Name	Benchmark	Value	Beta	Risk Free Rate	Equity Premium	Exp Return	Volatility	Weight	Raw
AMERICAN EXPRESS	S&P 500 INDEX	8,360.00	2.1700	0.0378	0.0443	0.1340	0.3390	0.0842	
AT&T	S&P 500 INDEX	0.00	0.6600	0.0378	0.0443	0.0671	0.1431	0.0000	
BANK OF AMERICA	S&P 500 INDEX	2,700.00	2.4500	0.0378	0.0443	0.1464	0.4113	0.0272	
BOEING	S&P 500 INDEX	0.00	1.3100	0.0378	0.0443	0.0959	0.3032	0.0000	
CATERPILLAR	S&P 500 INDEX	7,008.00	1.8200	0.0378	0.0443	0.1185	0.2907	0.0706	
CHEVRON	S&P 500 INDEX	15,600.00	0.6900	0.0378	0.0443	0.0684	0.1850	0.1572	
CISCO SYSTEMS	S&P 500 INDEX	0.00	1.2400	0.0378	0.0443	0.0928	0.4414	0.0000	
COCA-COLA	S&P 500 INDEX	0.00	0.6200	0.0378	0.0443	0.0653	0.1388	0.0000	
E.I DU PONT DE NEMOURS	S&P 500 INDEX	0.00	1.4900	0.0378	0.0443	0.1038	0.2901	0.0000	
EXXONMOBIL	S&P 500 INDEX	6,132.00	0.4000	0.0378	0.0443	0.0556	0.2017	0.0618	
GENERAL ELECTRIC CO	S&P 500 INDEX	3,078.50	1.7100	0.0378	0.0443	0.1136	0.2931	0.0310	
HEWLETT-PACKARD CO	S&P 500 INDEX	0.00	1.0000	0.0378	0.0443	0.0821	0.4048	0.0000	

We have circled the expected return and volatility estimates as well as the Edit menu item of the analytics display. You can see that Coca Cola has an estimated expected return of 6.53% and volatility of 13.88% while American Express has a higher expected return and volatility. The steps below are shown for these stocks, you should do the analysis for the stocks you have selected.

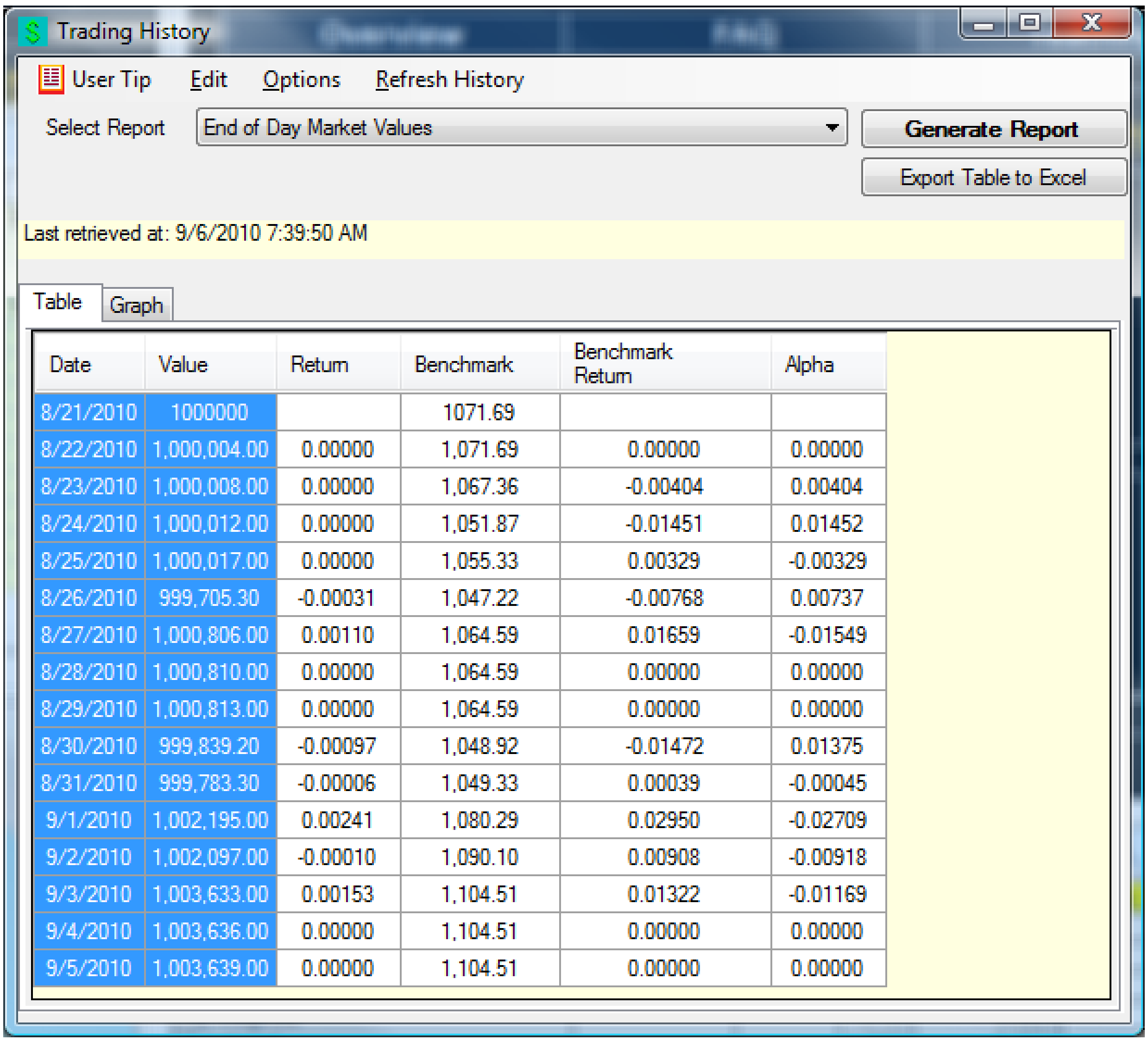
2. At the time you place your trades, keep a record of the expected return and volatility of the stocks you picked; the easiest way to do this is to export the analytics into Excel and save the spreadsheet; this is done by selecting "Export to Excel" from the Edit menu of the analytics

display, as shown above.   You can also copy and paste the information from the same edit menu.

3. After a few days (at least 5), calculate the realized average return and the volatility of each stock and your portfolio, as follows. The example below uses Coca Cola and American Express.
   - First, download your from the Reports menu at the top:

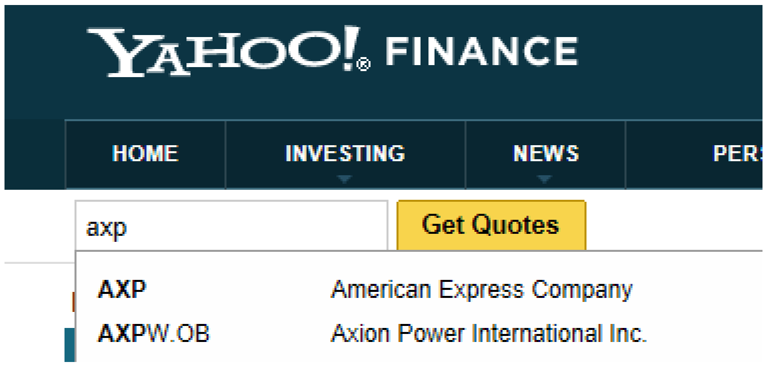


   - Generate the report "End of Day Market Values" and copy the selected information as shown and paste it into Excel:

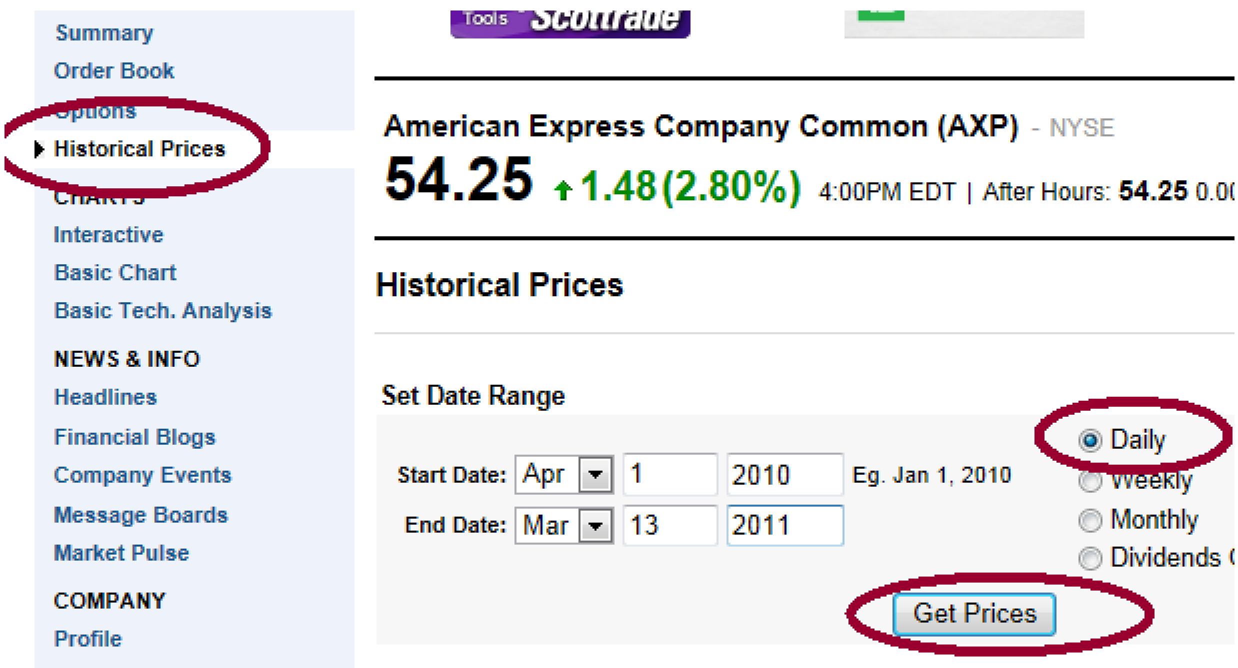


Date	Value	Return	Benchmark	Benchmark Return	Alpha
8/21/2010	1000000		1071.69		
8/22/2010	1,000,004.00	0.00000	1,071.69	0.00000	0.00000
8/23/2010	1,000,008.00	0.00000	1,067.36	-0.00404	0.00404
8/24/2010	1,000,012.00	0.00000	1,051.87	-0.01451	0.01452
8/25/2010	1,000,017.00	0.00000	1,055.33	0.00329	-0.00329
8/26/2010	999,705.30	-0.00031	1,047.22	-0.00768	0.00737
8/27/2010	1,000,806.00	0.00110	1,064.59	0.01659	-0.01549
8/28/2010	1,000,810.00	0.00000	1,064.59	0.00000	0.00000
8/29/2010	1,000,813.00	0.00000	1,064.59	0.00000	0.00000
8/30/2010	999,839.20	-0.00097	1,048.92	-0.01472	0.01375
8/31/2010	999,783.30	-0.00006	1,049.33	0.00039	-0.00045
9/1/2010	1,002,195.00	0.00241	1,080.29	0.02950	-0.02709
9/2/2010	1,002,097.00	-0.00010	1,090.10	0.00908	-0.00918
9/3/2010	1,003,633.00	0.00153	1,104.51	0.01322	-0.01169
9/4/2010	1,003,636.00	0.00000	1,104.51	0.00000	0.00000
9/5/2010	1,003,639.00	0.00000	1,104.51	0.00000	0.00000

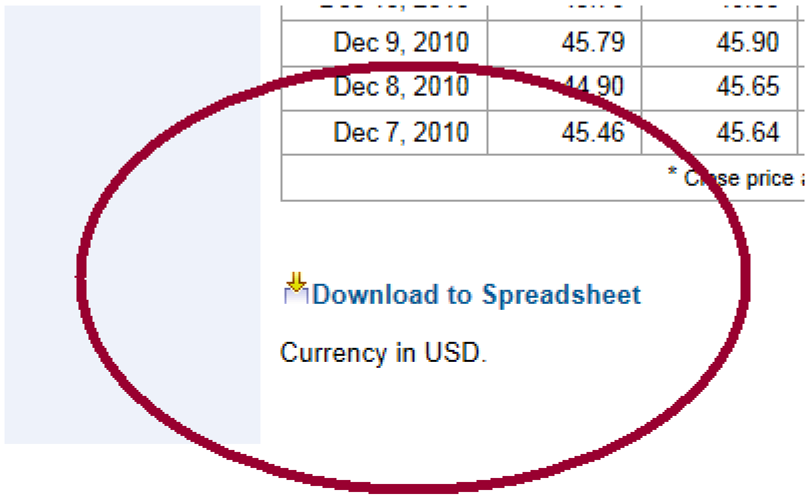
4. Download historical stock prices for AXP and KO. The easiest way to do this is through Yahoo Finance:
    - Go to finance.yahoo.com
    - Enter the ticker, say AXP and press Enter:



    - Click Historical Prices and set the date range. Make sure "Daily" is checked.

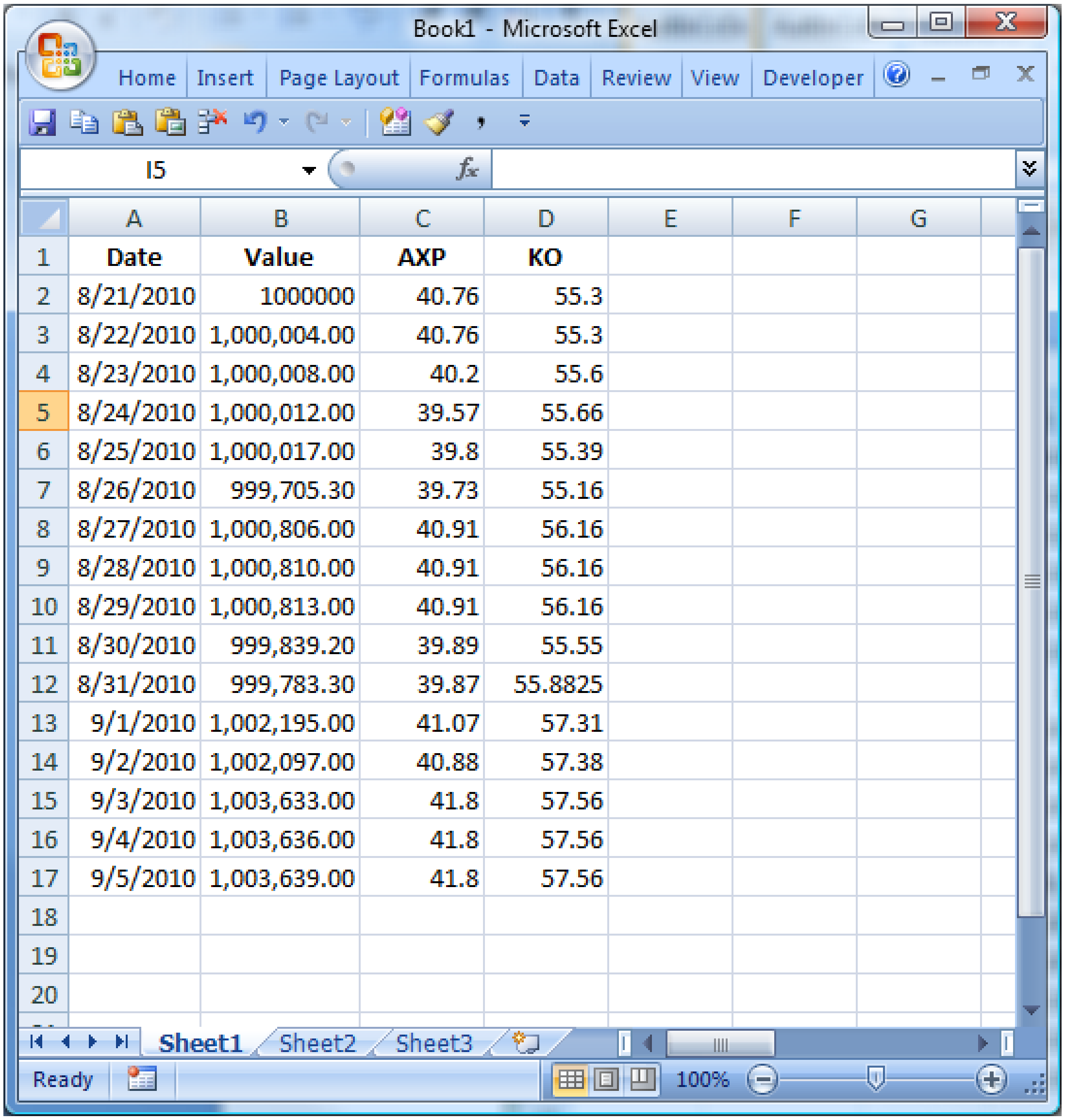


    - Click "Get Prices"
    - In the window that comes up, scroll down to where it says "Download to Spreadsheet:"



- This will download the historical prices for AXP into a spreadsheet. Now, you can copy and paste the data into the Excel spreadsheet with the daily market values.

5. In your Excel spreadsheet, line up the dates, and arrange the data as follows:



	Date	Value	AXP	KO
1	Date	Value	AXP	KO
2	8/21/2010	1000000	40.76	55.3
3	8/22/2010	1,000,004.00	40.76	55.3
4	8/23/2010	1,000,008.00	40.2	55.6
5	8/24/2010	1,000,012.00	39.57	55.66
6	8/25/2010	1,000,017.00	39.8	55.39
7	8/26/2010	999,705.30	39.73	55.16
8	8/27/2010	1,000,806.00	40.91	56.16
9	8/28/2010	1,000,810.00	40.91	56.16
10	8/29/2010	1,000,813.00	40.91	56.16
11	8/30/2010	999,839.20	39.89	55.55
12	8/31/2010	999,783.30	39.87	55.8825
13	9/1/2010	1,002,195.00	41.07	57.31
14	9/2/2010	1,002,097.00	40.88	57.38
15	9/3/2010	1,003,633.00	41.8	57.56
16	9/4/2010	1,003,636.00	41.8	57.56
17	9/5/2010	1,003,639.00	41.8	57.56

6. Now, we have to calculate returns. The return on a stock is calculated as:

$$r_{it} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}$$

where $P_{i,t}$ is the price of stock i on date t.

The return on your portfolio is calculated similarly:

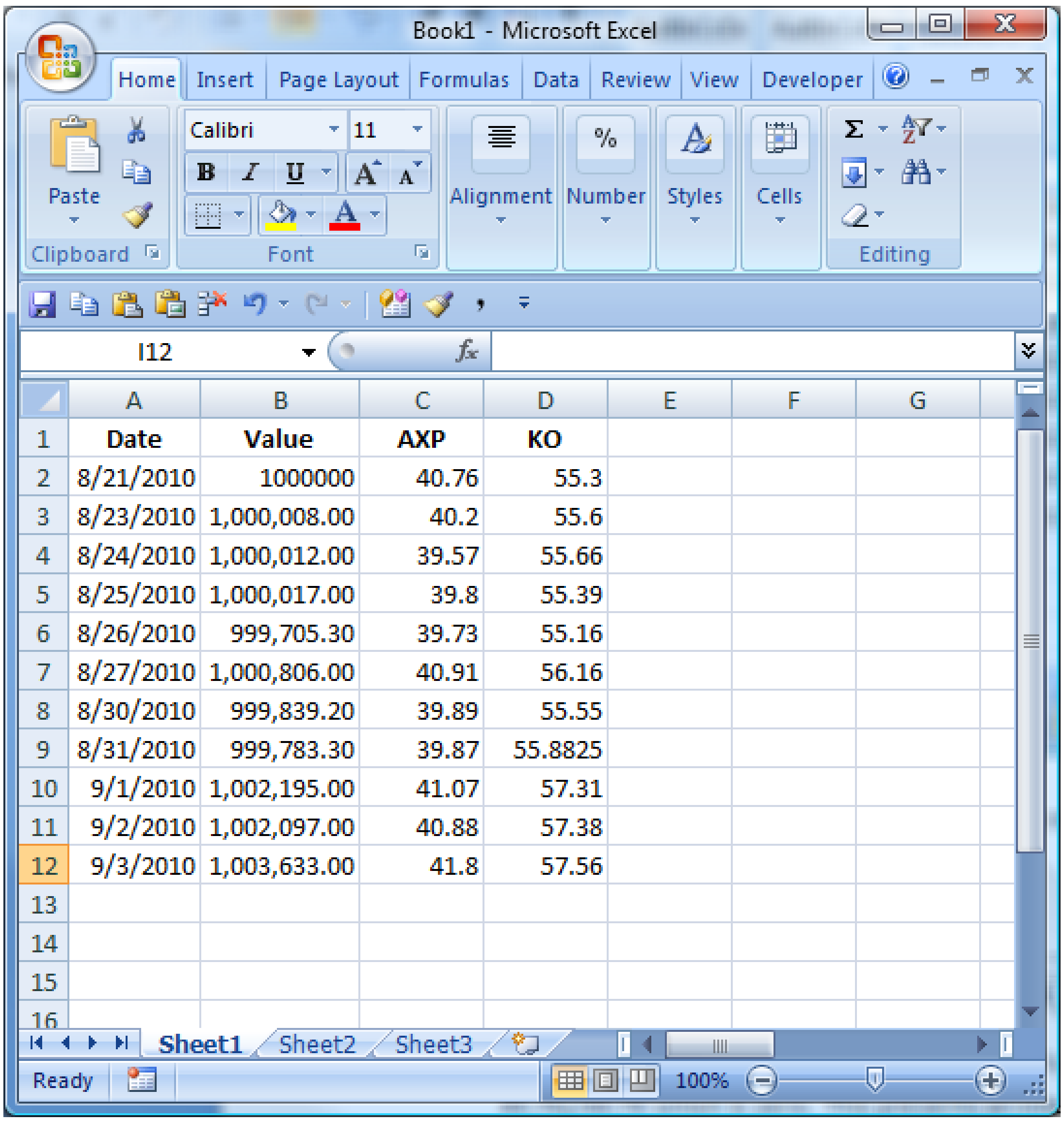
$$r_t = \frac{V_t - V_{t-1}}{V_{t-1}}$$

Where V_t is the value of your portfolio on date t.

In Excel, the stock returns are calculated as follows. For e.g. AXP, the return on 8/22/1010 is (40.76-40.76)/40.76 which is zero. This presents an interesting practical issue. 8/21/2010 was a Saturday, and 8/22/2010 was a Sunday, and so there was no change in the last traded price of AXP over those two days. So the return over these two days was zero. Some people prefer to ignore weekends because of this, because it artificially creates days of zero returns. You can see constant prices for three days on 8/27-8/29 and 9/3-9/5.

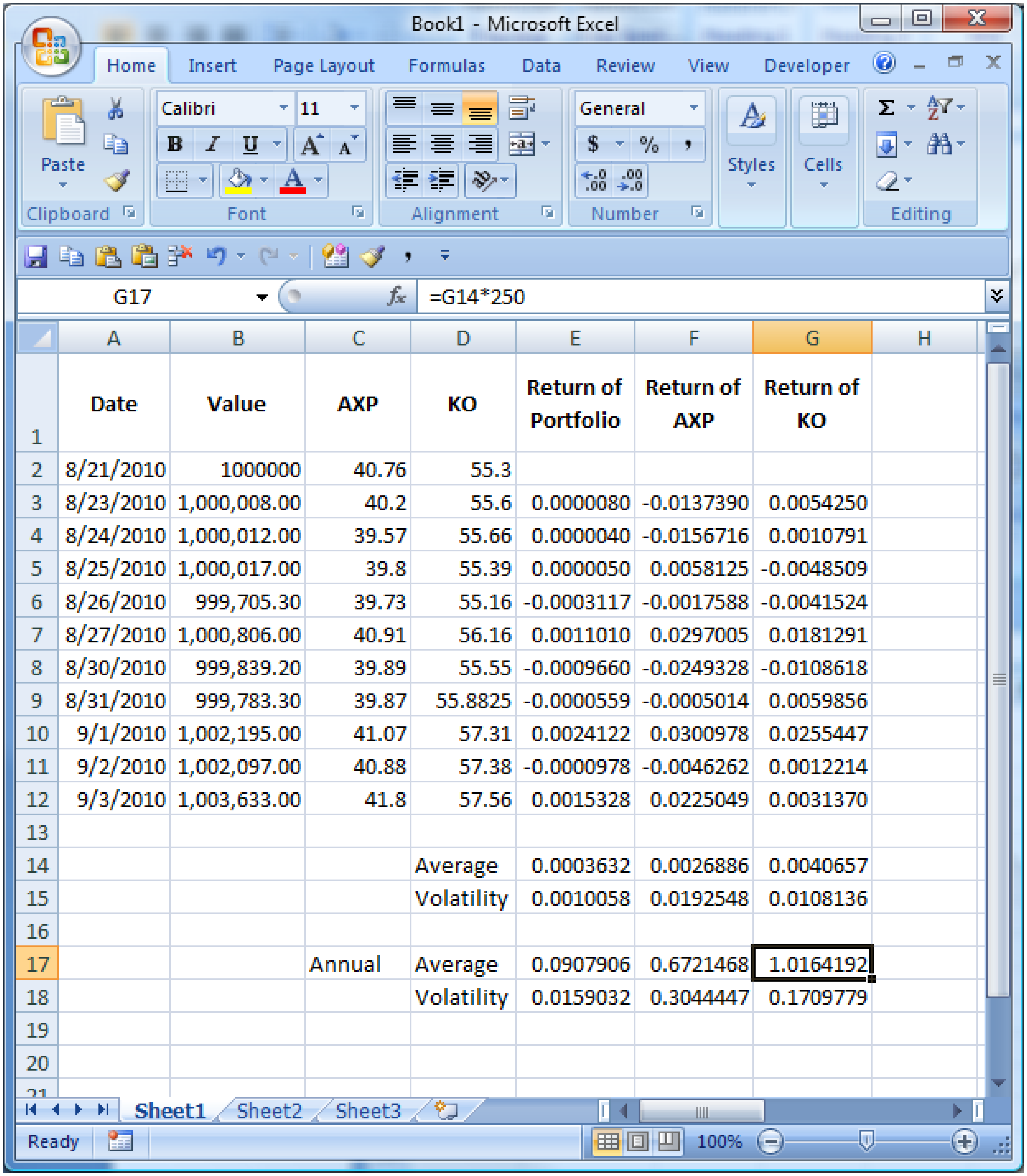
By replacing the stock price with your portfolio value, you can similarly calculate the portfolio return.

7. After removing the weekends (keeping the Friday price and deleting Saturday and Sunday), we get:
8.



	A	B	C	D
1	Date	Value	AXP	KO
2	8/21/2010	1000000	40.76	55.3
3	8/23/2010	1,000,008.00	40.2	55.6
4	8/24/2010	1,000,012.00	39.57	55.66
5	8/25/2010	1,000,017.00	39.8	55.39
6	8/26/2010	999,705.30	39.73	55.16
7	8/27/2010	1,000,806.00	40.91	56.16
8	8/30/2010	999,839.20	39.89	55.55
9	8/31/2010	999,783.30	39.87	55.8825
10	9/1/2010	1,002,195.00	41.07	57.31
11	9/2/2010	1,002,097.00	40.88	57.38
12	9/3/2010	1,003,633.00	41.8	57.56

Now, calculate the returns. For AXP, the return on 8/23 is (40.2-40.76)/40.2, so the cell formula, which we put in cell F3 is **=(C3-C2)/C2.** You can copy and paste this formula to cells F4 to F12 and then G3 to G12 to get all the returns for the two stocks. Copying it to cells E3 to E12 will give you the return on your portfolio:

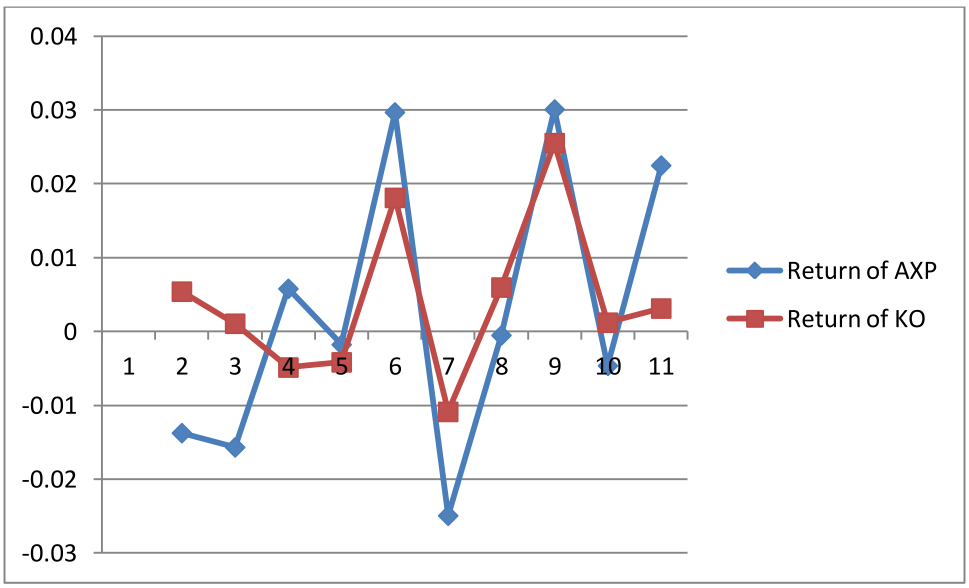


	A	B	C	D	E	F	G	H
1	Date	Value	AXP	KO	Return of Portfolio	Return of AXP	Return of KO	
2	8/21/2010	1000000	40.76	55.3				
3	8/23/2010	1,000,008.00	40.2	55.6	0.0000080	-0.0137390	0.0054250	
4	8/24/2010	1,000,012.00	39.57	55.66	0.0000040	-0.0156716	0.0010791	
5	8/25/2010	1,000,017.00	39.8	55.39	0.0000050	0.0058125	-0.0048509	
6	8/26/2010	999,705.30	39.73	55.16	-0.0003117	-0.0017588	-0.0041524	
7	8/27/2010	1,000,806.00	40.91	56.16	0.0011010	0.0297005	0.0181291	
8	8/30/2010	999,839.20	39.89	55.55	-0.0009660	-0.0249328	-0.0108618	
9	8/31/2010	999,783.30	39.87	55.8825	-0.0000559	-0.0005014	0.0059856	
10	9/1/2010	1,002,195.00	41.07	57.31	0.0024122	0.0300978	0.0255447	
11	9/2/2010	1,002,097.00	40.88	57.38	-0.0000978	-0.0046262	0.0012214	
12	9/3/2010	1,003,633.00	41.8	57.56	0.0015328	0.0225049	0.0031370	
13								
14				Average	0.0003632	0.0026886	0.0040657	
15				Volatility	0.0010058	0.0192548	0.0108136	
16								
17			Annual	Average	0.0907906	0.6721468	1.0164192	
18				Volatility	0.0159032	0.3044447	0.1709779	
19								
20								

We have calculated the returns as well as the average of each return and its volatility. The average return for AXP in cell F14 is the formula **=AVERAGE(F3:F12)** and the volatility, or standard deviation, of the return of AXP in Cell F15 is the formula **=STDEV(F3:F12).**

We have also calculated the annual average return and the volatility. The annual average return is the daily return multiplied by 250. The annual volatility is the daily volatility multiplied by the *square root* of 250.

You can see that over our small sample, the return of AXP was more volatile than the return of KO (0.0192 compared to 0.0108) and it had a lower average return. When we started, we expected AXP to have a higher volatility and a higher return. You can also see this by plotting the return in Excel:



Over our sample, the return of AXP had bigger movements than that of KO, which is a characteristic of higher volatility.

Finally, consider the portfolio volatility. It is much lower, 0.001. This is because we started the exercise with $1m in case, and only bought 1 of each stock. So most of our money was in cash. The small volatility of our portfolio is due mainly to this: the stocks are such a small part of the portfolio that their volatility did not affect the portfolio values that much.