



FTS Real Time 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.
 - You can conduct this project with any of the equity cases. In our description, we will use the FTS 30 Stock Case.
 - If you are not familiar with the FTS Real Time Client, we suggest you work through the [“How Securities are Traded”](#) project.

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 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.

Project

1. To start, buy two stocks. Invest an equal dollar amount in each. For example, if you start with \$1m, you could invest \$495,000 in each stock.
 - Why 495,000 and not 500,000? See below.
 - You have to calculate the number of shares of each stock. This is done as follows: if P is the price of the stock, and you want to invest \$495,000, then the number of shares is $495000/P$. If this is not a round number, you have to round it down or up.
 - You may not be able to trade at exactly the price at which you calculated the number of shares because stock prices can change fairly quickly. Also, you buy at the ask price, which is typically higher than the last traded price. So we recommend investing a slightly smaller amount, e.g. \$495,000, in each stock, so you don't run out of money.
 - So if P is the stock price, the number of shares will be rounded to $495000/P$.
 - If the number of shares is large, you may have to trade several times; this is illustrated below.
2. Choose the stocks to have different volatilities and expected returns. You can see the volatilities and expected returns in the Index Model (CAPM) analytics, shown below
 - We have circled the expected return and volatility estimates as well as the Edit menu item of the analytics display. We will select 3M and AT&T as our stocks.

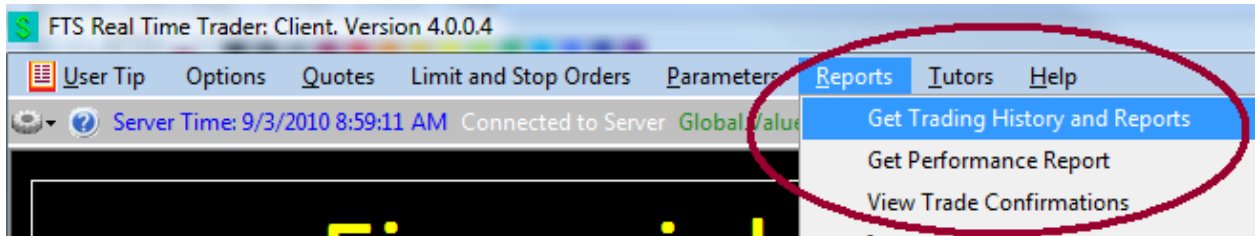
Financial TV and News	Analytics	Company Filings								
Edit	US Dollar	Stocks: Index Model (CAPM)	Parameters	UserTip						
Copy Selection			Value	Beta	Exp Return	Volatility	Sharpe	Treynor	Jen	
Copy All			0.00	0.0000	0.0000	0.0000	N/A	N/A	-0.0	
Find			1.7955	0.1102	0.2155	0.4249	0.0510	0.0		
Export to Excel			1.7955	0.1102	0.2155	0.4249	0.0510	0.0		
			0.9876	0.0690	0.1222	0.4120	0.0510	0.0		
Benchmark			1.0000	0.0696	0.1200	0.4250	0.0510	0.0		
Position (Raw)			0.00	0.0000	0.0000	0.0000			-0.0	
Name	Benchmark	Value	Beta	Risk Free Rate	Equity Premium	Exp Return	Volatility	We		
3M (MMM)	S&P 500 INDEX	0.00	1.0700	0.0186	0.0510	0.0732	0.1660			
ALCOA (AA)	S&P 500 INDEX	0.00	1.8600	0.0186	0.0510	0.1135	0.1938			
AMERICAN EXPRESS (AXP)	S&P 500 INDEX	0.00	1.0200	0.0186	0.0510	0.0707	0.1922			
AT&T (T)	S&P 500 INDEX	0.00	0.3900	0.0186	0.0510	0.0385	0.2012			
BANK OF AMERICA (BAC)	S&P 500 INDEX	0.00	1.7800	0.0186	0.0510	0.1094	0.2546			
CATERPILLAR (CAT)	S&P 500 INDEX	0.00	1.7900	0.0186	0.0510	0.1099	0.2175			
CHEVRON (CVX)	S&P 500 INDEX	0.00	1.1800	0.0186	0.0510	0.0788	0.1637			
CISCO SYSTEMS (CSCO)	S&P 500 INDEX	0.00	1.4100	0.0186	0.0510	0.0906	0.2185			
E.I DU PONT DE NEMOURS (DD)	S&P 500 INDEX	0.00	1.4800	0.0186	0.0510	0.0941	0.2060			
EXXON MOBIL (XOM)	S&P 500 INDEX	0.00	0.8600	0.0186	0.0510	0.0625	0.1571			
GENERAL ELECTRIC (GE)	S&P 500 INDEX	0.00	1.4000	0.0186	0.0510	0.0900	0.2116			
HEWLETT-PACKARD (HPQ)	S&P 500 INDEX	0.00	1.5200	0.0186	0.0510	0.0962	0.3502			
HOME DEPOT (HD)	S&P 500 INDEX	0.00	1.0100	0.0186	0.0510	0.0702	0.1502			
INTEL (INTC)	S&P 500 INDEX	0.00	0.0000	0.0186	0.0510	0.0601	0.2261			

- 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 can be 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, as we have done.
- When we placed our trades, we received the following trade confirmations:

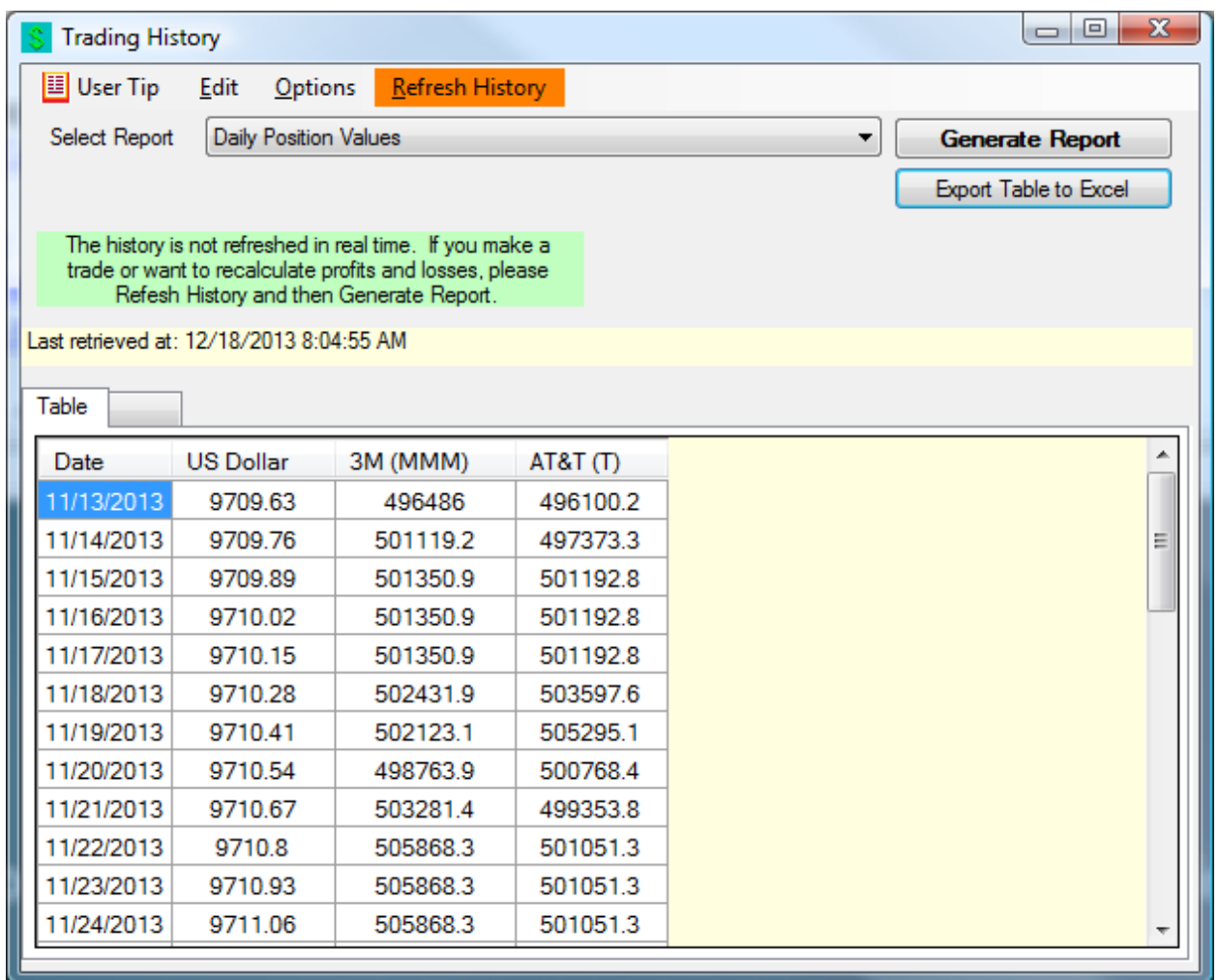
Trade Confirmations/Session History	
File	Edit Options
Time	Activity
11/13/2013 9:47:04 AM	CASHBUY BY
11/13/2013 9:47:52 AM	CASHBUY BY
11/13/2013 9:48:04 AM	CASHBUY BY

And your position summary shows that we have invested approximately \$495,000 in each of the stocks.

5. After a few days (at least 5), calculate the realized average return and the volatility of each stock and your portfolio, as follows.
 - First, download your history from the Reports menu at the top:



- Select the report "Daily Position Values"



- Export the table to Excel:

Book1 - Microsoft Excel

Home Insert Page Layout Formulas Data Review View Developer

Paste Font Alignment Number Styles Cells Editing

G28

	A	B	C	D	E	F	G	H	I
1	Date	US Dollar	3M (MMM)	AT&T (T)					
2	11/13/2013	9709.63	496486	496100.2					
3	11/14/2013	9709.76	501119.2	497373.3					
4	11/15/2013	9709.89	501350.9	501192.8					
5	11/16/2013	9710.02	501350.9	501192.8					
6	11/17/2013	9710.15	501350.9	501192.8					
7	11/18/2013	9710.28	502431.9	503597.6					
8	11/19/2013	9710.41	502123.1	505295.1					
9	11/20/2013	9710.54	498763.9	500768.4					
10	11/21/2013	9710.67	503281.4	499353.8					
11	11/22/2013	9710.8	505868.3	501051.3					
12	11/23/2013	9710.93	505868.3	501051.3					
13	11/24/2013	9711.06	505868.3	501051.3					
14	11/25/2013	9711.19	506679	500344					
15	11/26/2013	9711.32	510231.1	499070.9					
16	11/27/2013	9711.45	515443.5	500909.8					
17	11/28/2013	9711.58	515443.5	500909.8					
18	11/29/2013	9711.71	515482.1	498080.7					
19									
20									
21									
22									

Daily Position Values Sheet1 Sheet2 Sheet3

Ready 100%

6. Remove weekends and holidays

- Why: because markets are closed on those days and so the value of the position will not change, i.e. you will have a zero return on those days, which will bias your results.
 - During our exercise, the US Thanksgiving holiday was on November 28, as shown:

	A	B	C	D	E	F	G	H	I	J
1		Date	US Dollar	3M (MMM)	AT&T (T)					
2	Wednesday	11/13/2013	9709.63	496486	496100.2					
3	Thursday	11/14/2013	9709.76	501119.2	497373.3					
4	Friday	11/15/2013	9709.89	501350.9	501192.8					
5	Saturday	11/16/2013	9710.02	501350.9	501192.8					
6	Sunday	11/17/2013	9710.15	501350.9	501192.8					
7	Monday	11/18/2013	9710.28	502431.9	503597.6					
8	Tuesday	11/19/2013	9710.41	502123.1	505295.1					
9	Wednesday	11/20/2013	9710.54	498763.9	500768.4					
10	Thursday	11/21/2013	9710.67	503281.4	499353.8					
11	Friday	11/22/2013	9710.8	505868.3	501051.3					
12	Saturday	11/23/2013	9710.93	505868.3	501051.3					
13	Sunday	11/24/2013	9711.06	505868.3	501051.3					
14	Monday	11/25/2013	9711.19	506679	500344					
15	Tuesday	11/26/2013	9711.32	510231.1	499070.9					
16	Wednesday	11/27/2013	9711.45	515443.5	500909.8					
17	Thursday	11/28/2013	9711.58	515443.5	500909.8					
18	Friday	11/29/2013	9711.71	515482.1	498080.7					
19										
20										
21										

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

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

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

8. Calculate the returns in Excel. The first day on which we have a return is 11/14/2013, i.e. the second day. The value of our position in 3M on that day is 501119.2, up from 496486 on 11/13/2013.

- The return is $(501119.2 - 496486) / 496486 = 0.00933$
 - Side note: at the time we bought 3M on 11/13/2013, the value was 494980. The value at the end of the day was 496486, so the stock gained value within the day. The calculations here are all based on end-of-day values.

- The formula in the spreadsheet is $=(C3-C2)/C2$
- The formula for the first return for AT&T is $=(D3-D2)/D2$
- The formula's for all the returns are shown in this picture:

The screenshot shows a Microsoft Excel window titled "RT_RiskReturn.xlsx". The spreadsheet has columns labeled A through G. Column A contains dates from 41591 to 41607. Column B contains US Dollar values. Column C contains 3M (MMM) values. Column D contains AT&T (T) values. Column E contains MMM Return calculations, and Column F contains AT&T Return calculations. The formula bar shows $=(C3-C2)/C2$ for cell E3. The spreadsheet data is as follows:

	A	B	C	D	E	F
	Date	US Dollar	3M (MMM)	AT&T (T)	MMM Return	AT&T Return
1						
2	41591	9709.63	496486	496100.2		
3	41592	9709.76	501119.2	497373.3	$=(C3-C2)/C2$	$=(D3-D2)/D2$
4	41593	9709.89	501350.9	501192.8	$=(C4-C3)/C3$	$=(D4-D3)/D3$
5	41596	9710.28	502431.9	503597.6	$=(C5-C4)/C4$	$=(D5-D4)/D4$
6	41597	9710.41	502123.1	505295.1	$=(C6-C5)/C5$	$=(D6-D5)/D5$
7	41598	9710.54	498763.9	500768.4	$=(C7-C6)/C6$	$=(D7-D6)/D6$
8	41599	9710.67	503281.4	499353.8	$=(C8-C7)/C7$	$=(D8-D7)/D7$
9	41600	9710.8	505868.3	501051.3	$=(C9-C8)/C8$	$=(D9-D8)/D8$
10	41603	9711.19	506679	500344	$=(C10-C9)/C9$	$=(D10-D9)/D9$
11	41604	9711.32	510231.1	499070.9	$=(C11-C10)/C10$	$=(D11-D10)/D10$
12	41605	9711.45	515443.5	500909.8	$=(C12-C11)/C11$	$=(D12-D11)/D11$
13	41607	9711.71	515482.1	498080.7	$=(C13-C12)/C12$	$=(D13-D12)/D12$
14						
15						
16						
17						
18						

- The calculated numbers are:

	A	B	C	D	E	F	G	H	I	J
1	Date	US Dollar	3M (MMM)	AT&T (T)	MMM Return	AT&T Return				
2	11/13/2013	9709.63	496486	496100.2						
3	11/14/2013	9709.76	501119.2	497373.3	0.009332	0.002566				
4	11/15/2013	9709.89	501350.9	501192.8	0.000462	0.007679				
5	11/18/2013	9710.28	502431.9	503597.6	0.002156	0.004798				
6	11/19/2013	9710.41	502123.1	505295.1	-0.00061	0.003371				
7	11/20/2013	9710.54	498763.9	500768.4	-0.00669	-0.00896				
8	11/21/2013	9710.67	503281.4	499353.8	0.009057	-0.00282				
9	11/22/2013	9710.8	505868.3	501051.3	0.00514	0.003399				
10	11/25/2013	9711.19	506679	500344	0.001603	-0.00141				
11	11/26/2013	9711.32	510231.1	499070.9	0.007011	-0.00254				
12	11/27/2013	9711.45	515443.5	500909.8	0.010216	0.003685				
13	11/29/2013	9711.71	515482.1	498080.7	7.49E-05	-0.00565				
14										
15										
16										
17										
18										
19										

9. Now, we calculate the average return and the volatility. The average return for MMM is the Excel formula **=AVERAGE(E3:E13)** and the volatility, or standard deviation, of the return of MMM is the Excel formula **=STDEV(E3:E12)**.

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.

	B	C	D	E	F	G	H	I	J	K
1	US Dollar	3M (MMM)	AT&T (T)	MMM Return	AT&T Return					
2	9709.63	496486	496100.2							
3	9709.76	501119.2	497373.3	0.0093320	0.0025662	2.332996				
4	9709.89	501350.9	501192.8	0.0004624	0.0076793	0.115591				
5	9710.28	502431.9	503597.6	0.0021562	0.0047982	0.539044				
6	9710.41	502123.1	505295.1	-0.0006146	0.0033707	-0.15365				
7	9710.54	498763.9	500768.4	-0.0066900	-0.0089585	-1.6725				
8	9710.67	503281.4	499353.8	0.0090574	-0.0028249	2.264348				
9	9710.8	505868.3	501051.3	0.0051401	0.0033994	1.285017				
10	9711.19	506679	500344	0.0016026	-0.0014116	0.400648				
11	9711.32	510231.1	499070.9	0.0070106	-0.0025444	1.752638				
12	9711.45	515443.5	500909.8	0.0102158	0.0036846	2.553941				
13	9711.71	515482.1	498080.7	0.0000749	-0.0056479	0.018722				
14										
15			Average	0.00343156	0.00037374					
16			Volatility	0.00521623	0.00502134					
17										
18		Annualized	Average	0.85789031	0.09343428					
19			Volatility	0.08247591	0.07939443					
20										
21										

You can see that over our small sample, the return of MMM was more volatile than the return of AT&T and it had a higher average return. When we started, we expected the opposite.

10. Can we explain what happened?

- During this period, there was a lot of positive news and information about MMM. Here are news headlines, taken from Yahoo Finance. This explains the strong performance of MMM over this period.
 - If you look at the news for AT&T, you will see that there was nothing similar.

http://finance.yahoo.com/q/h?s=MMM&t=2013-11-28

MMM Headlines | 3M ...

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Major Holders
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Insider Roster
FINANCIALS
Income Statement
Balance Sheet
Cash Flow

3M Company (MMM) - NYSE ★ Follow

139.42 ↑0.07 (0.05%) Dec 30, 4:03PM EST

Headlines Get Headlines

Wednesday, November 27, 2013
Dow Today: 3M (MMM) Higher at TheStreet (Wed, Nov 27)

Tuesday, November 26, 2013
Dow Today: 3M (MMM) Higher at TheStreet (Tue, Nov 26)
The 3M Juggernaut at Barrons.com (Tue, Nov 26)

Monday, November 25, 2013
3M Announces 2013 Eco Grants Recipients Business Wire (Mon, Nov 25)
Only Eight Dow Components With Recent Insider Buying, MMM is One of Them at Forbes (Mon, Nov 25)
Want to Cut Government Waste? Find the \$8.5 Trillion the Pentagon Can't Account For The Daily Ticker (Mon, Nov 25)

Saturday, November 23, 2013
These 4 Stocks Made Dow 16,000 Happen at Motley Fool (Sat, Nov 23)

Wednesday, November 20, 2013
3M Introduces New Command Outdoor Decorating Products Business Wire (Wed, Nov 20)
3M Hits 52-Week High Zacks (Wed, Nov 20)
3M Innovation Helps Enable G2E 2013 "Best Slot Product" Show Winners Business Wire (Wed, Nov 20)

Tuesday, November 19, 2013
3M CO Files SEC form 8-K, Other Events EDGAR Online (Tue, Nov 19)
3M Licenses Fentanyl Transdermal Patch Technology to STADA Arzneimittel AG Business Wire (Tue, Nov 19)

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