Estimating the risk of a stock I (‘Total Risk’)

Recap: What is Risk?

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Risk can have many meanings and measures.

Ricciardi (2008) lists 188+ types of risk in the traditional & behavioural finance literature.

Ricciardi, V. 2008. 'Risk: Traditional Finance versus Behavioral Finance.' In *Handbook of Finance, 3: Valuation, Financial Modeling and Quantitative Tools,* pp. 11 – 38. Hoboken, NJL John Wiley & Sons, Inc.

Recap: What is Risk?

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The general consensus is that it’s the likelihood or value of you losing your money.

Exploring Risk

Generally speaking, all stocks are impacted by 2 types of risk:

- Firm specific risk
- Market risk

Exploring Risk

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Firms could...	Become insolvent (go bankrupt), face leadership issues, make poor decisions, scandals, etc.	Reasons your investments are risky.
Markets could face...	Inflation, deflation, recession, depression, political turmoil, changes in interest rates, natural calamities, etc.	

Exploring Risk

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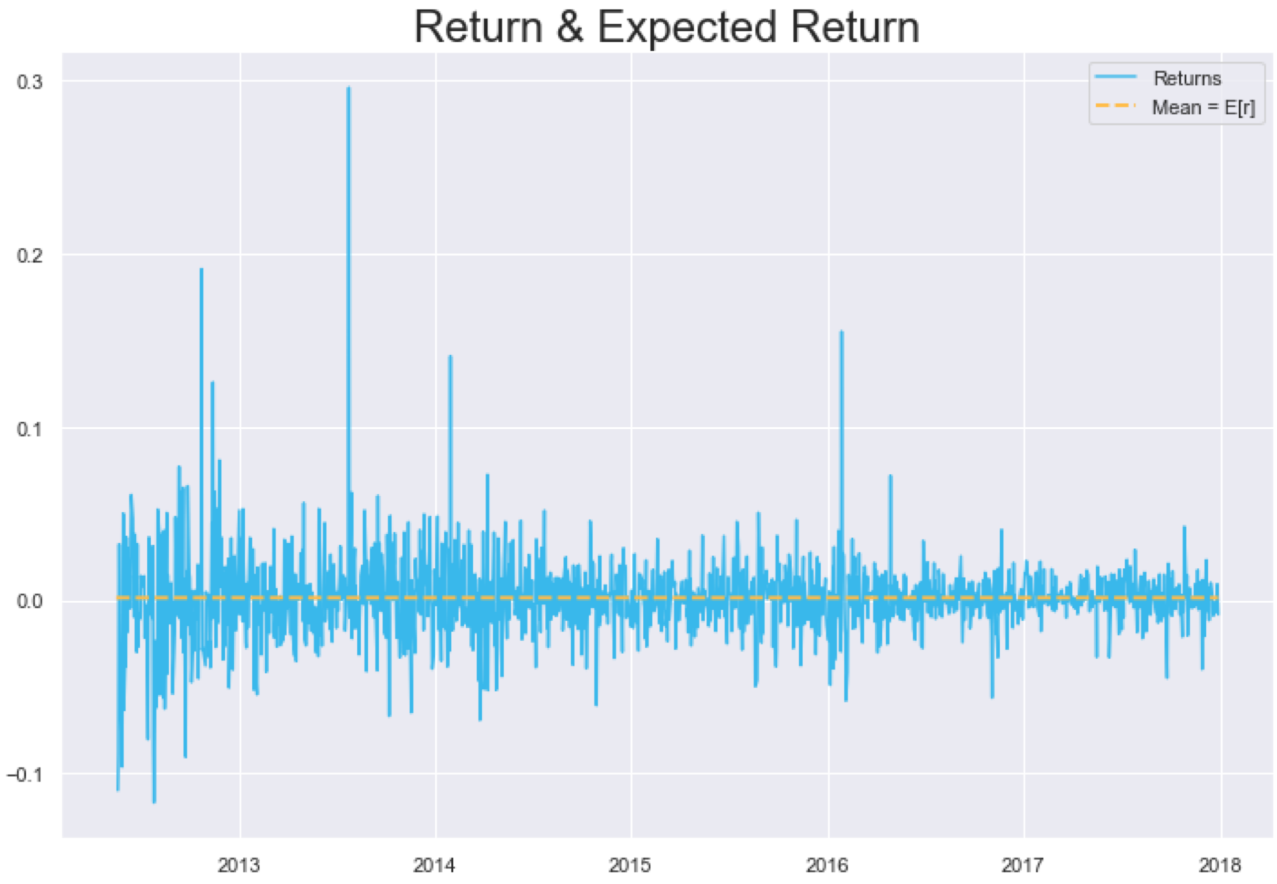
The 'Total Risk' of any stock / firm is then:

Total Risk = Market Risk + Firm Specific Risk

Measuring Total Risk

A generally accepted measure of the Total Risk of stocks is its volatility (i.e., its 'Standard Deviation').

Remember this graph?



r_{FB}

$E[r_{FB}] = 0.13\%$

Volatility ≈ Risk

The greater the disparity between r_j and $E[r_j]$, the greater the volatility of j.

And the greater the risk of j.

Volatility ≈ Risk

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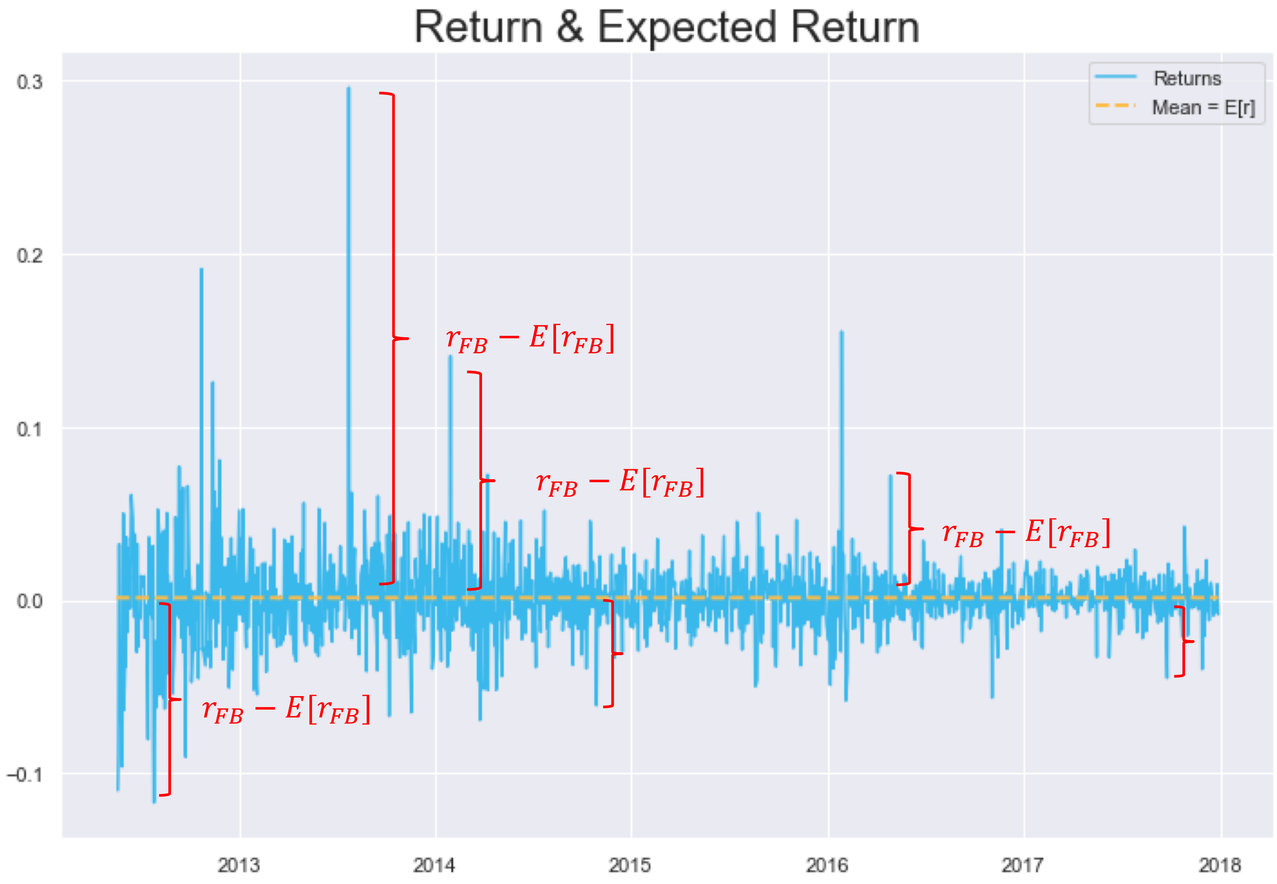
The volatility (risk) of a stock *j* increases as $(r_j - E[r_j])$ increases.

Deviations of Returns

We define $(r_j - E[r_j])$ as 'deviations'.

Because this value represents the deviation from the mean expectation.

Deviations of Returns



r_{FB}

$E[r_{FB}] = 0.13\%$

Sum of Deviations

Adding each deviation for all observations gives us the sum of all deviations.

This value will always be equal to 0.

Sum of Deviations = 0

That's because positive deviations cancel off negative deviations, resulting in a net effect of 0.

Sum of Deviations

$$\sum_{t=1}^{n} \left(r_j - E[r_j]\right) = 0$$

$$\left(r_{j1} - E[r_j]\right) + \left(r_{j2} - E[r_j]\right) + \cdots + \left(r_{jn} - E[r_j]\right) = 0$$

This only holds if $E[r_j] = \frac{1}{n}\sum_{t=1}^{n} r_j$

Application (Manual, FB)

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Date	P_{FB}	r_{FB}	$r_{FB} - E[r_{FB}]$
Jan 02, 2018	181.42	#N/a	#N/a
Jan 03, 2018	184.67	0.017914232	0.010870265
Jan 04, 2018	184.33	-0.001841122	-0.008885089
Jan 05, 2018	186.85	0.013671133	0.006627167
Jan 08, 2018	188.28	0.007653198	0.000609231
Jan 09, 2018	187.87	-0.002177608	-0.009221574

$$\boxed{E[r_{FB}] = \frac{1}{n}\sum_{t=1}^{n} r_{FB}}$$

Sum = 0

Sum of Deviations

$$\sum_{t=1}^{n}\left(r_j - E\left[r_j\right]\right) = 0\,, \forall\, j \in A$$

Where:

r_j = Return on a stock j

$E\left[r_j\right]$ = Expected Return on a stock j

$\forall\, j$ = For all j belonging to any asset class 'A'.

Sum of Deviations

Evidently, the sum of deviations by itself is of little value to us.

Sum of Squared Deviations

We can overcome the zero-sum issue by using the sum of squared deviations ("SSD").

Sum of Squared Deviations

$$SSD = \sum_{t=1}^{n} \left(r_j - E[r_j]\right)^2$$

$$SSD = \left(r_{j1} - E[r_j]\right)^2 + \left(r_{j2} - E[r_j]\right)^2 + \cdots + \left(r_{jn} - E[r_j]\right)^2$$

Sum of Squared Deviations

Squared deviations ensure that volatility is always expressed as a positive number.

Sum of Squared Deviations

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It also ensures that a value of 0 can reasonably be interpreted as ‘risk-free’.

Sum of Squared Deviations

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Finally, it ensures that deviations are penalised appropriately.

So that stocks with large deviations are interpreted as more risky (and vice-versa).

Variance of a Stock

Sum of Squared Deviations, divided by $n - 1$ gives us the 'variance'; a measure for volatility.

Variance of a Stock

$$var(r_j) = \frac{1}{n-1}\sum_{t=1}^{n}\left(r_j - E[r_j]\right)^2 \equiv \sigma_j^2$$

Where:

r_j = Return on a stock j

$E[r_j]$ = Expected Return on a stock j

n = Total number of 'time series' observations.

$var(r_j) \equiv \sigma_j^2$ = Variance of the returns on a stock j

Variance of a Stock ($n - 1$ rationale)

We divide the SSD by $n - 1$ because this is the 'unbiased estimator' of the 'true' variance.

Variance of a Stock

$$\sigma_j^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(r_j - E\left[r_j\right]\right)^2$$

$$\sigma_j^2 = \frac{\left(r_{j1} - E\left[r_j\right]\right)^2 + \left(r_{j2} - E\left[r_j\right]\right)^2 + \cdots + \left(r_{jn} - E\left[r_j\right]\right)^2}{n-1}$$

Variance of a Stock

While the variance is a measure of volatility (risk), its interpretation is limited.

It also tends to be a very small number.

Standard Deviation of a Stock

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We overcome the limitations of the variance by taking its square root.

Standard Deviation of a Stock

This also ensures that the value is expressed in percentage terms.

Standard Deviation of a Stock

This makes it easier to compare the risk with the return.

Standard Deviation of a Stock

$$SD(r_j) = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}\left(r_j - E[r_j]\right)^2} \equiv \sigma_j$$

$$\sigma_j = \sqrt{\sigma_j^2}$$

Standard Deviation of a Stock

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The standard deviation is the risk (volatility) of a stock.

$$\sigma_j = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(r_j - E\left[r_j\right]\right)^2} \equiv \sqrt{\sigma_j^2}$$

Summary

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Generally speaking, all stocks are impacted by 2 types of risk, including:

- ➢ Firm Specific Risk, and
- ➢ Market Risk.

The 'Total Risk' is equal to the Market Risk + Firm Specific Risk.

A generally accepted measure of the Total Risk of a stock is its volatility (i.e., its Standard Deviation).

Summary

The Standard Deviation (SD) of a stock is calculated by:

$$\sigma_j = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(r_j - E\left[r_j\right]\right)^2} \equiv \sqrt{\sigma_j^2}$$

Now have a go at the quiz!