

Video 28 - CAPM: Beta

The following is a supplementary transcript for tutorial videos from

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Hi everyone, in this video we are going to focus on one component of the capital asset pricing model, beta. Beta is a measure of the company's systematic risk, relative to the overall market risk. It shows us the impact of a company's risk on its expected return. By the end of this video, you will learn: (1) what beta is; (2) how to calculate beta; (3) how to interpret a company's beta.

Video at 00:31

Recall that the total risk of an asset can be broken into systematic and unsystematic risk. Systematic risk affects the whole market, or a large number of securities, which means it cannot be diversified away, even by holding a portfolio of assets with low correlation. Systematic risk is unavoidable and so investors expect to be compensated for it. Thus, the systematic risk of an asset impacts its required return, which is reflected in its market price.

Video at 00:58

But some assets are more vulnerable than others to these systematic risks. Some securities are like my overly emotional friend, Lisa. Sure, we all laughed at Steve's joke, but she is the only one who fell out of her chair and started rolling around on the ground. And we all cried when we watched Titanic, but she wailed so loudly, we were asked to leave the theatre. And some securities are like my friend, Mark, who didn't seem to care that any of this was happening and his expression didn't change the whole time. That is, some stock's return swings more than the market overtime and others swing less than the market over time.

Video at 01:37

The magnitude of variations in returns as a result of systematic risks is called beta (β). Beta represents the systematic risk of a stock in relation to the market risk:

- $\beta = 1$ means that the price of a security is as risky as the market.
- $\beta > 1$ means that the asset experiences more variation in its returns than the market as a whole, and
- $\beta < 1$ means that the asset has less variation in returns than the market.

Video at 02:02

An asset's risk premium, how much an asset rewards an investor for enduring the risk of the asset should be proportionate to its systematic risk. The systematic risk of an asset is its beta times the market's risk premium ($r - r_f$) which is how much the market portfolio rewards investors for holding on to the risky assets in the market portfolio.

$$\text{systematic risk} = \beta \times (r_m - r_f)$$

Beta ties into our capital asset pricing model (CAPM). Recall, an asset's expected return is the risk-free rate plus beta times the market's risk premium, which is the return of the market minus the risk-free rate.

$$\text{CAPM} : E(r) = r_f + \beta \times [E(r_m) - r_f]$$

Video at 02:32

There are two ways of calculating the beta of a stock and both will give you the same result. One method is to perform a regression analysis. By plotting the excess market return ($E(r_m) - r_f$) on the x-axis and the excess stock return ($E(r) - r_f$) on the y-axis, you can find the slope of the line of best fit (β), which is the beta of the stock. In this sense, the beta or the slope is telling us how much the stock's return will change for a given change in market returns. In other words, beta tells us how much the stock's return moves relative to the market. Or, how risky the stock is relative to the market.

Video at 03:10

Another method of calculating beta is by using this equation. Beta equals the covariance of the stock return and market return ($\sigma_{s,m}(r_s, r_m)$) over market variance (σ_m^2). If you convert covariance into correlation ($\rho_{s,m}$) times the standard deviation of the stock times the standard deviation of the market, you can cancel out the standard deviation of the market from the numerator and denominator. Resulting in beta equals correlation time standard deviation of the stock over standard deviation of the market.

$$\text{beta of a stock } (s) = \beta_s = \frac{\sigma_{s,m}(r_s, r_m)}{\sigma_m^2} = \frac{\rho_{s,m} \times \sigma_s \times \sigma_m}{\sigma_m \times \sigma_m} = \frac{\rho_{s,m} \times \sigma_s}{\sigma_m}$$

Video at 03:36

In both approaches, beta is capturing the systematic risk of a stock by conveying how much the asset's return fluctuates, given a change in the overall market return. Intuitively, you can expect that if a stock's return fluctuates a lot for just a minor change in the overall market return, then this stock would be considered risky because it will either earn extraordinary or disastrous returns. Tying this back to our discussion of the capital asset price model, that means a highly risky asset should earn higher returns than the market return, to compensate investors for holding on to such a risky asset.

Video at 04:13

The market portfolio has a $\beta = 1$. If the market portfolio represents all the assets in the market, then the market portfolio moves exactly in pace with itself, and hence the beta of 1. So when an asset has $\beta = 1$, it means the stock or portfolio's returns move exactly like the market for a given change in the market.

Video at 04:38

Looking at the formula we just learned, we can see that a company's beta is a combination of its correlation with the market portfolio ($\rho_{s,m}$) and the ratio of its volatility to the market volatility ($\frac{\sigma_s}{\sigma_m}$). Therefore there are two ways of interpreting the beta. If a beta is small, it might be because the stock:

- a. does not have a high correlation with the market, or
- b. the stock itself has low volatility.

Video at 04:58

An example of a low beta stock is Procter & Gamble. P&G operates in the industry of household and personal products, and is classified in the consumer defensive sector on Yahoo Finance. This industry does not take as much hit from economic downturns because people tend to buy household products regardless of the economic situation. Unlike industries like technology, which are inherently volatile, and therefore higher risk. Lower risk industries thus have a low correlation with the stock market. Therefore, it makes sense that P&G would have a 3-year monthly beta of less than 1, at $\beta = 0.34$. Try using $\beta = 0.34$ in the CAPM formula to calculate the expected returns for P&G. You can expect that, if the returns in the overall market dropped by 1%, P&G's stock returns would only drop by 0.34%, making it less risky than the market.

Video at 05:55

$\beta = 0$ means that the stock is uncorrelated with the market. In other words, this means that for a given change in market returns, the stock's returns would not be affected.

Video at 06:04

Negative betas ($\beta < 0$) are also possible if the stocks correlation with the market is negative. This often happens in commodity-related stocks, like gold mines. This means that when the market is performing poorly, the stock actually performs *better* and vice-versa. This makes sense when you think about commodity stocks like gold, because when the market performs poorly, many investors will turn to more tangible investments like gold, and thus, these commodities actually perform better.

Video at 06:29

If $\beta > 1$, it might be because:

- a. the stock is highly correlated with the market, or
- b. that the stock itself has a high volatility.

Out of the top 10 highest beta stocks in the S&P500, eight of them are technology or Internet related, with a few famous ones being Netflix and Amazon. This means that, if market returns took a dip, these tech firm's stock returns would plummet even more than the market, and vice versa, if the market overall experiences growing returns, the tech firm's stock returns would soar by a greater amount. $\beta > 1$ means that the good times are better, but the bad times are worse, making them riskier -- riskier in a way that CAPM tells us will reward investors with higher returns.

Video at 07:16

Today, we learned that a company's systematic risk relative to the market can be expressed as beta. Then, we learned how to calculate and interpret a company's beta. Remember that a higher beta means more risk, which means investors will require a higher return on their investment. Thank you for watching!