Video 27 - Security Market Line and the Capital Asset Pricing Model

The following is a supplementary transcript for tutorial videos from

https://blogs.ubc.ca/financefundamentals/

Hi everyone! Today we will be learning how to use the capital asset pricing model to calculate what a security's market price should be. We can use this to identify when a security is overvalued or undervalued. By the end of this video, you will learn about: (1) the CAPM formula; (2) the Security Market Line (SML) and its characteristics, and (3) the use of SML and Jensen's alpha in identifying mispriced securities (optional for the course).

Video at 00:32

CAPM stands for capital asset pricing model, which is an equation used to estimate the expected rate of return for a stock. The CAPM formula tells us that the expected rate of return of a stock ($E(r_p)$) equals the risk-free rate (r_f), plus the "beta" of the stock (β), times the difference between the expected market return rate ($E(r_m)$) and the risk-free rate.This difference is also known as the "market premium" ($[E(r_m) - r_f]$).

$$CAPM: E(r_p) = r_f + \beta \times [E(r_m) - r_f]$$

Video at 00:51

Let's go through each of these parts of the equation in more detail:

- r_f is the risk-free rate. This is the rate of return investors require in the absence of any risk to compensate them for the time value of money.
- Beta (β) is essentially meant to capture the risk of an asset relative to the market. We will be talking about Beta in further detail in its own video ("CAPM: Beta").
- $E(r_m)$ is the expected return of the market.
- $[E(r_m) - r_f]$ is often called the market risk premium.

In other words, the risk premium represents how much more investors in the market are being compensated for holding the *risky* market portfolio rather than the risk-free asset. The CAPM tells us how much stockholders, for each individual stock, will earn at the risk-free rate plus the market risk premium times beta, which is the amount of risk taken. The higher risk a stock is, relative to the rest of the market, the higher beta is, meaning that the stock should yield a higher return relative to the market risk premium. Try solving a few problems using the CAPM formula.

Video at 1:48

Stock A's beta is 1.2. The risk-free rate is 4%, and the equity risk premium is 8%. What is Stock A's expected return? Don't forget to use the CAPM formula. Pause this video for a moment and try this problem yourself.

Let's try it together. To solve a question, it is a good idea to list out all the given information first. The risk-rate r_f =4%, the beta β =1.2, the market risk premium $[E(r_m) - r_f]$ =8%. Now, we plug those numbers into the CAPM formula. The expected return equals

$$CAPM: E(r_A) = r_f + \beta \times [E(r_m) - r_f] = 0.04 + 1.2 \times [0.08] = 13.6\%$$

Solve that and we get the expected return of Stock A to be 13.6%.

In exam questions, you will either be given the expected return on the market ($E(r_m)$) or the market risk premium ($[E(r_m) - r_f]$). The risk premium is the *additional* return the market can earn above the risk-free rate; it is the expected return of the market minus the risk-free rate. Do not make the mistake of subtracting the risk-free rate from the market risk premium, otherwise you would be subtracting the risk-free rate twice.

Video at 02:95

Let's try another question that's a little bit harder. Stock B has an expected return of 10% with a beta of 0.8. Stock C has a beta of 1.3. The risk-free rate is 4%. What is Stock C's expected return? Pause the video again, try this problem yourself before watching the solution.

Once again, list up the variables. The risk-free rate r_f =4%, the expected return of Stock B $E(r_p)$ =10%, the beta of Stock B β_B =0.8, beta of Stock C β_C =1.3. How can we use this information to solve for what is missing? First, we will want to solve for the market risk premium using the information given for Stock B, and then use the market risk premium to solve for the expected return of Stock C. Plug the numbers for Stock B into the CAPM formula.

$$CAPM: E(r_B) = r_f + \beta \times [E(r_m) - r_f]$$

$$0.10 = 0.04 + 0.8 \times [E(r_m) - r_f]$$

$$[E(r_m) - r_f] = \frac{0.10 - 0.04}{0.8} = 7.5\%$$

Solve for the market risk premium to get 7.5%. Now, plug this back into our equation to solve for Stock C.

$$CAPM: E(r_C) = r_f + \beta \times [E(r_m) - r_f] = 0.04 + 1.3 \times [0.075] = 13.75\%$$

Thus, the expected return for Stock C is 13.75%

Video at 04:07

The security market line graphs the CAPM equation. This tells us what the expected return of an asset should be for each possible beta value. The expected return is on the y-axis, and beta is on the x-axis. The y-intercept is at the risk-free rate, because risk-free investments have no risk premium, and therefore have a beta of 0. The slope is the market risk premium, since it is a constant term multiplied by our x-variable, beta. The SML graphs out the "expected" return of stocks. If all stocks were to earn a return as expected, then all the stocks should fall on the security market line.

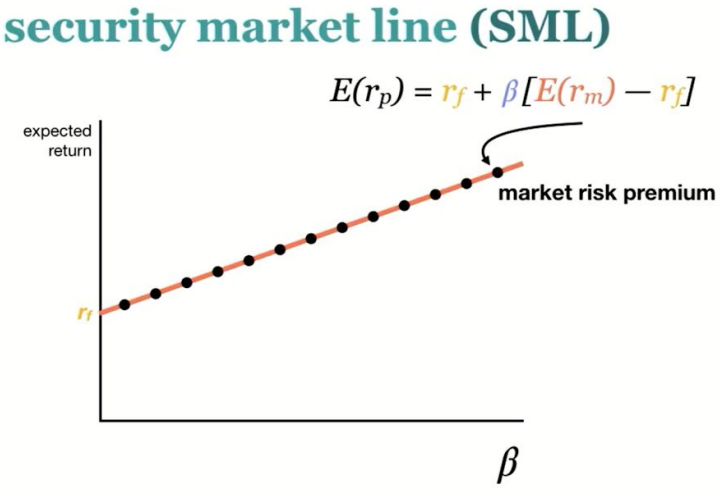

Figure 1

Another way of interpreting the SML, as well as the CAPM is that it depicts the relationship between required rate of return and risk. Investors require this amount of return for taking that amount of risk.This concept is useful for identifying mispriced securities.

Video at 05:00

If all stocks were to earn an "as expected" return, our graph should look something like this (Figure 1), where all the points (black dots) fall on the SML line (red line). But in reality, the graph looks more like this (Figure 2). These securities are "mispriced" because, compared to the risk associated with each stock, they are either earning a higher or lower return than expected.

If a stock falls in the part of the graph that is under the SML, we say it is overvalued. Take this security for example (far right black dot). According to the CAPM formula, it should, and the investors expected to, earn a return of approximately 9% (dark blue “x” on the SML), but it is only earning a return of 5%. This means that the price is higher than it should be, given the returns on the asset. The risk-return trade-off is unsatisfactory for investors, so we say it is overvalued and we should sell it. But don't worry, the market will guarantee that stocks will eventually go back up to its expected returns. If many investors sell this stock, it will increase the supply of this stock in the market, which will push its price down. If you can now pay less for the same asset that still pays the same expected return in dollars, this asset is now a more attractive investment as investors can now get "more bang for their buck". The lower price has the effect of increasing the percent return on the price you pay. Investors will continue to sell the stock until its expected rate of return is back to what investors expect, a return of 9%.

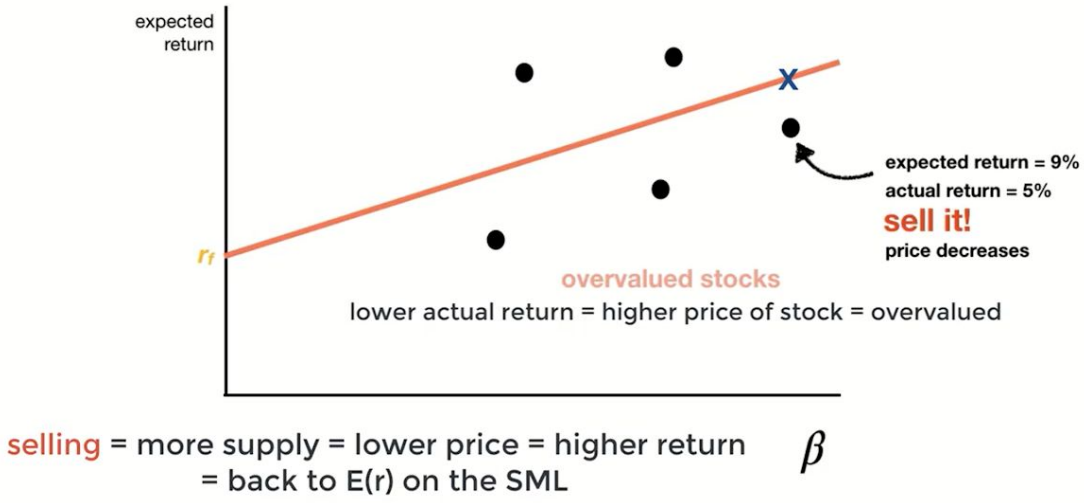

Figure 2

Video at 06:21

If a stock falls in the part of the graph that is above the SML (Figure 3), we say it is undervalued. This security is earning a return of 14%, but based on the SML, it should only earn a return of 7%. You can earn a higher percentage return than if the security was accurately priced on the SML. The risk-return trade-off is much more favourable than other stocks, so we say it's undervalued and we should buy it. But eventually, other investors will realize that this asset allows you to earn more than if it was accurately priced on the SML, so they will keep buying this undervalued stock until the demand grows enough to push the price of the stock up. When you have to pay more to earn the same dollar return, then, the percentage return on your

investment to you, as an investor, decreases. As you are now earning less "bang for your buck", lowering the expected return back down to its predicted level along the SML.

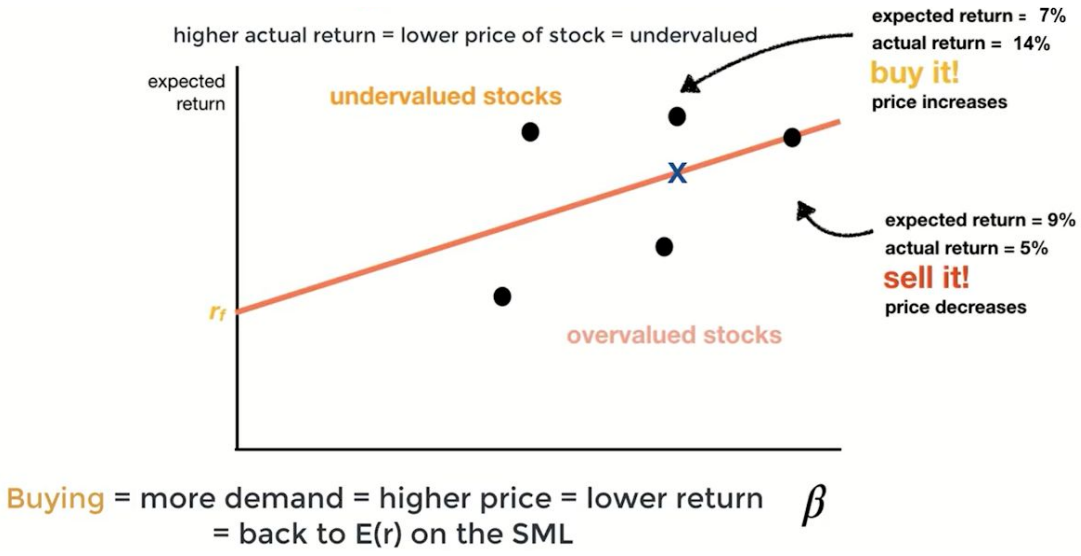

Figure 3

Video at 07:11

A similar method we can use to identify mispriced securities is by calculating security's Jensen's alpha (optional for the course). If we want to use our CAPM formula to solve for the realized return rather than the expected return, we must include another factor to account for the difference between the expected and realized return, and that factor is Jensen's alpha. This equation is called the security characteristics line.

$$Jensen's\ alpha = \alpha = actual\ return - E(r) = actual - (r_f + \beta \times [E(r_m) - r_f])$$

This line graphs the excess return, which is the return minus the risk-free rate, of the security against the excess returns in the market. The discrepancy between the expected and actual returns is our alpha value. For example, imagine that we expect for an asset to earn 10% ($E(r)$ on the red line, which is the SML), but it actually paid us 12% (black dot on the dark green line), then our realized rate is 2% higher than what we expected to earn, and this 2% difference is the alpha (Figure 4).

Video at 07:57

When Jensen's alpha is positive (Figure 4), it means that the security is earning a higher return than what's expected according to the CAPM, therefore it is undervalued. When Jensen's alpha is negative (dark green line would be below the red SML line), it means that the security is earning a lower return than expected, therefore is overvalued.

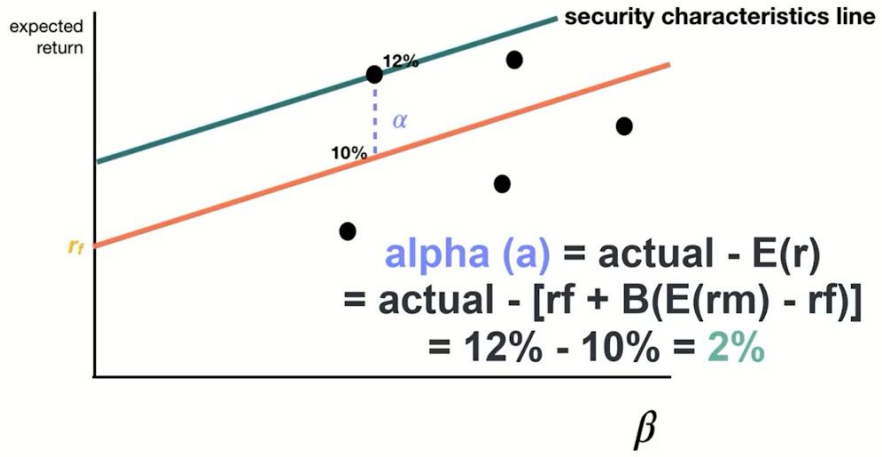

Figure 4

Video at 08:13

In today's video, we learned how to use the CAPM formula to calculate the expected return of a risky asset, and identify when a security is mispriced. Comparing the expected returns to the realized returns can help us to decide when to buy certain assets, and when to sell. Thank you for watching!