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The Essential Financial Toolkit*

Tool 5 – Required Returns and the CAPM

This article discusses the relationship between risk and return. It is obvious that investors would want a higher exposure to risk to be compensated with a higher return, but in order to estimate the actual return investors should require at different levels of risk, we need a model. The CAPM, one of the models most widely used in finance, provides a simple and intuitive way to tackle this issue.

Witty Professor (WP): We have spent some time in this course talking about risk and return, but we never quite put them together. That's exactly what we'll do today, so let me start with an 'easy' question: say you decide to buy a few Microsoft shares, what annual return would you require from those shares?

Insightful Student (IS): Wait a minute! We've just got here! We're trying to warm up to a new topic and you hit us with that question?! Are we even supposed to know that?!

WP: Well, from the top of your head, what would you say?

IS: From the top of my head? I'd say I don't have the slightest idea!

* All calculations in this note have been performed in Excel and the results reported are taken directly from the spreadsheet. If you want to reproduce the numbers discussed accurately and avoid rounding errors, you should also perform all calculations in a spreadsheet.

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WP: Well, you're certainly exaggerating. I'm sure that if I push you, you can do better than that, so I will. Let's say you take \$100 out of your pocket and you put them safely in the bank for one year. What return would you expect to get?

IS: Whatever the bank gives me, I guess.

WP: Sure, with \$100 you won't have any bargaining power, so you'll take whatever the bank offers you, or else you'll just keep the \$100 in your pocket. But let's think a bit harder. Given that you'll put your money safely in the bank for one year, and that you'll bear no risk whatsoever, what is the minimum return you'd require?

IS: Well, given that I'll bear no risk, the least I'd require is not to lose purchasing power, so that I could buy in one year the same things I can buy today with \$100.

WP: Or in other words, no risk, no return, but no loss of purchasing power, either. Does that make sense?

IS: It does.

WP: OK, but my initial question was a bit more complicated: what if instead of putting your money in a riskless investment you buy Microsoft shares?

IS: Well, first, if I'm buying any company shares, my return is not guaranteed, so I do get to bear some risk. Second, Microsoft strikes me as a particularly risky stock given that the company is in a volatile and rapidly-changing sector.

WP: I knew you could do better than just saying that you don't have the slightest idea! Your intuition is correct. So let's agree, first, that if you're buying stocks you'd require more return than you would if you were putting your money in a riskless investment. And let's also agree that you would not require the same return from all stocks; the riskier you perceive a company to be, the higher the return you would require. Do you agree?

IS: I do, on both counts.

WP: Great. So believe it or not we already came a long way. We established that the required return on a stock has two components, a compensation for the expected loss of purchasing power and an extra compensation for bearing risk. We can even express this a bit more formally by writing

$$R_i = R_f + RP_i \quad (1)$$

where R_i denotes the required return on stock i , R_f the risk-free rate, and RP_i the risk premium of stock i .

IS: That's easy enough, but how do we put numbers into those terms?

WP: Take it easy, don't get ahead of yourself. For now let's make sure we're clear about the fact that expression (1) says that the return we should require from the shares of a company has the two components we just mentioned: the risk-free



rate (R_f), which is a compensation for the expected loss of purchasing power; and the risk premium (RP_i), which is a compensation for bearing the risk of investing in the company. Is that clear?

IS: It is. But why is it that only two of the three terms have a subscript i ?

WP: Good question! The model we're discussing aims to calculate the required return on the shares of *any* company, which we simply call company i ; that explains the R_i . And it also aims to link the return we should require from that company with the risk of holding shares of that company; that explains the RP_i . But notice that the return we require as a compensation for the expected loss of purchasing power is, and should be, the same for all our investments. Does that make sense?

IS: It does. What you're saying is that whether we invest in a riskless asset, or in the shares of a low-risk company, or in the shares of a high-risk company, we'll still require, at the very least, not to lose purchasing power. Therefore, although the risk premium is specific to the company in which we invest, the risk-free rate is the same regardless of the company in which we invest.

WP: Exactly. So now let's take a look at what the CAPM, the Capital Asset Pricing Model, one of the models most widely used in finance, has to say about the estimation of the risk premium of stock i . This model simply says that we should estimate it as

$$RP_i = MRP \cdot \beta_i \quad (2)$$

where MPR denotes the so-called market risk premium and β_i the beta of company i .

IS: Is that the same beta we discussed in our previous session?

WP: It is.

IS: And what about the market risk premium?

WP: Well, interestingly, the two terms in expression (2) have a very close parallel to the two statements that you agreed with a few minutes ago. You said that if you were to buy stocks you'd require more return than you would from a riskless investment. And you also said that the riskier you perceive a company to be, the higher the return you'd require. You still agree with those two statements?

IS: I do.

WP: Great, because the market risk premium is the additional compensation required by investors for investing in relatively riskier stocks as opposed to in relatively safer bonds. And now let me ask you, can you guess why there is no subscript i in the market risk premium?

IS: I think so. Simply because we're talking about the comparison of two asset classes, stocks and bonds, and how much more return investors require to buy the riskier asset class.



WP: Exactly! And we'll talk about how to estimate that number in just a minute. But first let me ask you, what about the second component of the risk premium?

IS: Well, as you said, that is the same beta we discussed in our previous session, and therefore it measures the average return of a stock given a 1% fluctuation in the market. So stocks with betas larger than 1 magnify the market's fluctuations, and stocks with betas lower than 1 mitigate the market's fluctuations.

WP: Right again. And why the subscript i ?

IS: Because now we're not talking about stocks versus bonds but about the specific company we're considering. So beta is related to the second statement I had agreed with before, that the riskier the company the higher the return I'd require.

WP: Exactly! Now can you summarize for me the intuition behind expression (2)?

IS: Now it's easy. The CAPM suggests that the risk premium of any stock has two components. One, the market risk premium, is the same for all stocks and measures the extra compensation required for investing in relatively riskier stocks as opposed to in relatively safer bonds. The other, beta, is specific to the company considered, and measures the risk of investing in the shares of that company.

WP: Risk in general or something a bit more precise?

IS: It measures the *systematic* risk of investing in that company!

WP: Right! And, importantly, what is the CAPM implicitly assuming then?

IS: That investors hold diversified portfolios?

WP: Exactly! So now we're ready to write the full expression of the CAPM, which in a perhaps not too technical, but certainly accurate, way is given by

$$R_i = R_f + MRP \cdot \beta_i \quad (3)$$

where all the terms are those we've been discussing.

IS: That looks pretty simple. I thought the CAPM would be more scary than that!

WP: It is pretty simple, though as we'll soon see, the devil is in the details. But before we get there tell me, in very easy terms that even your grandmother could understand, what is the intuition behind the way the CAPM suggests we should compute the required return on the shares of any company?

IS: The CAPM says that if we're going to invest in the shares of any company we should require return for two reasons. One, because we want to be compensated for our expected loss of purchasing power; that's the risk-free rate and as the name suggests it is not related to risk. Two, because when we buy equity the return is not guaranteed and therefore we bear some risk; that's the risk premium and is made up of two components: one is the market risk premium, or the additional return required for investing in relatively riskier stocks as opposed to

in relatively safer bonds; and the other is beta, the reaction of a stock to fluctuations in the market. How's that?

WP: Outstanding! But your phrasing invites a question. You talked about *required* returns; how are they different from *expected* returns?

IS: I think you got me there.

WP: Well, it's not that difficult. Although I do want to avoid getting into theoretical discussions here, let me just say that the CAPM is an equilibrium model, which means that what you require and what you expect *must* be the same.

IS: I'm not sure I follow you there.

WP: Well, if investors require 10% from a stock but they expect only 5%, they're obviously going to do something about it. They will sell the stock putting downward pressure on its price and increasing its expected return. The process will stop when the required and the expected return are the same. Can you make the other side of the argument?

IS: I think so. If investors require 5% from a stock but they expect 10% they will obviously buy, putting upward pressure on its price and lowering its expected return. And again the process will stop when the expected and the required return are the same. Is that correct?

WP: It is, so I hope it is clear now why some people talk about the CAPM as a model that yields *required* returns and others talk about it as a model that yields *expected* returns. In the equilibrium the CAPM considers, both concepts are the same.

IS: I understand. But so far we haven't said anything about how to put specific numbers into expression (3).

WP: And we're getting to that right now. But remember we did talk about betas before, so putting numbers to betas should not be a problem, right?!

IS: Right. You suggested that betas are publicly available and rather easy to find, so instead of estimating them we should just stick to finding them in places like Yahoo Finance.

WP: Exactly. We may say a couple more things about them later, but let's first talk about the risk-free rate. We had agreed that it is the return required as a compensation for the expected loss of purchasing power, so how would you put a number to that?

IS: Well, as we discussed, that number should be pretty much in line with the expected rate of inflation, right?

WP: As a general argument that's correct. But are you suggesting that the average Joe in the street is knowledgeable about expected rates of inflation?



IS: No, that wouldn't make sense, most people have very little idea about finance. I don't know. How do we come up with that number?

WP: Well, here's the thing with the CAPM. It is a very neat model, derived very elegantly from theory, and as you can see from our discussion, very intuitive too. But from a practical point of view, it is very vague in the sense that although it is clear what the three terms we need are, it is far from clear how we actually estimate them.

IS: Are you saying that the theory is clear but the actual application is not?

WP: Pretty much. Think about the risk-free rate. What magnitude would you use as a proxy for the expected loss of purchasing power, or similarly, for the expected rate of inflation?

IS: I'm not sure, what would you use?

WP: Well, how about the yield on a government bond, which is risk-free if the bond is held until maturity?

IS: What do you mean by the yield?

WP: We'll talk about yields and bonds in more detail later in this course, but for the time being let's just say that the yield, or more precisely the yield to maturity, is the mean annual compound return you're going to get by buying the bond at the market price and holding it until maturity. You can easily find that number in the financial press and in financial web pages. So, do you think that yield would be a good proxy for the risk-free rate?

IS: Well, if we're talking about governments from developed countries, I do agree that they are risk-free, at least from a default perspective. But what maturity are you talking about? One year? Five? Ten? Thirty? Somewhere in between? Longer than thirty years?

WP: Good question. And here is precisely where it gets tricky. Theory won't help you and in practice you'll find many and varied opinions. Some investors that deal with short-term projects would tend to favor short-term yields, and some investors that deal with long-term projects would tend to favor long-term yields. Then again, some would tend to favor using the same yield regardless the length of the investments considered.

IS: So what are we supposed to do?

WP: Basically two things. One, know that the issue is controversial and that there are many and varied opinions. Two, look for some consensus among practitioners.

IS: Is there anything close to consensus?

WP: Well, I'll go as far as saying that the 10-year yield is a very popular choice. It helps that it is the most widely-followed yield, but it may also help that it looks like some sort of compromise between a short-term yield and a long-term yield.



IS: Should we then use the 10-year yield on government bonds as a proxy for the risk-free rate in the CAPM?

WP: Like I said, it's a popular choice and if you use that you'll be in good company. But also know that some people may disagree, so be ready to hear some arguments against that choice.

IS: I think I can live with that. But what about the market risk premium? Is there also controversy about how to calculate it?

WP: Yes, there is. Perhaps even more so than there is about the proper choice for the risk-free rate. Think about it. Remember that the market risk premium is the additional compensation required by investors for investing in relatively riskier stocks as opposed to in relatively safer bonds. How would you estimate that?

IS: No idea.

WP: Come on, try a bit harder.

IS: I guess I could look at the historical difference between the return of stocks and the return of bonds, and assume that in the future the difference will be pretty much as it's been in the past.

WP: Very good! Estimating the risk premium based on historical data, though by no means the only way of doing it, is a very popular choice. But your answer is still quite vague, isn't it? What do you mean by the return of stocks? The return of the Dow? Of the S&P? Of an even more comprehensive index? And what about the return of bonds? Is that the return of one-year bonds? Five-year bonds? Ten? Thirty?

IS: Lots of questions!

WP: And I'm not done! What do you mean by historical? The last 30 years? The last 60? The last 100? And what kind of historical average are you going to take, arithmetic or geometric?

IS: I think I speak for all my classmates if I say I'm overwhelmed!

WP: Well, don't feel too bad. I'm throwing all this at you because I want to make sure you understand that estimating the market risk premium opens a lot of questions, and like putting a number to the risk-free rate, there is a wide variety of more or less reasonable answers.

IS: So what are we supposed to do?

WP: Well, let me first remind you once again that the issue is controversial and that there are many answers to your question. And second, let me also remind you that this course is very practical and that whenever we can take a shortcut we do, so take a look at Table 1, which shows the market risk premium for several countries over the 1900-2000 period.



Table 1

Country	With respect to Bills		With respect to Bonds	
	Geometric	Arithmetic	Geometric	Arithmetic
Australia	7.1%	8.5%	6.3%	8.0%
Belgium	2.9%	5.1%	2.9%	4.8%
Canada	4.6%	5.9%	4.5%	6.0%
Denmark	1.8%	3.4%	2.0%	3.3%
France	7.4%	9.8%	4.9%	7.0%
Germany	4.9%	10.3%	6.7%	9.9%
Ireland	3.5%	5.4%	3.2%	4.6%
Italy	7.0%	11.0%	5.0%	8.4%
Japan	6.7%	9.9%	6.2%	10.3%
Netherlands	5.1%	7.1%	4.7%	6.7%
South Africa	6.0%	8.1%	5.4%	7.1%
Spain	3.2%	5.3%	2.3%	4.2%
Sweden	5.5%	7.7%	5.2%	7.4%
Switzerland	4.3%	6.1%	2.7%	4.2%
UK	4.8%	6.5%	4.4%	5.6%
USA	5.8%	7.7%	5.0%	7.0%
World	4.9%	6.2%	4.6%	5.6%

Source: adapted from *Triumph of the Optimists – 101 Years of Global Investment Returns*, by Elroy Dimson, Paul Marsh, and Mike Staunton. Princeton University Press, New Jersey, 2002.

IS: And what are we supposed to do with this table?

WP: Well, don't you think it gives you a good idea about the historical number you proposed to estimate? The figures in the table give you a cross-country view and a long-term perspective. Also, they are estimated with respect to both bills and bonds, and based on both arithmetic and geometric averages. And perhaps I should add that they come from the most comprehensive study of long-term data of international markets.

IS: So you're saying that if we need to use a market risk premium we can basically pick a number from the table, right?

WP: Right. The table will not solve all your problems, but it's a good starting point. You'll still have to decide whether you will use a number with respect to bills or bonds, or based on arithmetic or geometric averages.

IS: So, what should we do?

WP: Well, when estimating the market risk premium in the US, the interval between 5% and 6% seems to be a rather popular choice, and as you can see in the table, that closely matches the market risk premium based on geometric averages. If you choose a number in this interval, you may find some people that disagree with your choice, and perhaps rightly so, but again you will be in good company.



IS: So you're saying that the widely-used interval between 5% and 6% can be justified by historical data?

WP: Exactly. But again, make sure you keep in mind that there is a wide variety of ways of estimating the market risk premium, and empirically that yields a wide range of possible estimates. So, again, be ready to hear some arguments against that choice.

IS: And what about for other countries?

WP: Well, as you can see in the table, the numbers differ quite a bit across countries. That means that each country has its own market risk premium, just as much as each country has its own risk-free rate.

IS: I think I get it. And what about beta?

WP: I think it's best if, as we discussed before, you stick to finding betas in sites like Yahoo Finance rather than calculating them. But if you want to know just a bit more, I'll go as far as saying that a popular way to estimate betas is based on five years of monthly data.

IS: Why five years?

WP: It's yet again another compromise, in this case between not going too many years back so that we may end up using data on a company very different from the one we observe today; and not going too few years back so that we may end up considering only a very good or very bad short-term situation.

IS: And why monthly data?

WP: Monthly data is, from a statistical point of view, much better behaved than weekly or daily data, but as I asked you a few times before in this course, you don't want me to get into statistical discussions, do you?

IS: No, I guess we don't. But can you give us an example of how to calculate a required return on equity based on the CAPM?

WP: Sure, I was just getting to that. And since my initial question to you was about Microsoft let's close this discussion with that company. So here we go. Half way into 2008, the yield on 10-year US Treasury Notes was, roughly, 3.9%. Let's use 5.5% as the market risk premium, which is the midpoint of the popular 5–6% interval. Finally, according to Yahoo Finance, the beta of Microsoft is 1.3. Then, the required return on Microsoft stock according to the CAPM is

$$R_i = 3.9\% + (5.5\%)(1.3) = 11.1\%$$

IS: That's pretty easy!

WP: It is, but it's important that you don't forget that we're making very specific choices for the risk-free rate, the market risk premium, and beta, and many could reasonably question our choices. And of course, different choices would yield a



different number, so like just about everything else in finance, you have to have good reasons for your choices so you can defend them in a reasonable way.

IS: Wrap up time?

WP: I thought you'd never ask! The CAPM is the model most widely used to estimate the required return of stocks and is supported by an elegant theory and a clear intuition. The model argues that investors require a return for their expected loss of purchasing power and an additional return for bearing risk. This second component has two parts, a compensation required for investing in relatively riskier stocks as opposed to in relatively safer bonds, and an adjustment for the average reaction of a stock to fluctuations in the market. In practice, the three components of the model, the risk-free rate, the market risk premium, and beta, can be estimated in a variety of ways. Some ways are more popular than others but the model's implementation leaves ample room for reasonable disagreement. Coffee time now?!