C H A P T E R 7

Smart *Excel* Appendix

Appendix Contents

Excel prerequisites

Relative, absolute, and mixed cell references, covered in Chapter 4

Learn to solve for

Expected stock returns using the historical approach

Expected stock returns using the probabilistic approach

Expected stock returns using the CAPM approach

Expected portfolio return and risk measures

Use the Smart *Excel* spreadsheets and animated tutorials at the Smart Finance section of http://www.cengage.co.uk/megginson.

EXCEL PREREQUISITES

There are no new *Excel* features used in this appendix, but there is extensive use of absolute and mixed cell references. This material is reviewed and extended on the ***Excel Prereqs*** tab of the Chapter 7 file located at the **Smart Finance Web site**.

EXPECTED RETURN

Problem: You are considering investing in four companies and want to determine the expected return on each investment, if held on its own, over the next year. You are interested in comparing the expected return using three approaches: historical, probabilistic, and CAPM. You also want to find the return on a portfolio invested equally in each of the four investments. Last, you want to assess the risk of the potential investments. Information on the investments and current market conditions is provided here and below. You have return information for the 1964–2003 period. The current Treasury bill rate is 2.2%, and the average Treasury bill return over the period 1964–2003 was 4.1%. The expected return on a market portfolio is 11%. You want to consider returns under three possible economic scenarios over the next year: weak economy, average economy, strong economy. You believe the probability of a weak economy is 20%, the probability of an average economy is 50%, and the probability of a strong economy is 30%.

	Petrochemical	High Pressure Tires	J.R.R. Toykins	Karma-ceuticals
Average Return 1964–2003	0.121	0.098	0.111	0.178
Beta	1.2	0.9	1.0	1.6
Return in a weak economy	–0.25	0.22	–0.15	–0.40
Return in an avg economy		0.13	0.14	0.11	0.38
Return in a strong economy	0.35	–0.05	0.25	0.25

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HISTORICAL APPROACH TO CALCULATING EXPECTED RETURN

Use the historical approach to find the expected return on an investment in each of the four companies, as well as the portfolio invested equally in each of the four firms.

Remember, the expected return under the historical approach is found by adding the historical average risk premium for the firm (the premium over the historical average Treasury bill rate) to the current risk-free rate.

The portfolio return is a weighted average of the individual stock returns, as calculated in Chapter 6.

Approach: Create a simple model based on the historical risk premium to find the expected return.

Try it yourself in a blank *Excel* file. Think about what to include in inputs and how to set up your calculations and output. Alternatively, you can use the setup file provided on the *Historical* tab of the Chapter 7 *Excel* file at the Smart Finance Web site.

We set up the model as follows:

Approach: Build a simple model to estimate individual stock returns and portfolio returns.

In this model, we introduce new formatting. Blue background is used to denote inputs that can be changed. Green shading denotes formulas in calculatios and output that should not be changed. Smart *Excel* users employ color, borders, and even alternative fonts to make their spreadsheets easier for others to share and interpret. The formatting in this model signals to a user that anything in blue can be changed, while cells in green should not be altered. We will use this optional format in Chapter 7 to provide an introduction to alternative model designs and formats.

You should get the results above. The portfolio return is with weights of 25% in each of the four firms.

Apply it

What if you change the portfolio weights?

- *Suppose you invest 50% in Petrochemical, 50% in Karma-ceuticals, and 0% in the other two stocks.*
  Simply change the weights in cells C26–F26. Now the return is 13.1%.
- *Suppose you invest 25% in High Pressure Tires, 25% in Petrochemical, 50% in J.R.R. Toykins, and 0% in Karma-ceuticals.*
  The return is 9.1%.

PROBABILISTIC APPROACH TO CALCULATING EXPECTED RETURN

The historical approach provides an estimate of expected return based on historical data. What if you believe the future will not look like the past? You may want to develop future scenarios, consider the probability of each scenario, and estimate returns in each scenario. The scenarios could be based on economic conditions, product demand, or competitor responses. This is the probabilistic approach to estimating return. In this example, we look at three possible economic scenarios.

Use the probabilistic approach to find the expected return on an investment in each of the four companies, as well as the equally-weighted portfolio. Also find the variance and standard deviation of returns for the individual stocks and the portfolio.

The expected return under the probabilistic approach is a probability weighted average. The expected return is found by multiplying the return in each scenario by the probability of the scenario and then summing for all scenarios. The probabilities must sum to 100%.

Using the probabilistic approach, the variance and standard deviation cannot be calculated using the formulas in Chapter 6 and cannot be found using the *Excel* functions, because we need to consider the probabilities. You can find information on the calculation of variance and standard deviation with probabilities on page 288 of the chapter.

Approach: Create a basic model to find expected return, variance, and standard deviation using the probabilistic approach.

Open the setup file provided on the *Probab* tab of the Chapter 7 *Excel* file.

Enter the input data in the blue-shaded cells of the *Inputs & Portfolio Calculations* section. Note that portfolio calculations are included in this section. In earlier chapters, we placed inputs in a separate section to clearly distinguish the model inputs from calculations and output. In general, we recommend this. In this model, however, the portfolio returns in each economic condition are most easily calculated and most clearly displayed right next to the inputs. Therefore, we decided to include these calculations in the input section but use the green shading to highlight to users that these are not inputs and should not be changed. The portfolio calculations are formulas based on the inputs.

To find the portfolio return in the weak economy, multiply the portfolio weight of each investment by its return in the weak economy and sum the results.

In this example, the equally-weighted portfolio's return in a weak economy is: =25%*–0.25 + 25%*0.22+ 25%*–0.15+25%*–0.40 = –0.145

Apply it

- *Why does High Pressure Tires have such a high return in the weak economy?*
  Now try to create a formula in the *Excel* file for the portfolio return in each economic scenario.

  Tip: If you set up your formula carefully, you can copy across for the other firms and the portfolio.

  How? Make sure you absolute reference the probabilities in the formula.
  The formula for this, in cell H20, should read:

  =$D$23*D20+$E$23*E20+$F$23*F20+$G$23*G20

  The result is –0.145.
  Copy down for the average and strong scenarios.
  Your *Inputs & Portfolio Calculations* section should look like this:

Inputs and Portfolio Calculations   **Percent Return**

                                     Portfolio

Economic Conditions	Probability	Petrochem.	H.P. Tires	J.R.R. Toykins	Karma. Calcs
Weak economy	20%	–0.250	0.220	–0.150	–0.400	–0.145
Average economy	50%	0.130	0.140	0.110	0.380	0.190
Strong economy	30%	0.350	–0.050	0.280	0.250	0.208
Portfolio weights		25%	25%	25%	25%	

    While few companies really have such countercyclical results, assume this company manufactures replacement tires for automobiles. In weak economic conditions, the firm's sales are relatively high, as people buy fewer new cars and hold on to older cars longer. Older cars are more likely to need replacement tires.

Expected Return

Next, complete the return section of the *Calculations* section. Create a formula for the expected return for Petrochemical.

The formula is:
Expected return = probability of a weak economy *return in the weak economy
                + probability of an average economy *return in the average economy
                + probability of a strong economy *return in the strong economy

You should find the expected return for Petrochemical is 12%; the portfolio return is 12.8%.

Apply it

- *Can you find another approach to solving for the portfolio return?*
  Once you have found the expected returns for the individual stocks, you can find the portfolio return by taking a portfolio weighted average of the individual stock returns. Your results will be the same—12.8%.

  This illustrates that you can find the portfolio return two different ways.
  1. Use the portfolio return in each scenario and find the probability weighted average.
  2. Use the expected returns of the individual stocks and find the portfolio weighted average.

- *Can you find portfolio variance as portfolio weighted averages of the individual firm variances?*
  No, diversification often lowers portfolio variance. To find portfolio variance you need information on the portfolio return in each scenario to use in the calculations.

Variance Calculations

Calculating variance under scenarios can be confusing. The calculations are described on page 292 of the chapter. We broke the calculation into three steps in the ***Probab*** tab of the *Excel* file.

Step 1: Set up a formula to find the return minus the expected return. Start with Petrochemical in the weak economy. You'll save time if you set up a formula that you can copy across all firms and the portfolio and that can be copied down through all three scenarios. To accomplish this, you'll need to use mixed cell references. You may want to review the information on mixed cell references at the bottom of the *Excel Prereqs* tab.

The formula is: = Petrochemical return in weak economy minus Petrochemical expected return
$$= -0.25 - 0.12$$
$$= D20 - D\$26$$

Use a mixed cell reference for the expected return. **DO** lock the row so that when you copy the formula down for Petrochemical in the other scenarios, the formula refers back to the expected return. **DO NOT** lock the column so that you can copy the formula across for the other firms and the portfolio.

Copy the formula down through the average and strong economic scenarios, and across through the other firms and the portfolio.

Step 2: Take the result from Step 1, square it, and then multiply by the probability of that economic scenario. Start with Petrochemical in the weak economy.

The formula is = Return minus expected return squared * probability
$$= -0.37 \text{ squared} * 20\%$$
$$= D31\wedge 2 * \$C20$$

Again, you want to create one formula that can be copied down and across, so be careful with your cell references. **DO NOT** lock the row so that you can copy down for other scenarios. **DO** lock column C since all probabilities are in column C. This enables you to accurately copy across.

Copy the formula down through the average and strong economic scenarios, and across through the other firms and the portfolio.

Step 3: Find the variance by summing the results ofStep 2 for all three scenarios.

Your variance calculations should match this:

Variance Calcs

1. Find return minus exp return	Petrochemical	High Pressure Tires	J.R.R. Toykins	Karma-ceuticals	Portfolio Calcs
weak economy	–0.370	0.121	–0.259	–0.585	–0.273
avg economy	0.010	0.041	0.001	0.195	0.062
strong economy	0.230	–0.149	0.171	0.065	0.079
2. (Ret- exp ret)^2*Prob'y					
weak economy	0.027	0.003	0.013	0.068	0.015
avg economy	0.000	0.001	0.000	0.019	0.002
strong economy	0.016	0.007	0.009	0.001	0.002
3. Variance	0.043	0.010	0.022	0.089	0.019

Output

Now go to the output section and complete the model. Expected return and variance have already been calculated, so use cell references to pull the information through to this section. Standard deviation is the square root of variance. The final results are:

Output

		High Pressure	Petrochemical	Karma- Tires	J.R.R. Toykins ceuticals	Portfolio
Exp Return	0.120	0.099	0.109	0.185	0.128	
Variance	0.043	0.010	0.022	0.089	0.019	
Standard deviation	0.208	0.102	0.149	0.298	0.137	

Apply it

- **Is the standard deviation of the portfolio a weighted average of the standard deviations of the individual stocks?**
  No. Since the stocks in the portfolio do not move exactly in sync with each other, the portfolio standard deviation is less than the weighted average. The weighted average of the four standard deviations (assuming 25% in each stock) is 0.189, while the portfolio standard deviation in 0.137.
- **Change the scenario probabilities and note the effect. Be certain that the probabilities sum to 100%.**
  You will find that if the likelihood of a weak economy is 30%, an average economy is 50%, and a strong economy is 20%, the portfolio return drops to 9.3%.
- **Change the portfolio weights and note the effect. Weights must also sum to 100%.**
  Changes in portfolio weights can also effect portfolio return significantly.

CAPM APPROACH TO CALCULATING EXPECTED RETURN

Next, use the CAPM approach to find the expected return to on investment in each of the four companies as well as the portfolio invested equally in each of the four firms. Also find the portfolio beta.

Approach: Create a basic model to find expected return and portfolio beta, using the CAPM approach.

Open the setup file provided on the **CAPM** tab of the Chapter 7 *Excel* file. Enter the input data in the blue-shaded cells of the *Inputs & Portfolio Calculations* section. Note that portfolio calculations are again included in this section.

Complete the portfolio beta calculation. The portfolio beta is a weighted average of the firm betas. Your completed section should appear as:

Inputs and Portfolio Calculations

		High Pressure			Karma-	Portfolio
Current Tbill rate	0.022					
Expected market return	0.110 **Petrochemical**	**Tires**	**J.R.R. Toykins**	**ceuticals**	**Calcs**	
Beta		1.20	0.90	1.00	1.60	1.18
Portfolio weights		25%	25%	25%	25%	

Next, use the input information and portfolio beta to solve for the expected return of the individual stocks and the portfolio. Set up the formula for Petrochemical so that you can copy it across for the other firms and the portfolio. Use absolute cell references, as needed.

Again, we provide an alternative calculation for portfolio return to illustrate that the return using the CAPM, with the portfolio beta, yields the same result as a portfolio weighted average of the individual firm expected returns.

The results are:

	Petrochemical	High Pressure Tires	J.R.R. Toykins	Karma- ceuticals	Portfolio	Calcs
Exp return	0.128	0.101	0.110	0.163	0.125	
Exp return (alternative portfolio calc.)					0.125	
Beta	1.20	0.90	1.00	1.60	1.18	

Apply it

- *Suppose the entire portfolio is invested in J.R.R. Toykins.*
  The expected return is 11%, the same return expected on the market index. Why? Because J.R.R. Toykins has a beta of 1.0 and is about as risky as the market.
- *Suppose the current Treasury bill rate increases to 6%, and you invest 25% of your portfolio in each of the firms.*
  You will get expected returns as follows:

Output

	Petrochemical	High Pressure Tires	J.R.R. Toykins	Karma- ceuticals	Portfolio Calcs

Exp return	0.120	0.105	0.110	0.140	0.119
Exp return (alternative portfolio calc.)			0.119		
Beta	1.20	0.90	1.00	1.60	1.18

The expected returns are identical for J.R.R. Toykins, higher for High Pressure Tires, and lower for Petrochemical and Karma-ceuticals.

- *Why?*

  The CAPM equation for expected return is:
  $$E(R) = R_f + (R_m - R_f) * B$$

  This equation can be rewritten as:
  $$E(R) = R_f * (1 - B) + B * R_m$$

  When beta is equal to one, as with J.R.R. Toykins, the term $R_f * (1–B)$ falls out, leaving R_m, so changes in the risk-free rate have no effect on expected return.

  When beta exceeds one, as with Petrochemical and Karma-ceuticals, an increase in the risk-free rate leads to a decrease in expected return.

  Finally, when beta is less than one, as with High Pressure Tires, an increase in the risk-free rate leads to an increase in expected return.

  This assumes the expected market rate remains at 11%.