Microsoft Excel 2003: Financial Investments
Part 2: Risk Analysis

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Introduction

This handout is intended to provide step-by-step instructions on how to use Excel 2003 to analyze the risks and returns associated with investment decisions. Whether a consumer or an investor may make various financial decisions involved in opportunities costs. Some decisions will have higher rewards or returns while others have higher risks involved. Excel's financial capability is useful in computing Variance, Standard Deviation, Coefficient of Variation, and Risk Adjusted Rate of Return, in order to accurately analyze the risks and returns associated with any financial investment decisions.

Review of Some Useful Statistical Concepts

This section will deal with the review of the important statistical concepts of probability distribution and expected value.

PROBABILITY DISTRIBUTION

Any situation that has an uncertain outcome can be said to have a probability distribution associated with the possible outcomes. A probability distribution is simply a listing of the probabilities associated with potential outcomes. For example, when a coin is tossed, the probability of having heads is .5 and that of tails is .5. A probability distribution is said to be discrete if there is a limited number of potential outcomes, such as coin tossing. However, if there are an infinite number of possible outcomes, such as the weight of a person, then the distribution is said to be continuous.

THE EXPECTED VALUE

Expected value is used for average estimation of some random value. It is the mean of the probability distribution or the weighted average of all possible outcomes. For example, if a game has N different outcomes and probability of each outcome is ρ_i, the expected value of some variable x that takes value x_i can be given as:

$$E(x) = x_1 \rho_1 + x_2 \rho_2 + \ldots\ldots + x_n \rho_n$$

or

$$E(X) = \sum_{i=1}^{N} \rho_i X_i$$

Where:

- E (X) is the expected value of *X*.
- X_i is the *i*th possible outcome.
- ρ_i is the probability that X_i will occur.

When the probabilities of an outcome are unknown, adding all the values and dividing it by the number of outcomes gives the expected value. In this case the probabilities are considered to be equal and the expected value is given by:

$$E(x) = x_1/n + x_2/n + \ldots\ldots + x_n/n$$

NOTE: Expected value helps to predict the estimation of some random variable for a long period of trials. The mean of any random variable in a long term gets close to its expected value. For a normal distribution, the expected value is the same as the more familiar arithmetic mean.

Example 1:
Suppose that an opportunity to participate in a game has been offered. The rules of this particular game are such that $200 must be paid to play. If the probability of winning the game is 50%, what are the possible outcomes associated with this game? Table 1 lists the possible payoffs. To determine whether or not this game should be played, it is necessary to compare the expected payoff or the mean ($\overline{X}$) value to the cost of playing. If the expected cash flow is equal to or exceeds the cost, the game will be played. However, if the cost is higher than the expected cash inflow, the game is not profitable. Therefore, it should be rejected. The following table shows the payoffs for a $200 Game:

Table 1 - Probability Distribution

Probability	Cash Flow
0.25 = 25%	100
0.5 = 50%	200
0.25 = 25%	300

To calculate the Expected Value of this game given the probability distribution, multiply the value of cash flow with its probability distribution (see Table 2). The formula appears as:

$$E(C_f) = 0.25(100) + 0.50(200) + 0.25(300) = 200$$

Table 2 - Expected Value

Probability (distribution)	Cash Flow (Arith Mean)	Expected Value $E(C_f)$
0.25	100	25
0.5	200	100
0.25	300	75
Total		200

To calculate Expected Value (see Figure 1):

1. Open the "***Risk Analysis***" file from the student drive.
2. Ensure the *Risk* tab is the active worksheet.
3. Select cell **C3**.
4. Type **[=A3*B3]**.
5. Press **[Enter]**.
6. Drag down to cell **C5** to copy formula.
7. In cell **C6,** click the **Auto Sum** Σ button to total above values.
8. Press **[Enter]**.

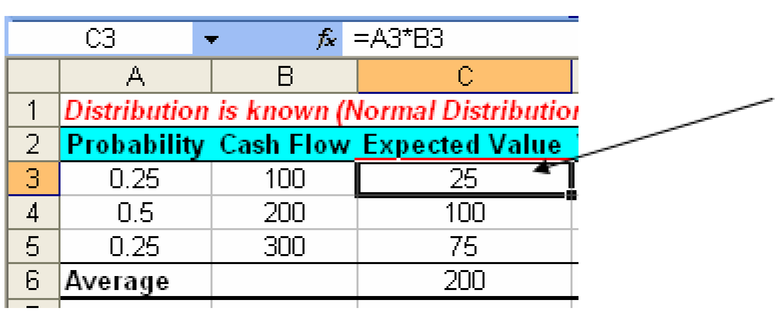


Figure 1 - Risk active worksheet

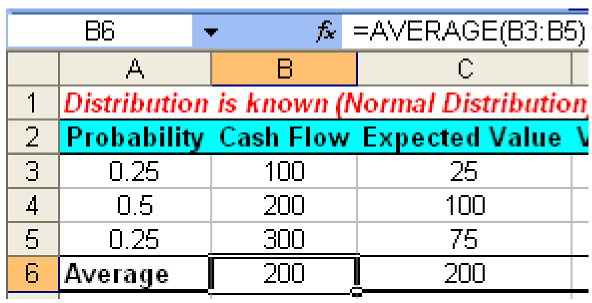
NOTE: This means that a player expects to break-even since the cost is equal to the winnings if the same is played a very large number of times. Actually, if the game is played only once, $100 could be either lost or won. However, the most likely outcome is a net gain of $0.00.

Compare the weighted mean to the arithmetic mean to check if the expected value is different (see Table 3).

$$\overline{C_f} = \frac{100 + 200 + 300}{3} = 200$$

Table 3 - Arithmetic Mean

Probability (distribution)	Cash Flow (Arith Mean $\overline{X}$)	Expected Value E(Cf)
0.25	100	25
0.5	200	100
0.25	300	75
Totals:	200	200


B6 | =AVERAGE(B3:B5)

	A	B	C
1	Distribution is known (Normal Distribution		
2	Probability	Cash Flow	Expected Value
3	0.25	100	25
4	0.5	200	100
5	0.25	300	75
6	Average	200	200

Figure 2 - Using Average Function for cash flow

To calculate Cash Flow:

1. In cell **B6** (see Figure 2), click the **Auto Sum** Σ drop down arrow.
2. Select ***"Average"***.
3. Press the **[Enter]** key.

The arithmetic mean also shows 200, which is equal to the expected value calculated earlier using weighted average. This is because the outcome of this game is symmetrically distributed, that is, it is a normal distribution.

Measures of Dispersion

The expected value shows only the central tendency by providing a fair estimate of what the expected value should be. Unfortunately, the actual outcome and the expected outcome are often different. Therefore, it is useful to know how much, on average, the actual outcome might deviate from the expected outcome.

For example, if the deviation is large, the outcome is less likely to occur. When comparing investment options, it is important not only to know expected value but also to consider the degree of deviation. Statistical concepts, such as variance and standard deviation, are used in order to measure the dispersion.

VARIANCE AND STANDARD DEVIATION

To measure risk, the size of the potential deviations from the mean can be calculated. One measure is the average deviation. The average deviation is calculated as:

$$\overline{D} = \sum_{i=1}^{N} \rho_i (X_i - \overline{X})$$

Where:

$\overline{X}$ = the mean or average of X_i

However, the above formula does not work for a normal distribution. In a normal distribution, the outcome of the formula will always be zero because each side of the distribution cancels the other side. For example, the calculated mean is 200. Inserting all the values of X_i, subtract each value from the mean, and add the results. The final result will be zero. Every positive result has an equal negative result.

Thus, another measure of dispersion should be considered to prevent the above flaw. Variance is the average of the square of the distance of each data point from the mean. The general formula to calculate variance when probabilities are not known is

$$\sigma_x^2 = \frac{1}{N}\sum_{i=1}^{N}(X_i - \overline{X})^2$$

When the probabilities are known, the variance is gives as

$$\sigma_x^2 = \sum_{i=1}^{N}\rho_i(X_i - \overline{X})^2$$

For computing variance, the deviations from the mean are squared in order to come up with a positive number. Therefore, variance must always be a positive value. The larger the variance, the less likely it is that the actual outcome will be near the expected outcome, and the higher the risk.

As seen in Figure 3, the solid line indicates less risk since most of the values are clustered around the mean when compared to the dashed lines where the values are deviating further and further away from the expected value.

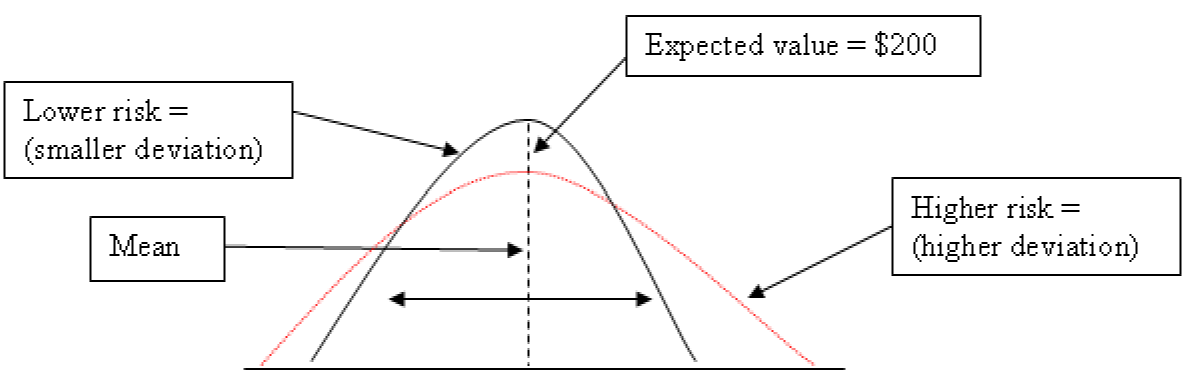


Figure 3 - Risk Comparison of two distributions

Returning to the example in Table 1, the possible number of outcomes calculated using variance is as follows:

$$\sigma^2 = 0.25(100-200)^2 + 0.50(200-200)^2 + 0.25(300-200)^2 = 5{,}000$$

Table 4 - Variance of possible outcomes

$0.25(100-200)^2$	$0.25(-100)^2$	0.25(-100*-100)	2,500
$0.50(200-200)^2$	$0.50(0)^2$	0.50(0*0)	0
$0.25(300-200)^2$	$0.25(100)^2$	0.25(100*100)	2,500
		Total:	5,000

For this particular game, the variance of possible outcomes is 5,000 (see Table 4). However, 5,000 in what units?

To make this measurement more understandable, take the square root of the variance, which is Standard Deviation. Therefore, the Standard Deviation is the square root of the variance.

$$\sigma_X = \sqrt{\sum_{t=1}^{N} \rho_t (X - \overline{X})^2}$$

Calculating Variance

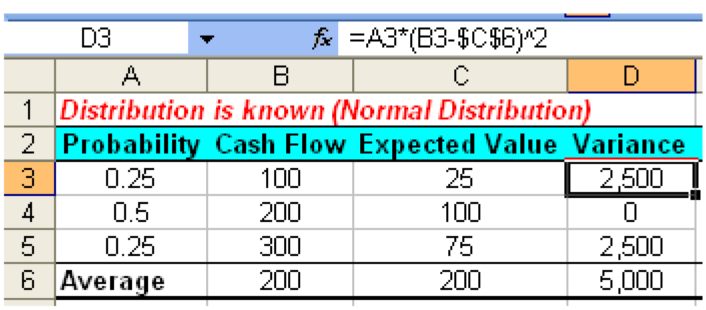
Find the variance using an absolute reference, the ***"F4"*** key.

To calculate Variance:

1. In **c**ell **D3**, type **[=A3*(B3-C6)^2]**.

   NOTE: The cell references can also be selected by clicking that cell.

2. In the **formula** bar, highlight ***"C6"***.
3. Press the **[F4]** key to make ***"C6"*** an absolute reference.
4. Highlight square **D3.**
5. Click, hold the square on the bottom right corner of the highlighted cell, and drag from cell **D3** to **D5**.
6. In cell **D6**, click the **AutoSum** button (see Figure 4).
7. Press the **[Enter]** key.



D3 =A3*(B3-C6)^2

	A	B	C	D
1	Distribution is known (Normal Distribution)			
2	Probability	Cash Flow	Expected Value	Variance
3	0.25	100	25	2,500
4	0.5	200	100	0
5	0.25	300	75	2,500
6	Average	200	200	5,000

Figure 4 - Calculating Variance in worksheet

Calculating Standard Deviation

Standard deviation can be computed using the previously calculated variance and the SQRT function.

To calculate Standard Deviation**:**

1. Click cell **E6**.
2. Press the **Insert Function** button .
3. From the *select a category* drop down list, select ***"Math & Trig"***.
4. In the *Select a function* scroll window, select ***"SQRT"***.
5. Click, hold the **title** bar, and drag the dialog box until all cells with values are visible.
6. For the ***Number*** text box, click cell **D6**, ***"5000"*** (see Figure 5).
7. Click the **OK** button.

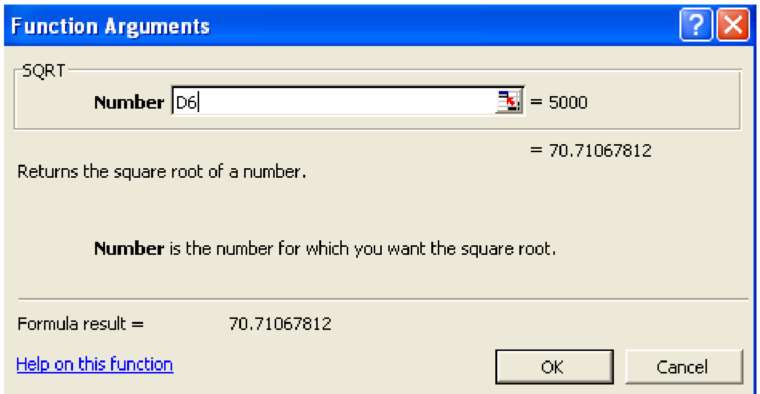


Figure 5 - Using SQRT to calculate Std Deviation

The standard deviation of potential outcomes in the game is:

$$\sigma = \sqrt{5{,}000} = 70.71$$

This means that about 68% of all outcomes will be within one standard deviation of the mean (200 ± 70.71) and 95.5% will be within two standard deviations (200 ± 141.42). Furthermore, it is exceedingly unlikely (<0.1%), but not impossible that the actual outcome will fall beyond three standard deviations from the mean (200 ± 212.13).

Using the rule of 68% and 95.5% percent in combination with the $200 mean we get the following results (see Figure 6):

$$\text{One Std D. from } \overline{X} = 68\% \text{ is within} \pm 70.71 \text{ of } 200$$
$$\text{Two Std D. from the } \overline{X} = 95.5\% \text{ is within} \pm 141.42 \text{ of } 200$$

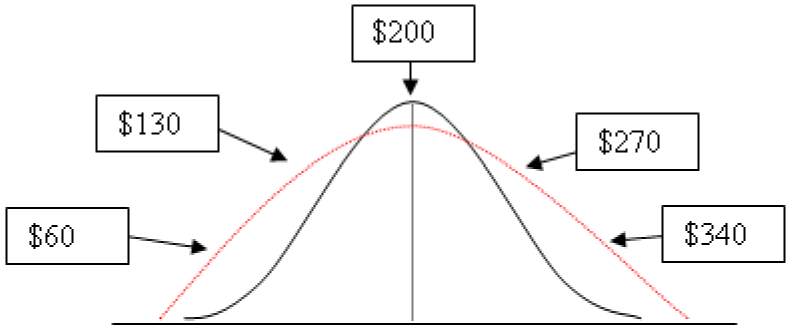


Figure 6 - Standard Deviations from the mean

THE COEFFICIENT OF VARIATION

Suppose that after playing the game once, another chance to play the game again has been offered, but this time the cost of the game is ten times larger (see Table 5).

Table 5 - Possible outcomes of larger game

Probability	Cash Flow
0.25 = 25%	1000
0.50= 50%	2000
0.25 = 25%	3000

Is this game riskier than the old game? The large cash flow makes this game seem riskier. However, the amount of cash flow does not change the risk as long as the probability is still the same. Of course, more money may be won or lost than in the previous game.

To understand the risk involved, compute the standard deviation and compare how this particular game deviated from the mean. Start by calculating the variance (see Table 6). Then use the result to calculate the standard deviation σ (see Figure 7).

$$\sigma = \sqrt{0.25(1000-2000)^2 + 0.50(2000-2000)^2 + 0.25(3000-2000)^2}$$

Table 6 – Calculating the Variance

$0.25(1000\text{-}2000)^2$	$0.25(\text{-}1000)^2$	0.25(-1000*-1000)	2,5000
$0.50(2000\text{-}2000)^2$	$0.50(0)^2$	0.50(0*0)	0
$0.25(3000\text{-}2000)^2$	$0.25(1000)^2$	0.25(1000*1000)	2,5000
		Variance:	50,000

E6 | f_x =SQRT(D6)

	A	B	C	D	E
1	Distribution is known (Normal Distribution)				
2	**Probability**	**Cash Flow**	**Expected Value**	**Variance**	**Standard Deviation**
3	0.25	1000	250	250000	
4	0.5	2000	1000	0	
5	0.25	3000	750	250000	
6	**Average**	2000	2000	500000.0	707.11

Figure 7 - Calculating the Standard Deviation

NOTE: The value for cell **E6** changes automatically by changing the cash flow values.

The standard deviation for this game is:

$$\sigma = \sqrt{50{,}000} = 707.106$$

Since the standard deviation is ten times larger than the previous result of 70.71, it appears that the new game is much riskier. Recall that high risk is associated with a high probability of loss. However in the new game, the probability of loss is unchanged (25%). Therefore, the risk should be the same.

Apparently, this method of calculating the standard deviation has a scale problem. In other words, large numbers cause larger standard deviations even if the relative dispersion is unchanged. The coefficient of variation handles the scale problem by dividing the standard deviation by the mean:

$$\gamma_x = \frac{\sigma_x}{\overline{\overline{X}}}$$

If the new game is truly riskier than the old game, it will have a higher coefficient of variation. The coefficient of variation is the standard deviation divided by the total expected value. To verify whether or not the new game is riskier, compare the coefficients of variation for both games:

$$\gamma_1 = \frac{70.7106}{200} = 0.3535$$

$$\gamma_2 = \frac{707.106}{2{,}000} = 0.3535$$

Comparing the values we see that $\gamma_1 = \gamma_2$. In other words, the two games are equally risky.

To calculate Coefficient of Variation:

1. In cell **F6**, type **[=E6/C6]**.
2. Press the **[Enter]** key (see Figure 8).

F6 | fx =SUM(E6/C6)

	A	B	C	D	E	F
1	Distribution is known (Normal Distribution)					
2	Probability	Cash Flow	Expected Value	Variance	Standard Deviation	CV
3	0.25	1000	250	250000		
4	0.5	2000	1000	0		
5	0.25	3000	750	250000		
6	Average	2000	2000	500000.0	707.11	0.353553

Figure 8 - Coefficient of Variation

Computing Cash Flow and Expected Value in Excel

If the distribution of possible cash flows is normal or binomial, the expected value and arithmetic mean are going to be the same.

Example 1:

Suppose that a potential new product for the Freshly Frozen Fish Company needs to be analyzed. An expert in the catfish market has been asked to develop cash flow forecast for a new frozen catfish product the company is considering. As an approximation, the projections for the first year's cash flows from the product will be developed as follows:

To calculate Cash Flow:

1. Ensure the *ABC* tab is the active worksheet.
2. In cell **B8,** click the **AutoSum** Σ drop down arrow.
3. Select ***"Average"***.
4. Click, hold the square on the bottom right corner of the highlighted cell and drag from cell **B3** through **B7** (see Figure 9) to copy the formula.
5. Press the **[Enter]** key.

B8 | fx =AVERAGE(B3:B7)

	A	B
1		
2	Probability	Cash Flow
3	0.05	(500,000.00)
4	0.20	100,000.00
5	0.50	700,000.00
6	0.20	1,300,000.00
7	0.05	1,900,000.00
8	Average	700,000.00

Figure 9 - Freshly Frozen Fish Company's first year projections

As an alternative, Excel's built-in Average can be used by clicking **Insert Function**, **Statistical category,** and the **Average** function to compute the average of the following numbers: ***Number1***,*Number2*, *Number*, and so on. Up to 29 numbers can be selected (see Figure 10).

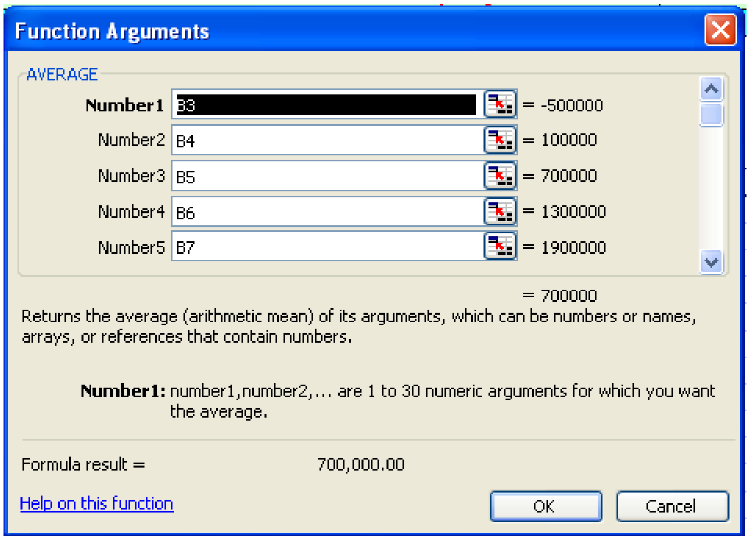


Figure 10 - Average Function dialog box

To calculate Expected Value (see Figure 11):

1. Click in cell **C3**.
2. Click the **AutoSum** button Σ.
3. Click cell **A3**, ***"0.05"***.
4. Type **[*]**.
5. Click cell **B3**, ***"-500,000.00"***.
6. Press the **[Enter]** key.
7. Click, hold the square on the bottom right corner of the highlighted cell, and drag from cell **C3** to **C7** to copy the formula.
8. Click in cell **C8**.
9. Click the **AutoSum** button Σ to highlight all expected values.
10. Press the **[Enter]** key.

C8 =SUM(C3:C7)

	A	B	C
1			ABC Comp
2	Probability	Cash Flow	Expected Value
3	0.05	(500,000.00)	(25,000.00)
4	0.20	100,000.00	20,000.00
5	0.50	700,000.00	350,000.00
6	0.20	1,300,000.00	260,000.00
7	0.05	1,900,000.00	95,000.00
8	Average	700,000.00	700,000.00

Figure 11 - Expected Value total

From the result, the expected value and the arithmetic mean are the same. This indicates a symmetrical distribution.

One problem with using the Average function under Cash Flow is that it will give inaccurate results because it does not take into consideration the probability distribution associated with each cash flow.

Calculating the Measures of Dispersion with Excel

As mentioned previously, the actual cash flow is rarely the exact same as the expected or projected cash flow. Therefore, the next step is to calculate the dispersion presented in this investment opportunity. As with the arithmetic average, Excel provides built-in functions to calculate the variance and standard deviation. However, these functions do not consider probability.

THE VARIANCE

Excel provides two functions for calculating the variance when the probability distribution is *unknown*: **VARP** and **VAR**. The functions are defined in exactly the same way, but *VARP* calculates the population variance, while *VAR* calculates the sample variance. These functions are defined as:

VARP(*Number1*,*Number2*, …)
and **VAR(*Number1***, *Number2* …)

Hereby, the population variance (VARP) should be used because the entire set of possible outcomes is already known.

To calculate Variance using the Cash Flows when Probability is NOT known:

1. Ensure the *ABC* tab is the active worksheet.
2. Click cell **D9**.
3. Click the **Insert Function** button. The *Insert Function* dialog box opens.
4. From the *select a category* drop-down list, select ***"Statistical"***.
5. From the *Select a Function* list, select ***"VARP"***.
6. Click the **OK** button. The *Function Arguments* dialog box opens up (see Figure 12).
7. In the ***Number 1*** textbox, specify a range of numbers for the variance. Click and drag from cell **B3** to cell **B7** in column B's Cash Flow.
8. VARP (**B3**:**B7**) equals 720,000,000,000.00 (see Figure 13).

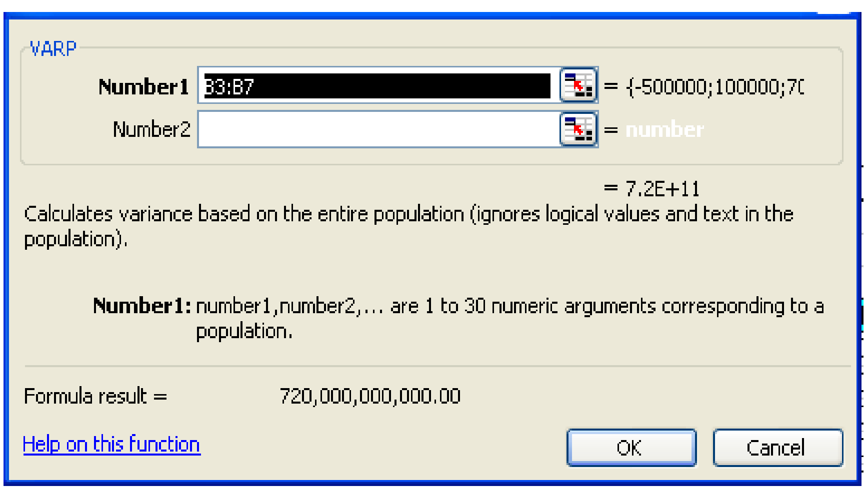


Figure 12 - Calculating Variance using Cash Flows

D9 | f_x =VARP(B3:B7)

	A	B	C	D
1			ABC Company	
2	Probability	Cash Flow	Expected Value	Variance
3	0.05	(500,000.00)	(25,000.00)	
4	0.20	100,000.00	20,000.00	
5	0.50	700,000.00	350,000.00	
6	0.20	1,300,000.00	260,000.00	
7	0.05	1,900,000.00	95,000.00	
8	Average	700,000.00	700,000.00	
9	*Using Paste Function*			720,000,000,000.00

Figure 13 - Variance total when probability is NOT known

The answer is 720,000,000,000 (or 7.2E+11). However, this function is not considering the fact that the probability distribution of the possible cash flows is known.

Since the probability distribution is known, the variance can be calculated by writing the formula without using Excel's built-in functions.

To calculate Variance when the Probabilities ARE known:

1. In **cell D3**, type **[=A3*(B3-C8)^2]**.
2. In the **formula** bar, highlight ***"C8"***.
3. Press the **[F4]** key.

NOTE: The cell reference to **C8** can be anchored with the $ sign by pressing the ***"F4"*** key (absolute reference).

4. Press the **[Enter]** key.
5. Click, hold the square on the bottom right corner of the highlighted cell, and drag from cell **D3** to **D7** to copy formula.
6. Click in cell **D8**.
7. Click the **AutoSum** button Σ.
8. Highlight cells **D3** to **D7**.
9. Press the **[Enter]** key.

This formula subtracts the expected cash flow average from the expected cash flow, squares the result, and multiplies it by the appropriate probability.

Finally, all of the sub-values are added together. The final result is 288,000,000,000 (or 2.88E+11), which is substantially different from the result calculated by the built-in function (see Figure 14).

	A	B	C	D
1			ABC Company	
2	Probability	Cash Flow	Expected Value	Variance
3	0.05	(500,000.00)	(25,000.00)	72,000,000,000.00
4	0.20	100,000.00	20,000.00	72,000,000,000.00
5	0.50	700,000.00	350,000.00	-
6	0.20	1,300,000.00	260,000.00	72,000,000,000.00
7	0.05	1,900,000.00	95,000.00	72,000,000,000.00
8	Average	700,000.00	700,000.00	288,000,000,000.00
9	*Using Paste Function*			720,000,000,000.00

Figure 14 - Variance total when probability is Known

NOTE: It is important to understand what the built-in functions are calculating or else the result might be erroneous.

THE STANDARD DEVIATION

The standard deviation is the true deviation of the expected value from the actual value. To calculate standard deviation, take the square root of the variance. Since variance is correctly calculated, this formula will provide the correct standard deviation.

Besides the aforementioned method of calculating standard deviation, Excel provides two built-in functions for calculating the Standard Deviation: **STDEVP** and **STDEV**. These functions are defined as:

STDEVP (*Number1*, *Number2* …)
and
STDEV (*Number1*, *Number2* …)

To calculate Standard Deviation when the probability is NOT known:

1. Click cell **E9** under Standard Deviation.
2. Click the **Insert Function** button. The *Insert Function* dialog box opens.
3. From the ***select a category*** text box, select ***"Math & Trig"***.
4. From the ***Select a function*** list, select ***"SQRT"***.
5. Press the **OK** button. The *Function Arguments* dialog box opens (see Figure 15).
6. Click, hold the **title** bar, and drag the dialog box until all cells with values are visible.
7. For the ***Number*** text box, select cell **D9**, ***"720,000,000,000"***, which is the variance.

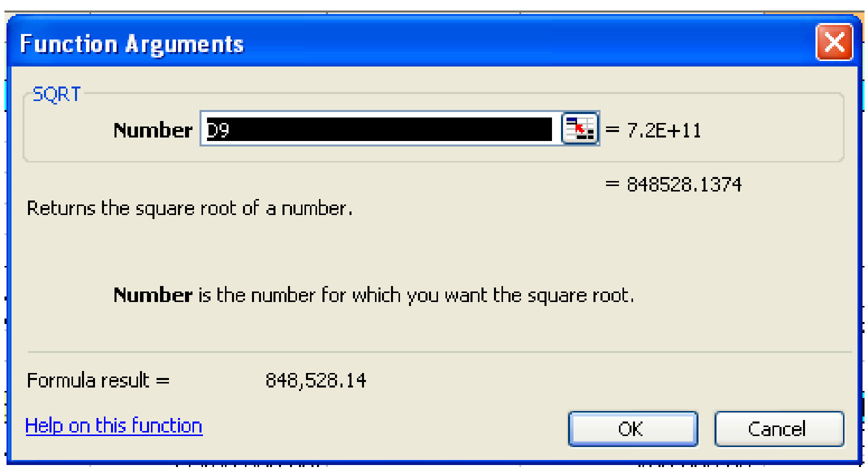


Figure 15 - SQRT dialog box to insert variance

8. Click the **OK** button.

Microsoft Excel - RiskAnalysis with formulas.xls

E9 =SQRT(D9)

	A	B	C	D	E
1	ABC Company				
2	Probability	Cash Flow	Expected Value	Variance	Standard Deviation
3	0.05	(500,000.00)	(25,000.00)		
4	0.20	100,000.00	20,000.00		
5	0.50	700,000.00	350,000.00		
6	0.20	1,300,000.00	260,000.00		
7	0.05	1,900,000.00	95,000.00		
8	Average	700,000.00	700,000.00		-
9	*Using Paste Function*			720,000,000,000.00	848,528.14

Figure 16- Standard Deviation when probability is NOT known

The built-in functions calculate the standard deviation to be 848,528.14 (see Figure 16). Similar to computing the variance, the probability distribution is ignored.

NOTE: If the probability distribution was not involved, the computation using Excel's function would have been correct.

To calculate Standard Deviation when the probability IS known:

1. Click cell **E8**.
2. Follow the steps 2-6 on page 14.
3. For the ***Number*** text box, select cell **D8**, ***"288,000,000,000"***, which is the correct variance.
4. Click the **OK** button.

E8 =SQRT(D8)

	A	B	C	D	E
1	ABC Company				
2	Probability	Cash Flow	Expected Value	Variance	Standard Deviation
3	0.05	(500,000.00)	(25,000.00)	72,000,000,000.00	
4	0.20	100,000.00	20,000.00	72,000,000,000.00	
5	0.50	700,000.00	350,000.00	-	
6	0.20	1,300,000.00	260,000.00	72,000,000,000.00	
7	0.05	1,900,000.00	95,000.00	72,000,000,000.00	
8	Average	700,000.00	700,000.00	288,000,000,000.00	536,656.31

Figure 17 - Standard Deviation total when probability is known

One Std D. from $\overline{X}$ = 68% is within ± 536,000 of 700,000

Two Std D. from the $\overline{X}$ = 95.5% is within ± 1,072,000 (2×536,000) of 700,000

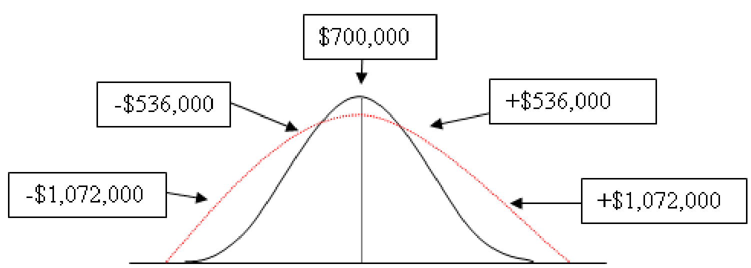


Figure 18 - Standard Deviations from the mean

Incorporating Risk into Capital Budgeting Decisions

In order to be effective, this discussion of investment analysis needs to encompass a more accurate and complete risk analysis. There are two important issues that must be considered before investing money, the time value of money and Internal Rate of Return.

WEIGHTED AVERAGE COST OF CAPITAL (WACC)

The Weighted Average Cost of Capital (WACC) is the discount data that should be applied to projects. The WACC takes into consideration the average level of risk for the firm. The assets of a company are financed by either debt or equity. WACC is the average of the cost of each of these sources. In other words, the weighted average cost of capital is the amount of interest the company has to pay for every dollar it borrows. For the purpose of this handout, the WACC is calculated by management. WACC is the overall required return on the firm as a whole.

There are several methods for incorporating risk into the decision-making process. These methods will be discussed while continuing with the Freshly Frozen Fish example:

Example 1:

Management at the Freshly Frozen Fish Company has expressed interest in the catfish project based upon first-year projections. As a result, the study needs to be expanded to cover the next five years and to determine whether the project is acceptable or not. Furthermore, the firm's *WACC* is 12% for the study, and the project would have an initial investment of $2,100,000. Freshly Frozen Fish uses all of the usual discounted cash flow techniques to evaluate projects. As a first approximation, and subject to later refinement, the cash flow projections will be applied to each of the five years of the project's life. Is the project acceptable?

THE RISK-ADJUSTED DISCOUNT RATE (RADR)

RADR adjusts the expected rate of return with the rate of risk premium in order to accurately estimate the required return that should be expected so as to gain a profit from a certain investment. Recall that the simple risk premium model was defined as:

Required Return = Base Rate + Risk Premium

The base rate and risk premium are subjectively determined. To use the RADR technique, the model will be modified to:

RADR = WACC + Risk Premium

> NOTE: The risk premium is still subjectively determined, while the base rate is the same as the *WACC*. Looking at the example above, the base rate or WACC is 12%. Therefore, the next step is to find the risk premium and the RADR.

Normally, the risk premium will be determined according to a schedule that has been approved by the firm's upper management. This schedule may assign risk premiums according to some calculated risk measure, by the type of project, or perhaps by some other method. Suppose that management at Freshly Frozen Fish gives the following schedule of risk premiums which is based on the coefficient of variation:

Table 7 - RADR, Coefficient of Variation and Risk Premium

Coefficient of Variation	Risk Premium	RADR
CV ≤ 0.20	-0.03	0.12 – 0.03 = 0.09
0.20 ≤ CV < 0.30	0.00	0.12 + 0.00 = 0.12
0.30 ≤ CV < 0.40	0.03	0.12 + 0.03 = 0.15
0.40 ≤ CV < 0.50	0.05	0.12 + 0.05 = 0.17
CV ≥ 0.50	0.07	0.12 + 0.07 = 0.19

The coefficient of variation for the company's average project is **0.7667** (Recall that $\gamma_x = \frac{\sigma x}{\overline{X}}$), so a risk premium of 0.07 is assigned to this project. For projects with less than average risk, assign a negative risk premium. For projects with greater than average risk, assign a progressively higher risk premium. Therefore:

$$RADR = Risk\ Premium + WACC = 0.07 + 0.12 = \underline{\underline{0.19}}$$

The cash flow forecast for each year is the expected value of the probability distribution, which describes the possible outcomes. Since the expected value is the most likely value, this value is used as the forecast (see Table 8). In actuality, a distribution would likely be different in each period thereby necessitating a different RADR for each period.

Table 8 - Projected Cash Flows

Year	Cash Flow
1	(2,100,000)
2	700,000
3	700,000
4	700,000
5	700,000
6	700,000

NET PRESENT VALUE (NPV)

To recall from part one, NPV compares the value of a dollar today versus the value of the same dollar in future, taking into account inflation and return. A positive value of NPV indicates profit or cash inflow, a negative value indicates loss or cash outflow while a zero value represents no profit-no loss situation.

To determine whether Freshly Frozen Fish for the ABC Company should accept this project, the *NPV* and *IRR* needs to be calculated. For the *NPV* calculation, Table 8. provides the information to determine the appropriate risk-adjusted discount rate. Since the coefficient of variation is greater than 0.50, we will add 7% to the *WACC* to arrive at the discount rate.

First, add the WACC %+ Risk Premium % together, then add all the values together, apart from the %'s (except for the initial outflow that occurred at the beginning of the year), then add the initial out flow after the first totals are calculated.

To calculate NPV:

1. Ensure the *ABC* tab is the active worksheet.
2. Click cell **B22** (see Figure 19).

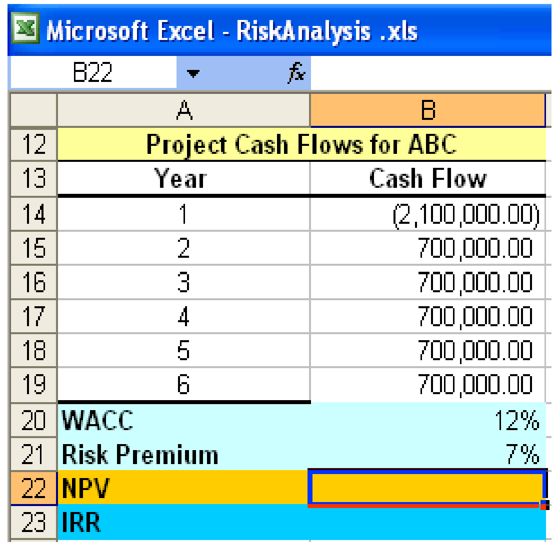


Figure 19 - Calculate NPV in Cell B22

3. Click the **Insert Function** button.
4. From the *select a category:* list box, select ***"Financial"***.
5. Under the *Select a Function name:* list box, select ***"NPV"***.
6. Click the **OK** button. The *Function Argument* dialog box opens (see Figure 20).
7. Click, hold the **title** bar, and drag the dialog box until all cells with values are visible.
8. For the ***Rate*** text box, select cell **B20**.
9. Continue by typing **[+]**.
10. Select cell **B21**, this will add the WACC (12%) to the Risk Premium (7%).

<u>NOTE</u>: Using cell references to calculate the discount rate, rather than just inserting a number, allows changes in the *WACC* to be instantly incorporated into the result.

11. For the ***Value1*** text box, click, hold, and drag from cell **B15** to **B19**, which is the 2nd through 6th year for the values (see Figure 20).

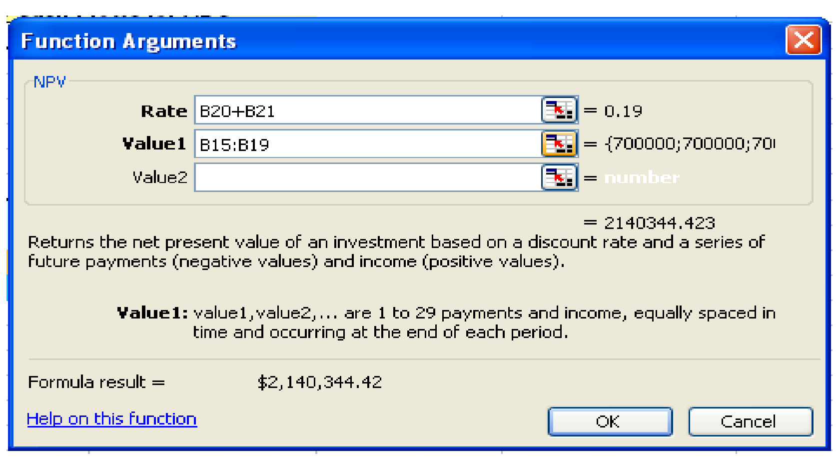
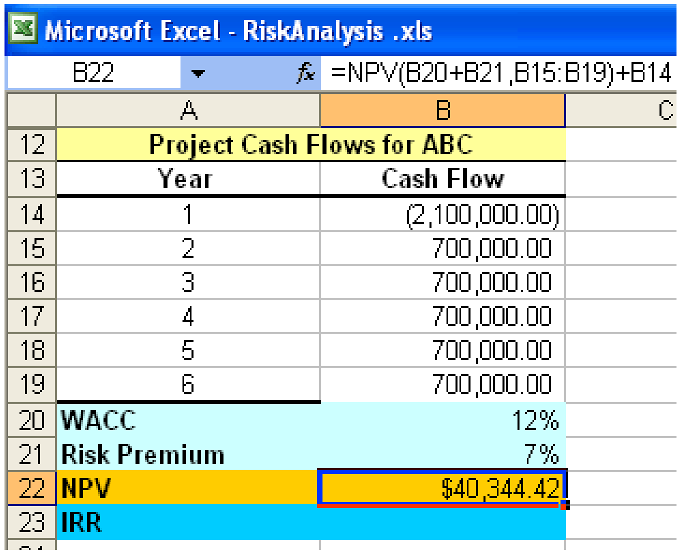


Figure 20 - NPV dialog box

12. Click the **OK** button.
13. Click on the **Formula** bar.
14. Type **[+B14]**, ***"-2,100,000"*** (see Figure 21).

NOTE: Cell **B14**, **"-2,100,000"**, is the initial outflow that occurred at the beginning of the year. Therefore is not subjected to the discount rate.

15. Press the **[Enter]** key.



Microsoft Excel - RiskAnalysis .xls

B22 =NPV(B20+B21,B15:B19)+B14

	A	B
12	Project Cash Flows for ABC	
13	Year	Cash Flow
14	1	(2,100,000.00)
15	2	700,000.00
16	3	700,000.00
17	4	700,000.00
18	5	700,000.00
19	6	700,000.00
20	WACC	12%
21	Risk Premium	7%
22	NPV	$40,344.42
23	IRR	

Figure 21 - NPV total and formula

The *NPV* is $40,344.42, so the project is acceptable (see Figure 21).

Since the NPV was positive, the project is acceptable. If the NPV was negative, then the project would be unacceptable. If the NPV were 0, then the project would have achieved its break-even point.

CALCULATING INTERNAL RATE OF RETURN (IRR)

The Internal Rate of Return is the interest rate received for an investment consisting of payments (negatives values) and income (positive values) that occur at regular periods. It returns the internal rate of return for a series of cash flows that must occur at regular intervals enough to cover original cost plus some profit.

IRR could be any number of positive, negative, or 0 percent values. When IRR is negative, it indicates that the investment in question is not profitable enough to return the initial cash investment. When IRR is 0%, it indicates a break-even point where neither profit nor loss is recognized.

Table 9 - IRR Syntax

IRR (values, guess)	
Values	Contain at least one positive value and one negative value indicating the outflows and expected inflows.
Guess	Guess the outcome of the IRR calculation.

- In most cases, the IRR calculation does not need a guess. If the guess is omitted, it is assumed to be 0.1 (10 percent). Normally, a 10% return is expected on the investment.
- If IRR gives the #NUM! error value, or if the result is not close to the expected value, try again with a different value for guess.
- Values must contain at least one positive value and one negative value to calculate the internal rate of return.

- IRR uses the order of values to interpret the order of cash flows. It is possible to enter payments and income values in any sequences.
- If an array or references argument contains text, logical values, or empty cells, those values are ignored.

To calculate IRR:

1. Click cell **B23**.
2. Click the **Insert Function** button.
3. From the *select a category:* list box, select ***"Financial"***.
4. Under the *Select a Function name:* list box, select ***"IRR"***.
5. Click the **OK** button. The *Function Argument* dialog box opens (see Figure 22).
6. Click, hold the **title** bar, and drag the dialog box until all cells with values are visible.
7. For the ***Values*** text box, click, hold, and drag from cell **B14** to **B19**.
8. In the ***Guess*** text box, type **[.10]**.
9. Click the **OK** button.

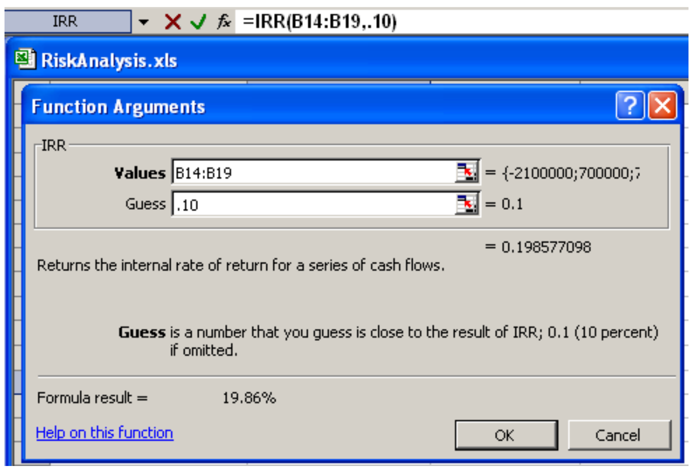
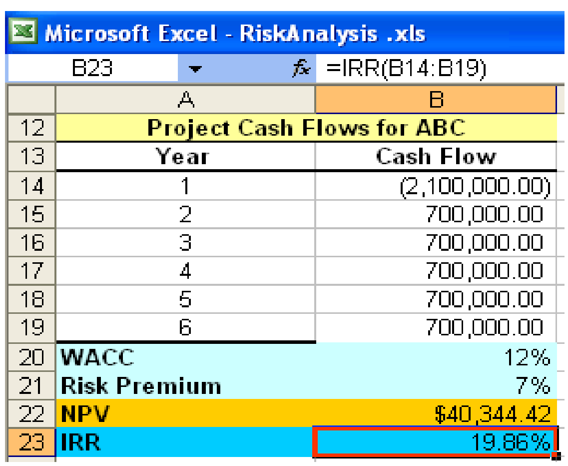


Figure 22 - IRR dialog box



Microsoft Excel - RiskAnalysis .xls

B23 =IRR(B14:B19)

	A	B
12	Project Cash Flows for ABC	
13	Year	Cash Flow
14	1	(2,100,000.00)
15	2	700,000.00
16	3	700,000.00
17	4	700,000.00
18	5	700,000.00
19	6	700,000.00
20	WACC	12%
21	Risk Premium	7%
22	NPV	$40,344.42
23	IRR	19.86%

Figure 23 - IRR total and formula

The IRR of 19.86% means that this particular investment will cover the initial cost plus a return of almost 20%. Therefore, consider this as a good investment opportunity (see Figure 23).
Practice Concept: Calculate the IRR assuming that Freshly Frozen Fish Company projected cash flow only until Year 4 rather than Year 6. Repeat formula above by replacing **B19** with **B17** (for year four) for the value, in the Function Argument.

The answer should be 0% or break-even instead of the previously calculated 19.86% for IRR. There is a difference due to certain investments ability to cover the initial cost and return a profit to the investor. Therefore, a 0% IRR indicates that this particular investment will not be able to provide adequate return by Year 4. However, waiting until Year 5 or Year 6, provides a positive return.

In conclusion, there are various important factors that must be known prior to investing in any form of business. Being able to compute, interpret, and analyze the risks and return associated with an investment is very important in order to determine if a particular investment meets expectations. Also, understanding these factors will help in making informed decisions whether as consumer and/or an investor.