Build your own Investment and Financial Calculator in Microsoft Excel

http://spreadsheetml.com/financialmodeling

Copyright (c) 2009, ConnectCode

All Rights Reserved.

ConnectCode accepts no responsibility for any adverse affect that may result from undertaking our training.

Microsoft and Microsoft Excel are registered trademarks of Microsoft Corporation. All other product names are trademarks, registered trademarks, or service marks of their respective owners

Table of Contents

1. Introduction 1-1
1.1 Time Value of Money and Discounted Cash Flow Analysis 1-1
1.1.1 Time Value of Money 1-1
1.1.2 Discounted Cash Flow Analysis 1-1
1.2 Background 1-1
2. Time Value of Money 2-2
2.1 Future Value of a Lump Sum 2-2
2.2 Future Value of a Lump Sum with more than 1 compounding periods per year 2-2
2.3 Future Value of a Lump Sum with Continuous Compounding 2-3
2.4 Future Value of an Ordinary Annuity 2-4
2.5 Future Value of a series of unequal cash flow 2-4
2.6 Present Value of a Lump Sum to be received in the Future 2-5
2.7 Present Value of a Lump Sum with more than 1 compounding period per year 2-5
2.8 Present Value of an Ordinary Annuity 2-6
2.9 Present Value of a Perpetuity 2-6
2.10 Present Value of a series of unequal cash flow 2-6
3. Discounted Cash Flow Analysis 3-8
3.1 Net Present Value (NPV) 3-8
3.2 Internal Rate of Return (IRR) 3-9
3.2.1 Money Weighted Rate of Return 3-9
3.2.2 Time Weighted Rate of Return 3-10
3.3 Holding Period Return 3-11
3.4 Bank Discount Yield 3-11
3.5 Effective Annual Yield 3-11
3.6 Money Market Yield (CD equivalent yield) 3-11

ConnectCode's Financial Modeling Templates

Have you thought about how many times you use or reuse your financial models? Everyday, day after day, model after model and project after project. We definitely have. That is why we build all our financial templates to be reusable, customizable and easy to understand. We also test our templates with different scenarios vigorously, so that you know you can be assured of their accuracy and quality and that you can save significant amount of time by reusing them. We have also provided comprehensive documentation on the templates so that you do not need to guess or figure out how we implemented the models.

All our template models are only in black and white color. We believe this is how a professional financial template should look like and also that this is the easiest way for you to understand and use the templates. All the input fields are marked with the '' symbol for you to identify them easily.*

Whether you are a financial analyst, investment banker or accounting personnel. Or whether you are a student aspiring to join the finance world or an entrepreneur needing to understand finance, we hope that you will find this package useful as we have spent our best effort and a lot of time in developing them.

ConnectCode

1. Introduction

1.1 Time Value of Money and Discounted Cash Flow Analysis

The Time Value of Money and Discounted Cash Flow Analysis are two cornerstone concepts of investment and financial analysis. The aim of this tutorial is to introduce these two concepts and at the same time use Microsoft Excel to develop financial models that utilize these concepts for analyzing investments.

It is known that most financial analysts in the industry developed their own set of models during their course of work over the years. The models usually form the basis of their analysis work and become an extremely important toolkit to them. This tutorial aims to provide the basis of building this toolkit and serve as a stepping stone for financial analysts to building more complex models. The concepts listed below will be discussed.

1.1.1 Time Value of Money

- Future Value of a Lump Sum
- Future Value of a Lump Sum with more than 1 compounding period per year
- Future Value of a Lump Sum with Continuous Compounding
- Future Value of an Ordinary Annuity
- Future Value of a series of unequal cash flow
- Present Value of a Lump Sum to be received in the Future
- Present Value of a Lump Sum with more than 1 compounding period per year
- Present Value of an Ordinary Annuity
- Present Value of a Perpetuity
- Present Value of a series of unequal cash flow

1.1.2 Discounted Cash Flow Analysis

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Money Weighted Rate of Return
- Time Weighted Rate of Return
- Holding Period Return
- Bank Discount Yield
- Money Market Yield

1.2 Background

If given a choice of $1000 to be received today or two years later, most people will no doubt choose to receive the money today. The reason is very simple, the $1000 received today can be put in the banks or in risk free instruments like the US Treasury Bills to earn interest. In two years' time, the $1000 with interest will be worth more than the $1000 today. This simple concept forms the basis of the Time Value of Money.

If given a choice of receiving $1000 today or $1050 two years later, what would you choose? This is slightly more difficult. We will need to compare these two values on a fair and comparable basis. For example, what is $1000 worth two years later or what is the $1050 in two years' time worth today? In other words, we are asking what the future value of the $1000 is in two years' time or what the present value of the $1050 is now.

2. Time Value of Money

2.1 Future Value of a Lump Sum

The Future Value is defined as the value of a given sum of money today at a specific future date taking into account compound interests. If your $1000 earns $50 of interest in one year and the $50 earned is used to earn further interest in the subsequent year, this is compound interest.

Formula of Future Value

FVn = PV * (1+r)^n

- FVn is the Future Value after a specific period
- PV is Present Value
- r is the interest rate
- n is the period. For example 5 years.

Now you can bring up the Future Value.xls. The first worksheet contains the template to calculate the Future Value of a Lump Sum. Simply key in the Present Value, Rate of Interest and Period to calculate the Future Value. The fields marked with * are input fields. The table below illustrates the future value at different periods.

	A	B	C	D
1				
2		Future Value (Lump Sum)		
3				
4		Present Value (PV)*	$100,000.00	
5		Periods (N)*	7.00	
6		Rate of Interest (r)*	3.00%	
7		Future Value (FV)	$122,987.39	
8				
9	Periods	Future Value	Periods	Future Value
10	0	$100,000.00		
11	1	$103,000.00	31	$250,008.03
12	2	$106,090.00	32	$257,508.28
13	3	$109,272.70	33	$265,233.52
14	4	$112,550.88	34	$273,190.53

Some of you may be familiar with the FV (Future Value) formula provided by Excel. We will however not be using it at this moment as we will be building the models from the very basic calculations instead. Once we are familiar with the basics, we can move on to further evolve the models to use the formulas provided by Excel.

2.2 Future Value of a Lump Sum with more than 1 compounding periods per year

The previous definition of Future Value assumes that interests are paid at the end of each year. Sometimes, certain institutions pay out interest more than once per year. It is possible that the interests are paid out

- Semi Annualy
- Quarterly

- Monthly
- Daily
- Continuously (Continuous Compounding. See the next section.)

For Semi Annual, the compounding periods is 2, Quarterly, the compounding period is 4, Monthly the compounding period is 12 and Daily the compounding period is 365.

For some financial formulas, special compounding periods like 360 days will sometimes be used. Basically the more frequent the compounding period, the better the interest.

Formula of Future Value with more than 1 compounding periods

FVn = PV * (1+(r/m))^(m*n)

- FVn is the Future Value after a specific period
- PV is Present Value
- r is the interest rate
- n is the period. For example 5 years.
- m is the number of compounding periods

Open up the Future Value.xls spreadsheet and look into the Worksheet Future Value(m Compound Periods). The additional parameter compared to the previous formula is m, the number of compounding periods.

	A	B	C	D	E
1					
2	Future Value (Multiple Compounding Periods)				
3					
4		Present Value (PV)*	$100,000.00		
5		Periods (N)*	1.00		
6		Compounding Period (m)*	12		
7		Rate of Interest (r)*	7.00%		
8		Future Value (FV)	$107,229.01		
9	Periods	Future Value	Periods	Future Value	
10	0	$100,000.00			
11	1	$107,229.01	31	$870,323.97	
12	2	$114,980.60	32	$933,239.76	
13	3	$123,292.56	33	$1,000,703.74	
14	4	$132,205.39	34	$1,073,044.70	
15	5	$141,762.53	35	$1,150,615.18	
16	6	$152,010.55	36	$1,233,793.25	
17	7	$162,999.41	37	$1,322,984.26	
18	8	$174,782.65	38	$1,418,622.90	

2.3 Future Value of a Lump Sum with Continuous Compounding

In the previous section, the Future Value of a lump sum is calculated with a fix number of compounding periods. The Future Value of a Lump Sum with Continuous Compounding means that the Future Value is calculated with infinite number of compounding periods.

Formula of Future Value of a Lump Sum with Continuous Compounding

FVn=PV*e^(r*n)

- PV is Present Value
- r is the interest rate

- n is the period. For example 5 years.
- e is 2.71828

Open up the Future Value.xls spreadsheet and look into the Worksheet Future Value(Continuous Compound).

2.4 Future Value of an Ordinary Annuity

An Annuity is a series of equal cash flow over a period of time. The Future Value of an Ordinary Annuity is defined as the total value of the series of equal cashflow at a specific future date taking into account compound interests.

For example,

Period 1	Cashflow of $1000	Future Value at Period 3 is $1102.50
Period 2	Cashflow of $1000	Future Value at Period 3 is $1050.00
Period 3	Cashflow of $1000	Future Value at Period 3 is $1000.00

A spreadsheet of the above can be used to calculate the Future Value by summing up all the future values. Alternatively, as the cashflow is of equal value, the following formula can be used.

Formula of Future Value of an Ordinary Annuity

FVn = A * (((1+r)^(n)-1)/r)

- FVn is the Future Value after a specific period
- PV is Present Value
- r is the interest rate
- n is the period. For example 5 years.
- A is the Annuity amount

2.5 Future Value of a series of unequal cash flow

The Future Value of a series of unequal cash flow is defined as the total value of the series of unequal cash flow at a specific future date taking into account compound interests.

For example,

Period 1	Cashflow of $1000	Future Value at Period 3 is $1102.50
Period 2	Cashflow of $2000	Future Value at Period 3 is $2100.00
Period 3	Cashflow of $1500	Future Value at Period 3 is $1500.00

The Worksheet Future Value(Unequal Cash Flow) in Future Value.xls illustrates how to calculate the future value of a series of unequal cash flow as above.

	A	B	C	D	E
1					
2		Future Value (Series of Unequal Cash Flow)			
3					
4		Periods (N)*	3.00		
5		Rate of Interest (r)*	5.00%		
6					
7	Periods	Cash Flow*	Future Value of this Cash Flow	Future Value	
8	1	$1,000.00	$1,102.50	$1,102.50	
9	2	$2,000.00	$2,100.00	$3,202.50	
10	3	$1,500.00	$1,500.00	$4,702.50	

We have completed the discussion on Future Value. Basically Future Value allows us to compute the value of an amount of money today or a series of cash flow at a specific future date taking into account compound interests. This allows us a consistent point of comparison and measurement at a specific date to make our financial decisions. In the next section, we will proceed to discuss Present Value, which is the opposite or reverse of Future Value.

2.6 Present Value of a Lump Sum to be received in the Future

If you are going to receive $1102.50 in two years time, what is the value of the amount you are going to receive worth today? We should think of Present Value as follows:

Future Value = Present Value today + Compound Interests earned in two years = $1102.50

Present Value = Future Value – Compound Interests earned in two years

Basically, we need to discount the compound interests we have earned over the two years to derive the Present Value. Thus, the Present Value is defined as the value today of a given sum of money to be provided at a specific future date discounting the compound interests.

Formula of Present Value of a Lump Sum to be received in the Future

PV = FVn*(1+r)^(-n)

- FVn is the Future Value after a specific period
- PV is Present Value
- r is the interest rate
- n is the period. For example 5 years.

You might want to bring up the Present Value.xls spreadsheet and refer to the first Worksheet Present Value (Lump Sum). The table below in the worksheet shows the Future Value at different specific period.

2.7 Present Value of a Lump Sum with more than 1 compounding period per year

Sometimes, certain institutions pay out interest more than once each year. It is possible the interests are paid out

- Semi Annualy
- Quarterly
- Monthly
- Daily
- Continuously

Basically, we will need to discount the compound interests we have earned over the two years taking into account that interests are paid out more than once in a year to derive the Present Value.

Formula of Present Value of a Lump Sum with more than 1 compounding period per year

PV = FVn * (1+(r/m))^(-(m*n))

- FVn is the Future Value after a specific period
- PV is Present Value
- r is the interest rate
- n is the period. For example 5 years.
- m is the compounding period

You may want to bring up the Present Value.xls spreadsheet and refer to the Worksheet Present Value (m CompoundPeriod).

2.8 Present Value of an Ordinary Annuity

An Annuity is a series of equal cash flow over a period of time. The Present Value of an Ordinary Annuity is defined as the total value of the series of equal cash flow discounting compound interests.

Formula of Present Value of an Ordinary Annuity

PV = A * ((1-(1/((1+r)^n)))/r)

- FVn is the Future Value after a specific period
- PV is Present Value
- r is the interest rate
- n is the period. For example 5 years.
- A is the Annuity amount

You may want to bring up the Present Value.xls spreadsheet and refer to the Worksheet Present Value (Cash Flow).

2.9 Present Value of a Perpetuity

A Perpetuity is a series of indefinite cash flows. It can thus be considered as a special case of an Annuity where the annuity extends indefinitely. Basically, we can use the Present Value of an Annuity formula to derive the Present Value of a Perpetuity. Just imagine that the value of n (period) in the Present Value of an Annuity formula becomes infinitely large, the value of (1/((1+r)^n)) will tend towards 0, leading to the simplification of the formula.

Formula of Present Value of a Perpetuity

PV = A / r

- PV is Present Value
- r is the interest rate
- A is the Annuity amount

You may want to bring up the Present Value.xls spreadsheet and refer to the Worksheet Present Value (Perpetuity).

2.10 Present Value of a series of unequal cash flow

The Present Value of a series of unequal cash flow is defined as the total value of the series of unequal cash flow discounting compound interests. One way of calculating this Present Value is to calculate the Present Value of each of the cash flow. This is shown in column C in the spreadsheet below. After which, the individual Present Value are summed up in column D. Cell D12 contains the final Present Value of the Series of Unequal Cash Flow.

You may want to refer to the Worksheet Present Value(Unequal Cash Flow) in Present Value.xls.

	A	B	C	D
1				
2	Present Value (Series of Unequal Cash Flow)			
3				
4		Periods (N)*	5.00	
5		Rate of Interest	5.00%	
6				
7	Periods	Cash Flow*	Present Value of this Cash Flow at Year 0	Present Value
8	1	$1,000.00	$952.38	$952.38
9	2	$2,000.00	$1,814.06	$2,766.44
10	3	$4,000.00	$3,455.35	$6,221.79
11	4	$5,000.00	$4,113.51	$10,335.30
12	5	$6,000.00	$4,701.16	$15,036.46

3. Discounted Cash Flow Analysis

3.1 Net Present Value (NPV)

Now that we have defined what Present Value and Future Value is, we have a standard and consistent manner which we can compare the different investments. An investment typically involves putting in an initial amount (cash outflow) and subsequently reaping the rewards in following years (cash inflow). For the investment to make sense, the Cash Inflow will need to be greater than the Outflow.

The rewards in subsequent years need to be discounted with interest. As it is possible to simply put the initial investment amount in the Banks or US Treasury Bills which are relatively risk free to earn interest.

With this as the basis, Net Present Value (NPV) is defined as the present value of all cash inflows minus the present value of all cash outflows. If NPV is positive, the investment is making money. If you have two investments, both with positive NPV, you should consider the one with the higher NPV as it is making more money.

NPV = Present Value of all cash inflow - Present Value of all cash outflow

or

NPV = Sum of Net Cash Flow discounted with interest from t=0..n
= Sum(CFt/((1+r)^t)) where t is 0..n

- CFt is the Cash inflow minus the cash outflow at time t
- NPV is Net Present Value
- n is the whole investment period
- t is the specific investment period
- r is the interest rate

The Net Present Value.xls spreadsheet illustrates how the Net Present Value can be calculated easily. Simply key in the Discount Rate, Cash Outflow (column B) and Cash Inflow (column C) to get the NPV.

	A	B	C	D	E
1					
2		Net Present Value			
3					
4		Discount rate (r)*	10.00%		
5		Net Present Value (NPV)	$88,655.15		
6					
7	Periods	Cash Outflow or Investment	Cash Inflow*	Expected Net Cash Flow	Time t Calculation
8	0	$2,000,000.00	$0.00	-$2,000,000.00	-$2,000,000.00
9	1	$0.00	$500,000.00	$500,000.00	$454,545.45
10	2	$0.00	$750,000.00	$750,000.00	$619,834.71
11	3	$0.00	$1,350,000.00	$1,350,000.00	$1,014,274.98

A spreadsheet model to calculate the Net Present Value of multiple projects is also provided in the same file. This is shown below.

	A	B	C	D	E	F	G	H	I	J	K
1											
2		Net Present Value (Multiple Projects)									
3											
4											
5											
6	1	Project Name 1									
7						Periods	0	1	2	3	4
8		Discount rate (r)*	10.00%			Cash Outflow*	$2,000,000.00	$0.00	$0.00	$0.00	$0.00
9		Net Present Value (NPV)	$88,655.15			Cash Inflow*	$0.00	$500,000.00	$750,000.00	$1,350,000.00	$0.00
10						Expected Net Cash Flow	-$2,000,000.00	$500,000.00	$750,000.00	$1,350,000.00	$0.00
11						Time t Calculation	-$2,000,000.00	$454,545.45	$619,834.71	$1,014,274.98	$0.00
12	2	Project Name 2									
13						Periods	0	1	2	3	4
14		Discount rate (r)*	10.00%			Cash Outflow*	$0.00	$0.00	$0.00	$0.00	$0.00
15		Net Present Value (NPV)	$0.00			Cash Inflow*	$0.00	$0.00	$0.00	$0.00	$0.00
16						Expected Net Cash Flow	$0.00	$0.00	$0.00	$0.00	$0.00
17						Time t Calculation	$0.00	$0.00	$0.00	$0.00	$0.00
18	3	Project Name 3									
19						Periods	0	1	2	3	4
20		Discount rate (r)*	10.00%			Cash Outflow*	$0.00	$0.00	$0.00	$0.00	$0.00
21		Net Present Value (NPV)	$0.00			Cash Inflow*	$0.00	$0.00	$0.00	$0.00	$0.00
22						Expected Net Cash Flow	$0.00	$0.00	$0.00	$0.00	$0.00
23						Time t Calculation	$0.00	$0.00	$0.00	$0.00	$0.00

3.2 Internal Rate of Return (IRR)

Internal Rate of Return (IRR) is defined as the discount rate that makes the Net Present Value zero. If the IRR is greater than the opportunity cost of capital then the investment is feasible. The greater the value the IRR, the more feasible it is.

It is however important to note that the IRR which makes the NPV zero is possible only if all the cash flow earned are invested at the IRR rate immediately. In real life circumstances, this is considered very ideal and not easily achievable.

The spreadsheet in Rate of Return.xls illustrates how to calculate the IRR of an Investment with NPV zero. Basically it involves in using the Goal Seek capabilities of Microsoft Excel. Basically Goal Seek will iterate through a set of values to determine the IRR value that will make NPV zero. The spreadsheet has already been setup for you to easily do this. First fill in the Cash Outflow and Cash Inflow in column B and C. Use Goal Seek to set Cell C4 to "Value 0" by "Changing cell C5". The field marked with "**" means that the value of the field will be calculated by Goal Seek.

	A	B	C	D	E
1					
2		Internal Rate of Return			
3					
4		Net Present Value (NPV)*	$0.00		
5		Internal Rate of Return (r)	36.85%		
6		Use Goal Seek to Set Cell C4, To Value 0, By Changing Cell C5			
7					
8	Periods	Cash Outflow or Investment*	Cash Inflow*	Expected Net Cash Flow	Time t Calculation
9	0	$1,000,000.00	$0.00	-$1,000,000.00	-$1,000,000.00
10	1	$0.00	$500,000.00	$500,000.00	$365,374.60
11	2	$0.00	$750,000.00	$750,000.00	$400,495.80
12	3	$0.00	$600,000.00	$600,000.00	$234,129.59

It is possible that the NPV and IRR will give conflicting results. If there are two investments, A and B, NPV may suggest selecting investment A while IRR may suggest selecting investment B. In this scenario, we should tend towards using the NPV to select the investment. The reason is NPV represents the actual amount an investment will make which increases actual wealth by the biggest amount. The IRR formula also assumes we are able to reinvest the earnings at the IRR rate which is an ideal scenario.

3.2.1 Money Weighted Rate of Return

Money Weigthed Rate of Return is also known as the Dollar Weighted Rate of Return in the US. It uses the IRR formula calculation as described in the previous section. In the Money Weighted Rate

of Return, the formula places more weightage on the period where more money is invested. If more money is invested in an unfavourable time, it will lower the overall Money Rate of Return. Likewise, more money is invested in a favourable time, it will increase the Money Rate of Return.

Consider the scenario where an investment manager performed very well in the past few years but only average this year. And you decided to further invest a significant amount of money this year to him. This will further lower his Money Weighted Rate of Return as more money this year means that the formula calculation will put more "emphasis" on the returns this year. This is considered unfair to the investment manager. We thus require a Rate of Return which we can judge without the bias in weightage of money. This is explained in the next section Time Weighted Rate of Return.

You may want to refer to the Money Weighted Rate of Return in the Rate of Return.xls spreadsheet.

3.2.2 Time Weighted Rate of Return

The Time Weighted Rate of Return measures the compound rate of growth over a period of time by assuming an investment at the beginning of a period and measuring the growth of market value at the end of the period. This calculation removes the money weighted effects on investments and is typically used to compare the returns of investment managers.

The following Excel worksheet Time Weighted Rate of Return in the Rate of Return.xls spreadsheet describes how to calculate the Time-Weighted Rate of Return.

	A	B	C	D	E
1					
2		Time Weighted Rate of Return			
3					
4		TIme Weigted Return (r)	27.0080%		
5					
6	Periods	Cash Inflow*	Cash Outflow*	Holding Period Return (HPR)	(1+HPR)
7	1	$5,000,000.00	$6,000,000.00	0.2000	1.2000
8	2	$5,500,000.00	$5,775,000.00	0.0500	1.0500
9	3	$6,000,000.00	$6,720,000.00	0.1200	1.1200
10	4	$6,120,000.00	$5,508,000.00	-0.1000	0.9000

The worksheet first calculates the Holding Period Return of the Cash inflow and outflow of each period.

Time Weighted Return = ((1+Holding Period Return at time 1) *
(1+Holding Period Return at time 2) *
..
(1+Holding Period Return at time n)) - 1

Holding Period Return is described in the next section.

3.3 Holding Period Return

Holding Period Return is defined as the return an investor makes over a period of time.

Holding Period Return (HPR) = (PE - PB + D) / PB

- PE is the price at the end of the investment
- PB is the price at the beginning of the investment
- D is cash received, for example, dividends.

Please refer to the Holding Period Return worksheet in Rate of Return.xls.

3.4 Bank Discount Yield

The Bank Discount Yield is a method used by financial institutions when quoting prices for certain securities sold at a discount. The yield annualizes based on 360 day year and is presented as a percentage of the face value.

rbd = (D * 360) / (F * t)

- D is Dollar Discount
- F is Face value of the T-bill
- t is number of remaining Days to Maturiy
- rbd is Bank Discount Yield

Please refer to the Yields worksheet in Yields.xls.

3.5 Effective Annual Yield

As we already know that the number of compounding periods per year will affect the total interest earned. The Effective Annual Yield measures the yield of an investment if compounding happened annually.

EAY = (1 + HPY)^(365/t) - 1

- HPY is Holding Period Yield
- t is number of remaining Days to Maturiy
- EAY is Effective Annual Yield

Please refer to the Yields worksheet in Yields.xls

3.6 Money Market Yield (CD equivalent yield)

The Money Market Yield measures the annual yield based on the number of days before the security matures.

rmm = (360 * rbd)/ (360 - (t * rbd))

- rbd is Bank Discount Yield
- t is Number of remaining Days to Maturity
- rmm is Money Market Yield

Please refer to the Yields worksheet in Yields.xls

Please note that this tutorial and all the Excel templates are Copyright materials of ConnectCode. You are allowed to use or customize the templates as long as you keep the Copyright message intact with the templates.