Excel & Business Math
Video/Class Project #43
Compound Interest & Calculating Future Value of a Lump Sum

Topics

1) Simple Interest Compared to Compound Interest for a Loan (Debt) on Paper:

Loan of $100 for 4 years @ 10%

Simple Interest

Interest Paid or Earned on original Principal only.

Year	Interest	Balance
year 0	$0	$100
year 1	100 * 0.1 = 10	10 + 100 = 110
year 2	100 * 0.1 = 10	10 + 110 = 120
year 3	100 * 0.1 = 10	120 + 10 = 130
year 4	100 * 0.1 = 10	130 + 10 = 140

same every year

Compound Interest

Interest Paid or Earned on both the original Principal & interest reinvested from prior periods.

Year	Interest	Balance
year 0	$0	$100
year 1	100 * 0.1 = 10	10 + 100 = 110
year 2	110 * 0.1 = 11	11 + 110 = 121
year 3	121 * 0.1 = 12.10	12.1 + 121 = 133.1
year 4	133.1 * 0.1 = 13.31	13.31 + 133.1 = 146.41

different each year

* Earning Interest on Interest

2) Simple Interest Compared to Compound Interest for a Loan (Debt) in Excel:

	A	B	C	D	E	F	G	H	I
1	**Example 1: Loan of $100.00 for 4 Years with an Annual Interest Rate = 10.00%**								
2									
3	Principal =			$100.00					
4	Annual Interest Rate =			0.1					
5	Term (Years) =			4	Years				
6									
7	**Simple Interest**					**Compound Interest**			
8	Interest Paid or Earned on Original Principal ONLY.					Interest Paid or Earned on BOTH the Original Principal & Interest Reinvested from Prior Periods.			
9			Formula in cell C12 is: =$D$11*$D$4	Formula in cell D12 is: =D11+C12				Formula in cell H12 is: =I11*$D$4	Formula in cell I12 is: =I11+H12
10	Year	Formula for Simple Interest	Interest Earned	Amount Owed		Year	Formula for Compound Interest	Interest Earned	Amount Owed
11	Year 0			$100.00		Year 0			$100.00
12	Year 1	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$110.00		Year 1	Amount Owed From Previous Year * Annual Rate = $100.00 * 10.00% = $10.00	$10.00	$110.00
13	Year 2	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$120.00		Year 2	Amount Owed From Previous Year * Annual Rate = $110.00 * 10.00% = $11.00	$11.00	$121.00
14	Year 3	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$130.00		Year 3	Amount Owed From Previous Year * Annual Rate = $121.00 * 10.00% = $12.10	$12.10	$133.10
15	Year 4	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$140.00		Year 4	Amount Owed From Previous Year * Annual Rate = $133.10 * 10.00% = $13.31	$13.31	$146.41
16									
17	Same Each Year					Different Each Year			
18	Maturity Value for Simple Interest Loan:			$140.00		=D15			
19	Maturity Value for Compound Interest Loan:			$146.41		=I15			
20	The difference is: "Interest on Interest":			$6.41		=D19-D18			

3) There are Two Sides to Every Debt Financial Transaction -- Here You Borrow the Money:

There are Two Sides to Every Debt Financial Transaction:

Debt Side for Compound Interest Loan:	
Borrow Principal:	$100.00
In 4 Years **Pay** Back Maturity Value:	$146.41
Interest Paid:	$46.41

Investment Side for Compound Interest Loan:	
Lend Principal:	$100.00
In 4 Years **Receive** Maturity Value:	$146.41
Interest Earned:	$46.41

Here YOU Borrow The Money

4) Simple Interest Compared to Compound Interest for a Savings Account in Excel:

	A	B	C	D	E	F	G	H	I
1	**Example 2: Deposit $100.00 in Savings Account for 4 Years with an Annual Interest Rate = 10.00%**								
2									
3	Principal =			$100.00					
4	Annual Interest Rate =			0.1					
5	Term (Years) =			4	Years				
6									
7	**Simple Interest**					**Compound Interest**			
8	Interest Paid or Earned on Original Principal ONLY.					Interest Paid or Earned on BOTH the Original Principal & Interest Reinvested from Prior Periods.			
9			Formula in cell C12 is: =$D$11*$D$4	Formula in cell D12 is: =D11+C12				Formula in cell H12 is: =I11*$D$4	Formula in cell I12 is: =I11+H12
10	Year	Formula for Simple Interest	Interest Earned	Amount Owed		Year	Formula for Compound Interest	Interest Earned	Amount Owed
11	Year 0			$100.00		Year 0			$100.00
12	Year 1	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$110.00		Year 1	Amount Owed From Previous Year * Annual Rate = $100.00 * 10.00% = $10.00	$10.00	$110.00
13	Year 2	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$120.00		Year 2	Amount Owed From Previous Year * Annual Rate = $110.00 * 10.00% = $11.00	$11.00	$121.00
14	Year 3	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$130.00		Year 3	Amount Owed From Previous Year * Annual Rate = $121.00 * 10.00% = $12.10	$12.10	$133.10
15	Year 4	Principal * Annual Rate = $100.00 * 010% = $10.00	$10.00	$140.00		Year 4	Amount Owed From Previous Year * Annual Rate = $133.10 * 10.00% = $13.31	$13.31	$146.41
16									
17	Same Each Year					Different Each Year			
18	Maturity Value for Simple Interest Savings Account:			$140.00		=D15			
19	Maturity Value for Compound Interest Savings Account:			$146.41		=I15			
20	The difference is: "Interest on Interest":			$6.41		=D19-D18			

5) There are Two Sides to Every Debt Financial Transaction -- Here You Lend the Money:

There are Two Sides to Every Debt Financial Transaction:

Debt Side for Compound Interest Savings Account:	
Borrow Principal:	$100.00
In 4 Years **Pay** Back Maturity Value:	$146.41
Interest Paid:	$46.41

Investment Side for Compound Interest Savings Account:	
Lend Principal:	$100.00
In 4 Years **Receive** Maturity Value:	$146.41
Interest Earned:	$46.41

Here YOU Lend The Money

6) New Terms for Compound Interest:

New Terms used for Compound Interest

Simple Interest

Interest Paid or Earned on Original Principal ONLY.
Usually used for Debt less than one year.
Maturity Value Formula: MV = P + P*R*T

Variable	Name of Variable	Description
P	Principal	Amount Borrowed/Lent Out/Invested.
MV	Maturity Value	Total Amount to pay on Maturity Date = Principal + Interest.
	Maturity Date	The Date that the Principal and Interest is Due.
R	Rate	Annula Simple Interest Rate
T	Time	Fraction of Year
	Term	Length of time until the loan is due - given in days, months or years

Compound Interest for a Lump Sum Amount either Borrowed or Invested

Interest Paid or Earned on BOTH the Original Principal & Interest Reinvested from Prior Periods.
Usually used for Debt and Investments more than one year
Future Value Formula for Lump Sum Amount: FV = PV*(1+i/n)^(x*n)

Variable	Name of Variable	Description
	Lump Sum Amount	A Single Amount either Borrowed or Invested.
PV	Present Value	Lump Sum Amount Borrowed/Lent Out/Invested at Time 0. It is the "Present Value" of the amount at Time 0.
FV	Future Value	Future Value of Lump Sum Debt/Investment at the end of all the Compounding Periods at Time n.
	Maturity Date	Day that Future Value is paid or earned.
i	Annual Interest Rate	Annual Interest Rate, usually given as APR (Annual Percentage Rate)
n	Number of Compounding Periods per Year	* Interest paid once a year, n = 1 * Interest paid quarterly (every 3 months), n = 4 * Interest paid daily, n = 365 * Note: The Bigger the n, the More the Interest.
x	Years	Total Years of Debt/Investment
i/n	Period Rate	Rate given per Compounding Period * Example: Bank Account pays 8%, compounded quarterly, then Interest Rate per Quarter = 8%/4 = 2%
x*n	Total Number of Compounding Periods	Total Number of Periods that the Debt/Investment Earns Interest

7) Math Formula & Terms for Future Value Calculations:

Future Value Math Formula

$$FV = PV * \left(1 + \frac{i}{n}\right)^{(x*n)}$$

FV = Future Value = Future Value of Debt or Investment after total Number of Periods.

PV = Present Value = Amount you borrow or invest today at Time 0.

i = Annual Interest Rate, usually APR

n = Number of compounding Periods per Year

X = Number of Years for Investment / Debt

$\frac{i}{n}$ = Period Rate

$X * n$ = Total Number of compounding Periods

Example: what is Future Value of savings plan if you deposit $100 in Account at 10%, compounded yearly and leave it in account for 4 years?

$PV = 100$
$i = 0.1$
$n = 1$
$X = 4$
$\frac{i}{n} = \frac{0.1}{1} = 0.1$
$X * n = 4 * 1 = 4$

$FV = PV * \left(1 + \frac{i}{n}\right)^{(x*n)}$
$FV = 100 * (1 + 0.1)^4$
$FV = 100 * (1.01)^4$
$FV = 100 * 1.4641$
$FV = 146.41$

8) For Compound Interest Calculations in Excel, the Direction of the Cash Flow Matters:

For Compound Interest Calculations in Excel, the Direction of the Cash Flow Matters.

Always think about Cash Flow in regards to your Wallet or Purse.

Is the Cash Flowing **Into** your Wallet or Purse?

Into Wallet or Purse = **+ $100**

Into Wallet or Purse = **Positive Cash Flow**

Is the Cash Flowing **Out Of** your Wallet or Purse?

Out Of Wallet or Purse = **- $100**

Out Of Wallet or Purse = **Negative Cash Flow**

Lend Money

Borrow Money

Lend Principal at Year 0:	-$100.00

Borrow Principal at Year 0:	$100.00

In 4 Years Receive Maturity Value:	$146.41

In 4 Years Pay Back Maturity Value	-$146.41

9) Excel FV Function & Terms for Future Value Calculations:

Excel Function for Future Value

Variable Name	Math Variable	Excel Variable
Future Value	FV	FV
Present Value	PV	PV
Period Rate	$\frac{i}{n}$	rate
Total Periods (Total # of compounding periods)	$x * n$	nper

Excel FV Function $= FV(rate, nper, , PV)$

- rate: Period rate
- nper: Total Number of compounding periods
- ,, : For Lump Sum Debt/Investment leave PMT argument empty, must type two commas
- PV: must put correct cash flow positive for Borrower negative for Investor

Example: Deposit 100 for 4 years
Annual Rate = 10%, compounded yearly.

$= FV(0.1, 4, , -100)$

$= 146.41$

10) Excel FV Function for Future Value Calculations:

	A	B	C	D	E
1	**Example 3: What is the Future Value of a Savings Plan if You Deposit $100.00 in Savings Account for**				
2	**4 Years with an Annual Interest Rate = 10.00%, compounded yearly.**				
3					
4	PV = Present Value =		$100.00	Amount Deposited today, Time 0	
5	x = Years =		4	Years	
6	i = Annual Interest Rate =		0.1		
7	n = Number Counpounding Periods per Year =		1		
8	i/n = Period Interest Rate =		0.1		=C6/C7
9	x*n = Total Number of Periods =		4		=C5*C7
10	What is Future Value Long Way =		$146.41		=C20
11	Future Value done with Math Formula		$146.41		=C4*(1+C8)^C9
12	Future Value done with Excel Functions		$146.41		=FV(C8,C9,,-C4)
13					
14		Formula in cell B17 is: =C16*$C$6	Formula in cell C17 is: =C16+B17		
15	Year	Interest Earned	Amount Owed		
16	Year 0		$100.00		
17	Year 1	$10.00	$110.00		
18	Year 2	$11.00	$121.00		
19	Year 3	$12.10	$133.10		
20	Year 4	$13.31	$146.41		

11) Video Example #04 for Future Value Calculation for Investment

Example 4:

If you deposit $5,000.00 in an account for 5 years that pays an annual rate of 5.00%, compounded Quarterly, what is the Future Value?

Variable	Math Variable	Excel Variable	Value
Present Value	PV	PV	$5,000.00
Cash Flow Direction of PV?	Deposit/Invest Money in Bank, comes **OUT OF** Your Wallet/Purse = Negative		
Annual Rate (APR)	i		5.00%
Compounding Periods per year	n		4
Years	x		5
Period Rate	i/n	rate	1.25%
Total Number of Periods	x*n	nper	20
Future Value	FV	FV	$6,410.19
Interest **Earned** on Investment		FV - PV	$1,410.19
		Check FV	$6,410.19

=D8/D9

=D10*D9

=FV(D11,D12,,-D6) =FV(rate,nper,,-PV) =FV(i/n,x*n,,-PV)

=D13-D6

=D6*(1+D11)^D12 =PV*(1+i/n)^(x*n)

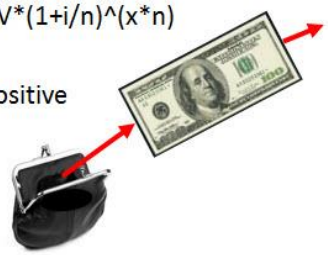
Cash Flow Direction of FV?	When we withdraw the Money in 5 Years, it comes **INTO** Our Wallet/Purse = Positive

12) Video Example #05 for Future Value Calculation for Debt

Example 5:

If you Borrow $5,000.00 from the bank for 5 years that charges an annual rate of 5.00%, compounded Quarterly, what is the Future Value? How Much We Pay Back?

Variable	Math Variable	Excel Variable	Value			
Present Value	PV	PV	$5,000.00			
Cash Flow Direction of PV?	Borrow/Get Money from Bank, comes **INTO** Your Wallet/Purse = Positive					
Annual Rate (APR)	i		5.00%			
Compounding Periods per year	n		4			
Years	x		5			
Period Rate	i/n	rate	1.25%	=D8/D9		
Total Number of Periods	x*n	nper	20	=D10*D9		
Future Value	FV	FV	-$6,410.19	=FV(D11,D12,,D6)	=FV(rate,nper,,PV)	=FV(i/n,x*n,,PV)
Interest **Paid** on Debt		FV - PV	-$1,410.19	=D13+D6		
		Check FV	$6,410.19	=D6*(1+D11)^D12	=PV*(1+i/n)^(x*n)	
Cash Flow Direction of FV?	When we Payback the Money + Interest in 5 Years, it comes **OUT OF** Our Wallet/Purse = Positive					



13) Video Example #06: Comparing Simple Interest and Compound Interest in a Graph

Example 6: Deposit $5,000.00 in Savings Account for 10 Years with an Annual Interest Rate = 10.00% Compounded Yearly

PV =	$5,000.00		
i = Annual Interest Rate =	0.1		
n = # Compound Periods / Year =	1		
x = Years =	10	Years	
i/n = Period Rate =	0.1		
x*n = Total # Compound Periods =	10		

Simple Interest

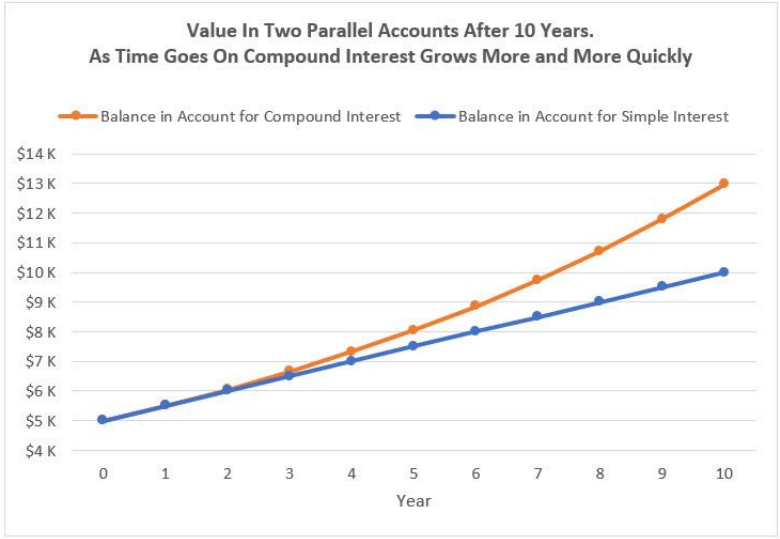
Year	Balance in Account for Simple Interest
0	$5,000.00
1	$5,500.00
2	$6,000.00
3	$6,500.00
4	$7,000.00
5	$7,500.00
6	$8,000.00
7	$8,500.00
8	$9,000.00
9	$9,500.00
10	$10,000.00

=$C$3+$C$4*$C$3*A13

Compound Interest

Year	Balance in Account for Compound Interest
0	$5,000.00
1	$5,500.00
2	$6,050.00
3	$6,655.00
4	$7,320.50
5	$8,052.55
6	$8,857.81
7	$9,743.59
8	$10,717.94
9	$11,789.74
10	$12,968.71

=FV($C$7,E13,,-$C$3)



14) Video Example #07 for Future Value Calculation for Investment

Example 7:

If you deposit $10,000.00 in an account for 15 years that pays an annual rate of 6.50%, compounded Daily, what is the Future Value?

Variable	Math Variable	Excel Variable	Value				
Present Value	PV	PV	$10,000.00				
Cash Flow Direction of PV?	Deposit/Invest Money in Bank, comes **OUT OF** Your Wallet/Purse = Negative						
Annual Rate (APR)	i		6.50%				
Compounding Periods per year	n		365				
Years	x		15				
Period Rate	i/n	rate	0.000178082	=D8/D9			
Total Number of Periods	x*n	nper	5475	=D10*D9			
Future Value	FV	FV	$26,509.37	=FV(D11,D12,,-D6)	=FV(rate,nper,,-PV)	=FV(i/n,x*n,,-PV)	
Interest **Earned** on Investment		FV - PV	$16,509.37	=D13-D6			
		Check FV	$26,509.37	=D6*(1+D11)^D12	=PV*(1+i/n)^(x*n)		

Cash Flow Direction of FV?	When we withdraw the Money in 5 Years, it comes **INTO** Our Wallet/Purse = Positive

15) Video Example #08 for Future Value Calculation for Investment

Example 8:

If you deposit $125,000.00 in an account for 35 years that pays an annual rate of 5.00%, compounded Quarterly, what is the Future Value?

Variable	Math Variable	Excel Variable	Value				
Present Value	PV	PV	$125,000.00				
Cash Flow Direction of PV?	Deposit/Invest Money in Bank, comes **OUT OF** Your Wallet/Purse = Negative						
Annual Rate (APR)	i		5.00%				
Compounding Periods per year	n		4				
Years	x		35				
Period Rate	i/n	rate	1.25%	=D8/D9			
Total Number of Periods	x*n	nper	140	=D10*D9			
Future Value	FV	FV	$711,564.83	=FV(D11,D12,,-D6)	=FV(rate,nper,,-PV)	=FV(i/n,x*n,,-PV)	
Interest **Earned** on Investment		FV - PV	$586,564.83	=D13-D6			
		Check FV	$711,564.83	=D6*(1+D11)^D12	=PV*(1+i/n)^(x*n)		

Cash Flow Direction of FV?	When we withdraw the Money in 5 Years, it comes **INTO** Our Wallet/Purse = Positive

16) Daily Savings Account Examples

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Example 9:**											
2	Calculate Future Value for a Daily Savings Account											
3												
4		PV	Annual Rate	Years	Number Compounding Periods per Year	Total Number of Periods	Period Rate		Total Interest			
5	Math Variable:	PV	i	x	n	x*n	i/n	FV				
6	Excel Variable:	PV				nper	rate	FV			**Check**	
7		$12,000.00	3.00%	2	365	730	0.00008219178	$12,742.01	$742.01		12742.00714	TRUE
8		$8,000.00	4.00%	8	365	2920	0.00010958904	$11,016.83	$3,016.83		11016.82896	TRUE
9												
10												
11						=D7*E7	=C7/E7	=FV(G7,F7,,-B7)	=H7-B7		=B7*(1+G7)^F7	=K7=H7
12												

	A	B	C	D	E	F	G	H	I	J	K
1	**Example 10:**										
2	Calculate Future Value for a Daily Savings Account for Partial Years										
3											
4		PV	Annual Rate	Date Deposited	Date Withdrawn	Number of Days (Total Periods)	Period Rate = Daily Rate (Annual/365)	FV	Total Interest		
5	Math Variable:	PV	i				i/n	FV			
6	Excel Excel:	PV				nper	rate	FV			**Check**
7		$4,850.00	0.035	4/3/2018	4/24/2018	21	0.00009589	$4,859.78	$9.78		4859.775809
8		$9,235.00	0.025	12/1/2020	1/30/2022	425	0.0000684932	$9,507.77	$272.77		9507.768543
9											
10											
11						=E7-D7	=C7/365	=FV(G7,F7,,-B7)	=H7-B7		=B7*(1+G7)^F7

17) But What if You Wanted to Do The Reverse? Find out how much to put in bank today to you can have a certain amount in the future? That is Next Video!