The Power of Excel

Example

Consumption bundle (consumption vector), $x=(x_1,...,x_n)$,

price vector $p=(p_1,...,p_n)$

income I.

$$Max_x\{U(x)\,|\,x\geq 0,\ p\cdot x\leq I\}.$$

Remember that the dot notation indicates the sum of the products of the prices and quantities purchased. In EXCEL the vector of prices $(p_1,...,p_n)$ is called an array. In EXCEL we write the sum of the products as follows.

$$p\cdot x=SUMPRODUCT(p_1:p_n,x_1:x_n)$$

Consider the following example $U(x)=f(x_1)*g(x_2)$

where $f(x_1)=(b_1+x_1)^{a_1}$ and $g(x_2)=(b_2+x_2)^{a_2}$

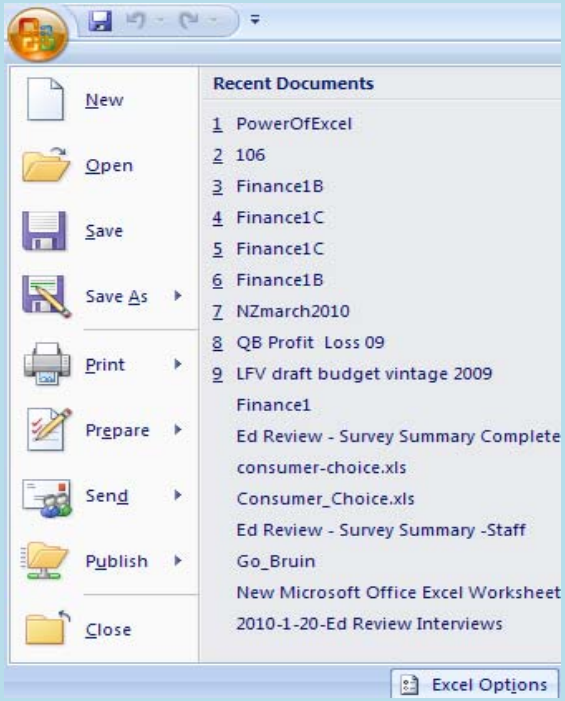
This is a very simple problem for a computer to solve for any particular set of parameters.

Step 0: Add-Ins

To unleash the Power of EXCEL you need to download a pair of "Add-Ins."

In the Computer Lab this should already be set up. On your own computer follow the steps below.

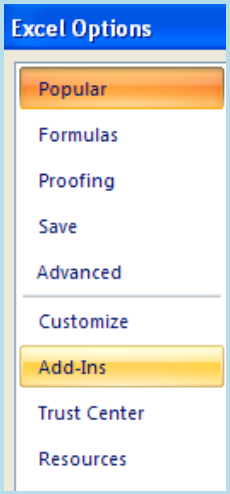
Excel 2007: Open an EXCEL spread-sheet, click on the Button and then Excel Options (see below.)



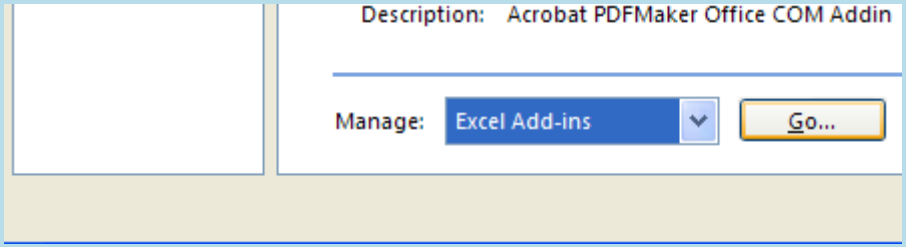
Choose the Option **Add-Ins**

Excel 2010: This similar. Click on FILE then Options. For more help go to

http://office.microsoft.com/en-us/excel-help/quick-start-activate-and-use-an-add-in-HA010370161.aspx

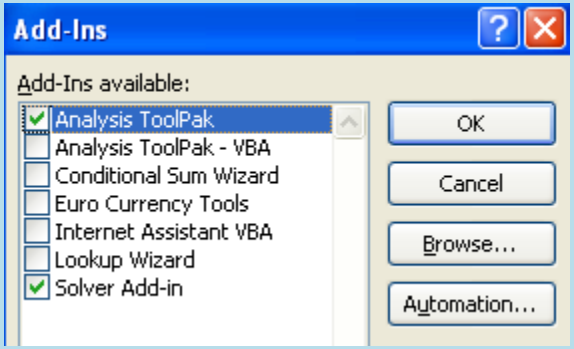


Click on Go…. at bottom



Check off the two options that you will need

Analysis ToolPak and Solver Add-In



It will take some seconds to load on your personal computer. But once loaded you should not have to load again.

Step 0: Statement of the problem

It is good practice to provide a brief statement of the problem at the top of the spreadsheet. You might wish to use a Text Box as shown below. We begin with a special case.

Statement of the problem

A consumer chooses x to solve Max{U(x) | x>=0, p1*x1+p2*x2 <= I}
where U(x)=(1+x1)^(1/2)*(3+x2)^(1/3).

To simplify the computations we can write this as the product of two functions of one variable.

U=f(x1)*g(x2) where f(x1)=(1+x1)^(1/2) and g(x2)=(3+x2)^(1/3)

Step 1: The Data

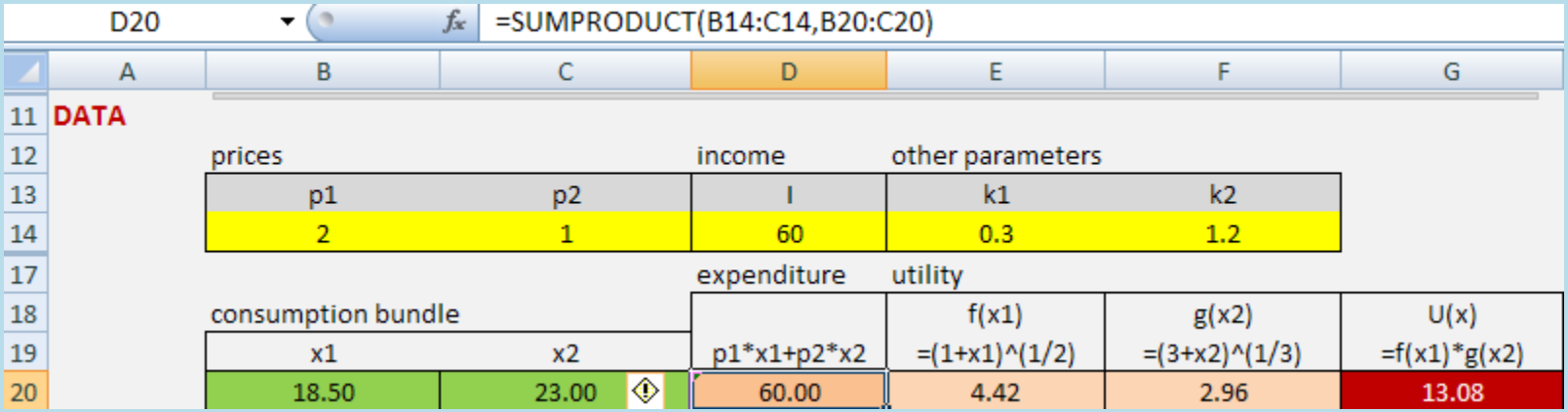
There are 3 parameters in the problem. See below. I added in a couple of extra parameters for use in creating a Chart.

11	DATA					
12		prices		income	other parameters	
13		p1	p2	I	k1	k2
14		2	1	60	0.3	1.2

All data is color coded yellow.

Step 2: Preparing to Solver

The first step is to enter some arbitrary consumption bundle (see cells B20:C20.) These are the cells that will be changed in the numerical optimization. They are known as the CHANGING CELLS.



In the chart the cursor is on cell D20 (total expenditure). You can see how the sumproduct formula is written at the top.

You can type it out as shown or type =sumproduct(

Then click on the price array [B14:C14] add a comma then click on the quantity array [B20:C20]. Finally add the “close parenthesis”.

You also need to compute the utility U=f(x1)*g(x2). See how cell E20 is typed on the formula line at the top.

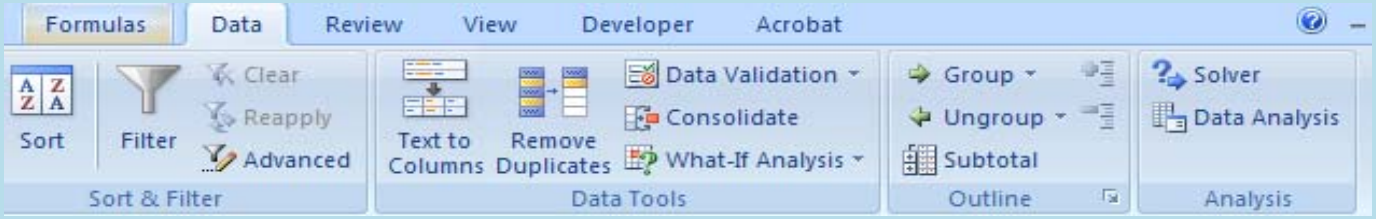
E20 f_x =(1+B20)^(1/2)

	A	B	C	D	E	F	G
18		consumption bundle			f(x1)	g(x2)	U(x)
19		x1	x2	p1*x1+p2*x2	=(1+x1)^(1/2)	=(3+x2)^(1/3)	=f(x1)*g(x2)
20		18.50	23.00	60.00	4.42	2.96	13.08

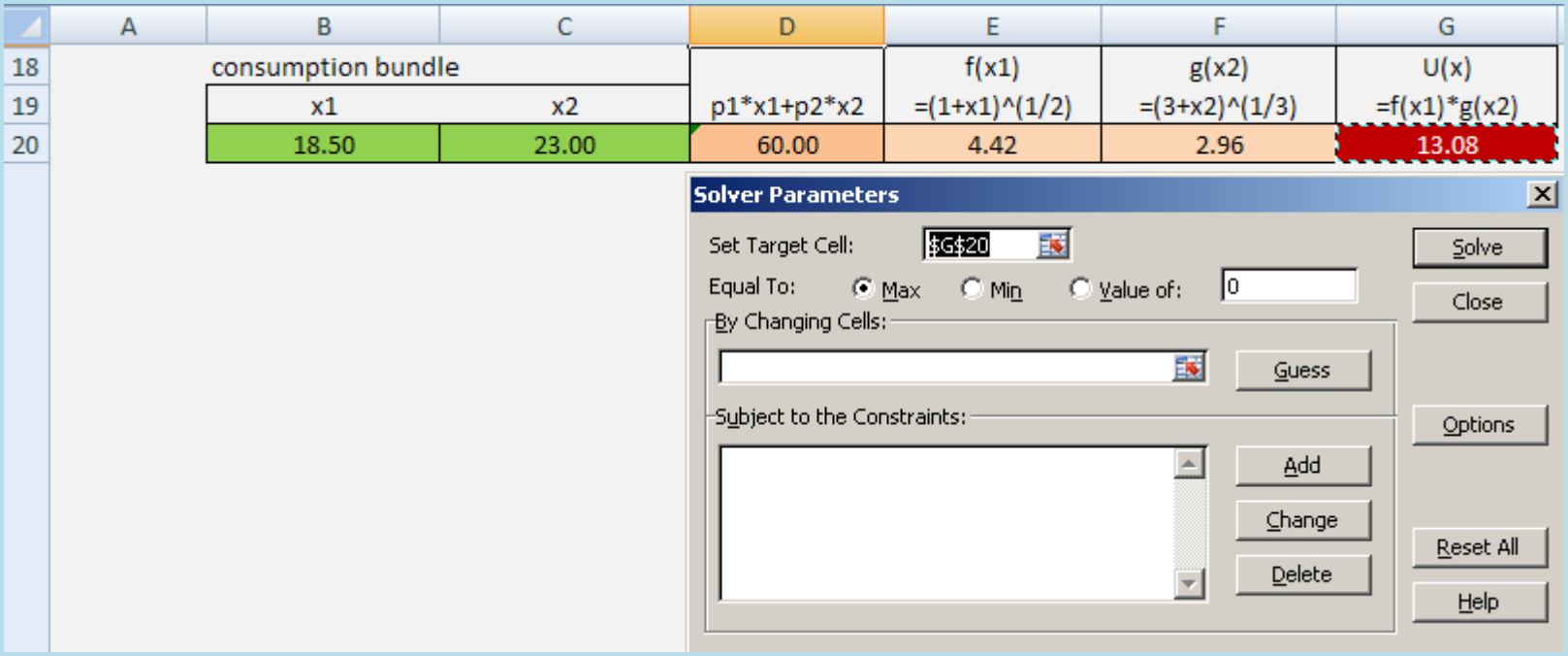
Step 3: Using Solver

(You should have already downloaded Solver from the Add-Ons.)

Click on the cell you are going to maximize. The click on Data and choose Solver.



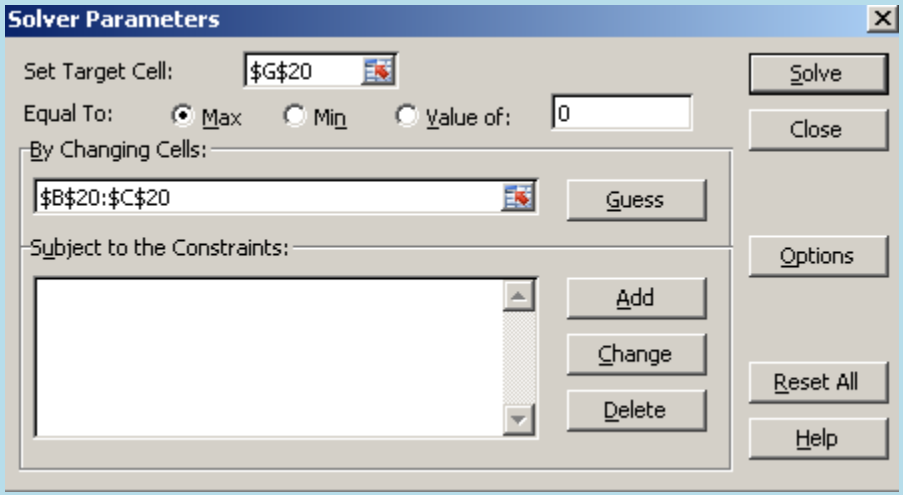
You will see the following menu



Note that the target cell is already complete. In this case you want to maximize so make sure that the dot is on Max. The changing cells are the green consumption cells.

Click in the empty space then block out the array [B20:C20].

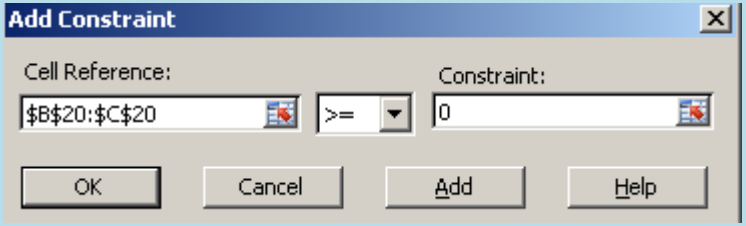
See below.



It remains to add the constraints. Click on **Add**. The following option pops up

We will first add the non-negativity constraints. Click in the cell reference box then block out the consumption array. Then change the inequality to >=. Click on the constraint box and type in zero.

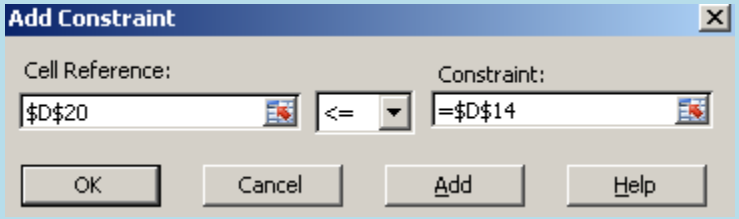
You should end up with the following.



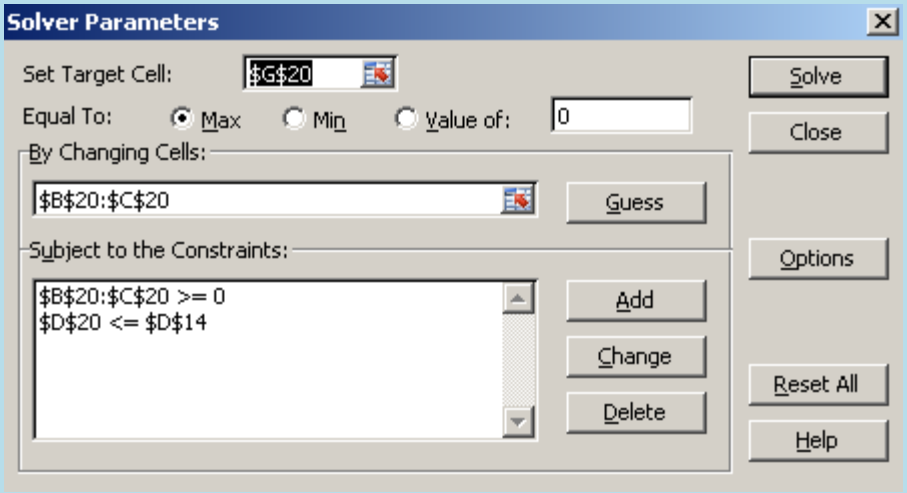
If so choose OK or Add.

Finally we add the budget constraint.

Click on the cell reference box and then click on the total expenditure cell. Then click on the constraint box and click on income.



Click on OK



Now you are ready to hit the SOLVE BUTTON.

WARNING! Microsoft provides a cheap program so Solver can crash. If so you have either set up the problem wrong or try the following.

(i) start with a guess that is nearer the actual solution

(ii) if the program stops with an infeasible value start with the closest feasible value.

For example if the program stops with x1<0, start Solver with an x1 value of zero.

A more general approach

We have solved for a specific utility function. But what if we want to change it? Rather than retype sometimes complicated formulas we add some parameters.

UTILITY MAXIMIZATION

Statement of the problem

A consumer chooses x to solve Max{U(x) | x>=0, p1*x1+p2*x2 <= I}
where U(x)=(b1+x1)^a1*(b2+x2)^a2.

To simplify the computations we can write this as the product of two functions of one variable.

U=f(x1)*g(x2) where f(x1)=(b1+x1)^a1 and g(x2)=(b2+x2)^a2)

DATA

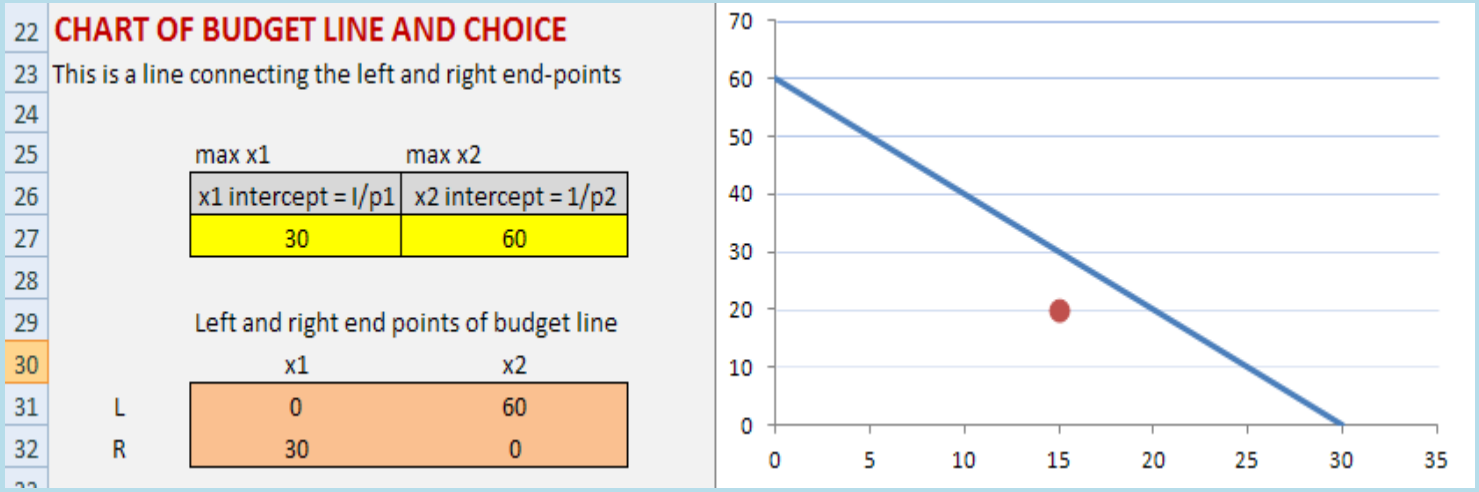
power parameters		shift parameters		prices		income
a1	a2	b1	b2	p1	p2	I
0.50	0.33	1	3	2	1	60

Now it is a very simple matter to resolve with new parameters. Just change the data cells and solve again.

CHARTS

Since in this first example we are only considering two variables we can illustrate the consumer's choice using budget lines and indifference curves.

The budget line and current consumption bundle are depicted below.

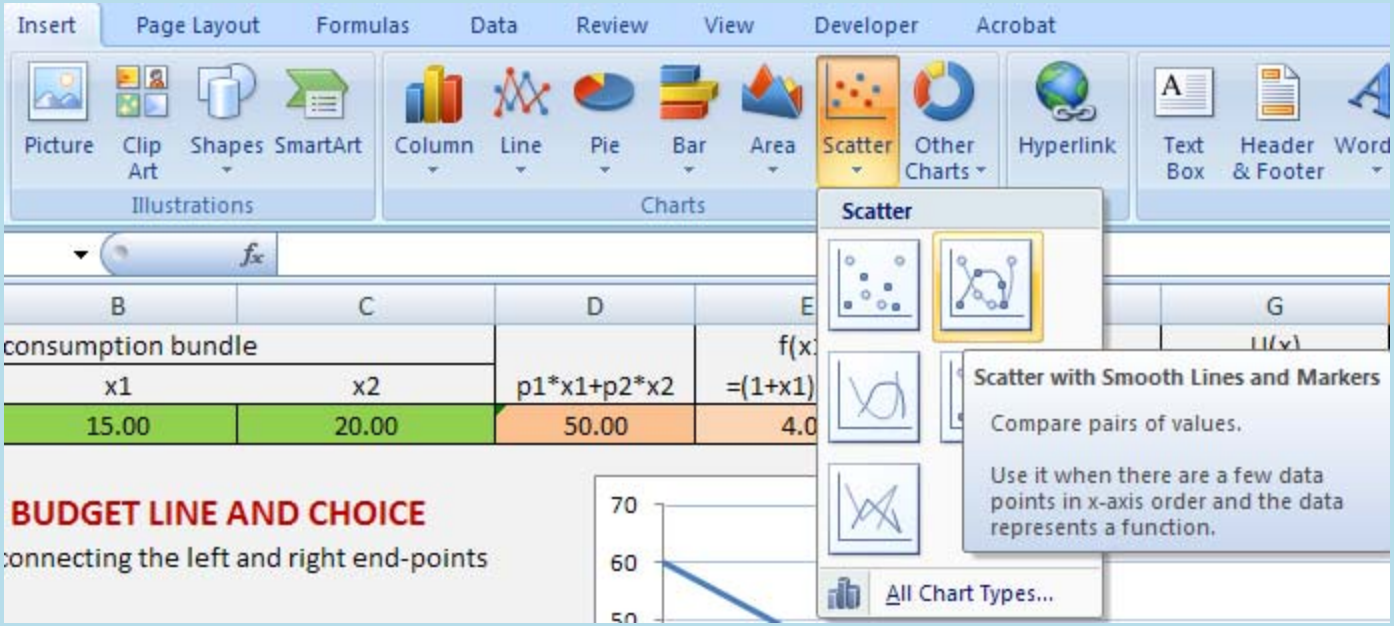


22	CHART OF BUDGET LINE AND CHOICE		
23	This is a line connecting the left and right end-points		
24			
25		max x1	max x2
26		x1 intercept = I/p1	x2 intercept = 1/p2
27		30	60
28			
29		Left and right end points of budget line	
30		x1	x2
31	L	0	60
32	R	30	0

Note that the red marker and blue line are very simple curves. The first is a single data point. The second is a line connecting two points. We will see how to create a chart with these two "curves".

In row 27 we compute the intercepts of the budget line with each axis. The points L and R are the left and right end-points of the budget line.

With the cursor NOT on any data click on the INSERT tab for the Insert Ribbon. Choose Scatter and then the top right hand Type that has both markers and curves.



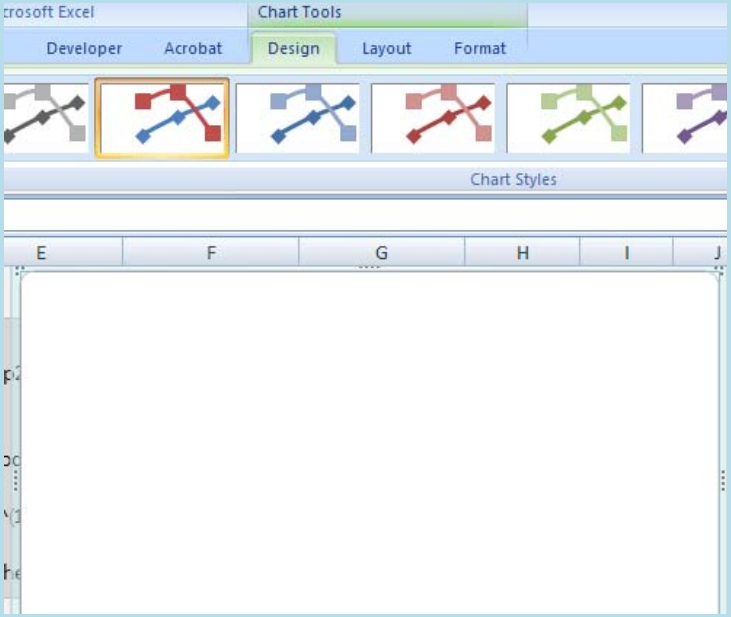
If you later want to delete a marker or line you can easily edit a chart later.

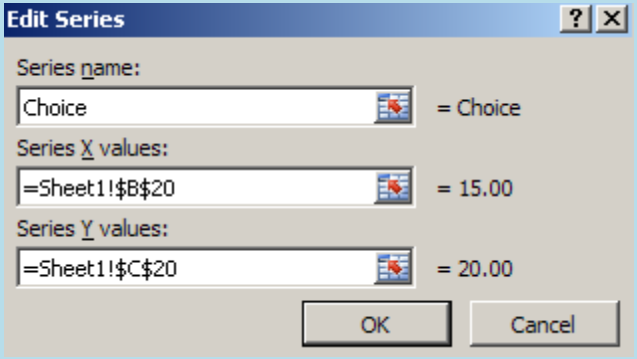
Note that there are three tabs under Chart Tools.

We are in the design phases to click on that and

Choose the option Select Data. You wish to

Add Data so click on Add.





We begin with the Choice so that is a reasonable name.

The X value is B20 and the Y value is C20

Then click on OK. To Add another data

series choose Add.

Then complete as shown.

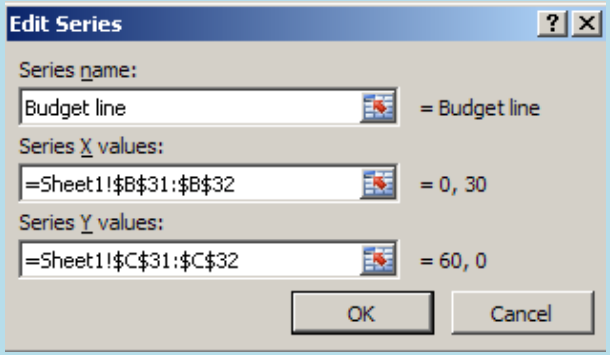


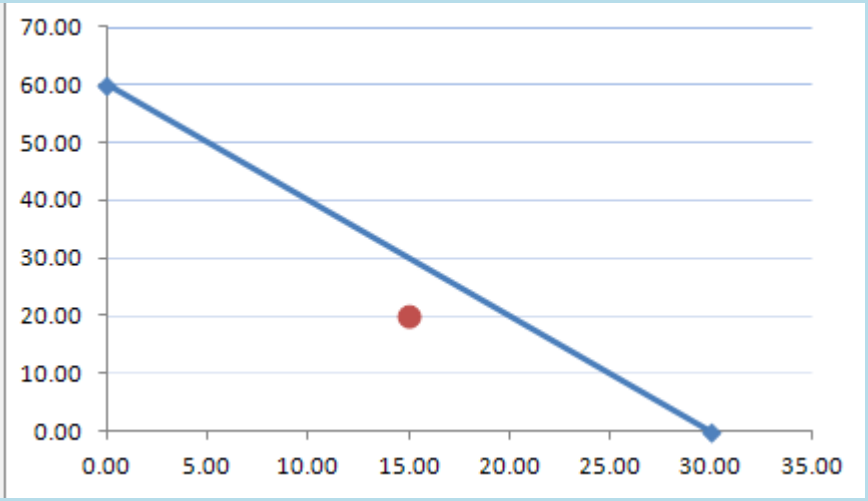
CHART OF BUDGET LINE AND CHOICE

This is a line connecting the left and right end-points

max x1	max x2
x1 intercept = I/p1	x2 intercept = 1/p2
30	60

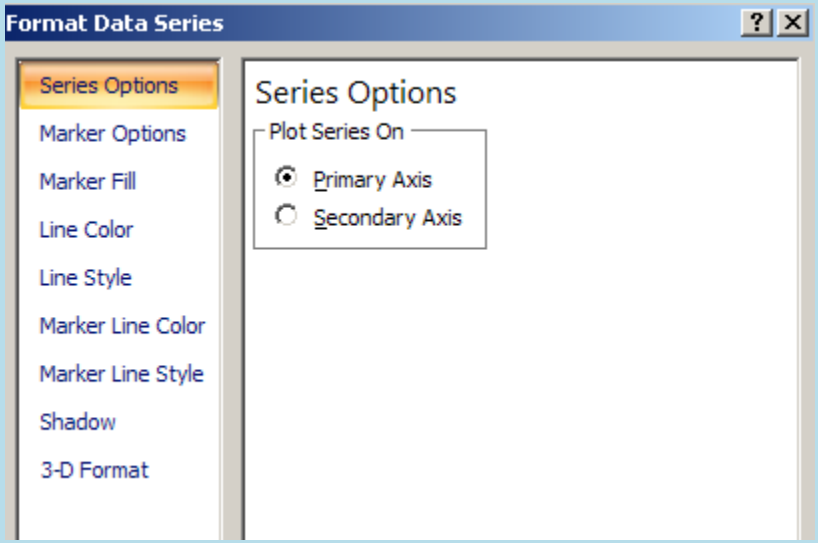
Left and right end points of budget line

	x1	x2
L	0	60
R	30	0



Formatting each data series

I am a bit fussy. For the budget line I want to eliminate the markers. Right click on the line and choose Format Data Series.



Click on Marker Options and choose No Markers.

For the consumption choice I want a larger solid circle.

Click on the marker, choose Format data series, choose Marker Options and select Built in to choose from a range of options.

Data for the indifference curve

To draw a curve we need to solve for a number of points $x = (x_1, x_2)$ on an indifference curve. Let the changing cell array be $\overline{x}$ with utility $u = U(\overline{x})$. We need to decide on the range of values of x1. It proves advantageous to make the min and max values fractions of the **intercept** of the budget line with the horizontal axis. This is where we define two additional paramters (k1,k2). Choose a number k1 that is positive and small and k2 a number close to but greater than 1. Then in row 38 below,

x1min = k1*intercept and x1max = k2*intercept

36		x1min	x1max
37	**First:**	=k1*intercept	=K2*intercept
38	Select a range of values for x1	9	36
39			
40	**Second:**	number	step size
41	Choose the number of steps	50	0.54
42	and hence the step size		

In row 41 I chose 50 steps so the step size is (x1max – x1min)/step number

Now we are ready to put all the x1 values in an array. We will have 50 steps between x1min and x1max. The first few are shown below.

B49 f_x =C$38+A49*D$41

	A	B	C	D	E	F
36			x1min	x1max		
37	**First:**		=k1*intercept	=K2*intercept		
38	Select a range of values for x1		9	36		
39						
40	**Second:**		number	step size		
41	Choose the number of steps		50	0.54		
42	and hence the step size					
43						
44	**Third:**					
45	Compute the value of x2 on the indifference curve for each x1				Note that g(2)=(3+x2)^(1/3)	
46					Hence 3+x2 = g(x2)^3	
47	step	x1	f(x1)=(1+x1)^(1/2)	g(x2)=U/f(x1)	3+x2	x2
48	0	9	3.16	3.60	46.55	43.55
49	1	9.54	3.25	3.50	43.02	40.02
50	2	10.08	3.33	3.42	39.91	36.91

Note the formula for cell B49 on the formula line.

Then drag down to create the x1 values. Onlt the step number changes as the other references are absolute references.

Columns C and D are similarly created. Now you have 51 values of g(x2) = (3+x2)^3.

C48 =(1+B48)^(1/2)

	A	B	C	D	E	F
44	**Third:**					
45	Compute the value of x2 on the indifference curve for each x1				Note that g(2)=(3+x2)^(1/3)	
46					Hence 3+x2 = g(x2)^3	
47	step	x1	f(x1)=(1+x1)^(1/2)	g(x2)=U/f(x1)	3+x2	x2
48	0	9	3.16	3.60	46.55	43.55
49	1	9.54	3.25	3.50	43.02	40.02

D48 =G$20/C48

	A	B	C	D	E	F
44	**Third:**					
45	Compute the value of x2 on the indifference curve for each x1				Note that g(2)=(3+x2)^(1/3)	
46					Hence 3+x2 = g(x2)^3	
47	step	x1	f(x1)=(1+x1)^(1/2)	g(x2)=U/f(x1)	3+x2	x2
48	0	9	3.16	3.60	46.55	43.55
49	1	9.54	3.25	3.50	43.02	40.02

But g(x2)=(b2+x2)^(1/3). Therefore b2+x2=g(x20^3. (column E) .

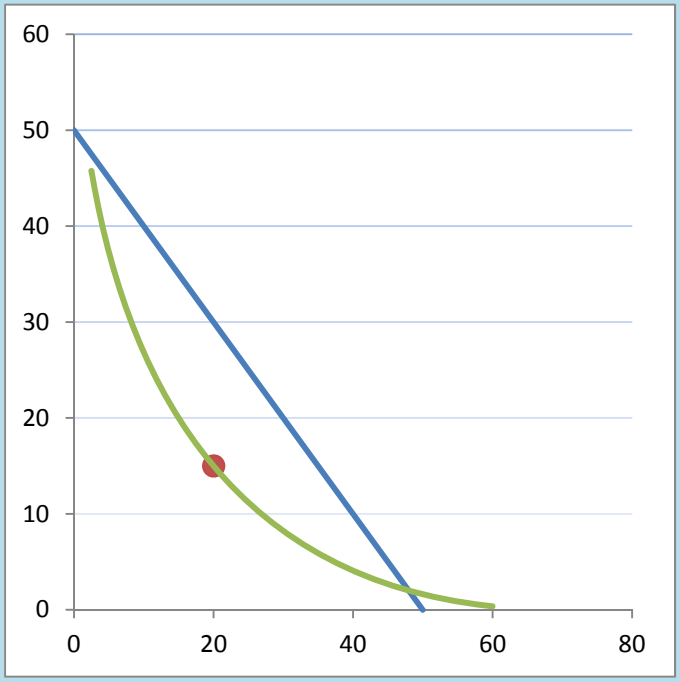
E48 =D48^3

	A	B	C	D	E	F
44	**Third:**					
45	Compute the value of x2 on the indifference curve for each x1				Note that g(2)=(3+x2)^(1/3)	
46					Hence 3+x2 = g(x2)^3	
47	step	x1	f(x1)=(1+x1)^(1/2)	g(x2)=U/f(x1)	3+x2	x2
48	0	9	3.16	3.60	46.55	43.55
49	1	9.54	3.25	3.50	43.02	40.02

Finally compute x2 in column F.

Drag the colums down and you have 51 values of x1 and x2 around the indifference curve.

Click on the chart and add the third data series using the data in columns B and F



You can adjust the look of any particular series by right clicking on the series and choosing Format data series.

Excel Tip:

If the formatting of the rows needs to be fixed, click on the cell in the left corner (above 1 and t the left of A.

Then from the HOME ribbon choose Format from the Cell tab. The second option will adjust the rows to for the data.