# Chapter 26: Data Tables

## 26.1. Introduction

Data table commands are powerful commands that make it possible to do complex sensitivity analyses. Excel offers the opportunity to build a table in which only one variable is changed, or one in which two, variables are changed. Excel data tables are array functions, and thus change dynamically when related spreadsheet cells are changed.

In this chapter you will learn how to build both one-dimensional and two-dimensional Excel data tables.

## 26.2. An example

Consider a project which has an initial cost of $1,150, and seven subsequent cash flows. The cash flows in year 1-7 grow at rate *g*, so that the cash flow in year t is $CF_t = CF_{t-1} * (1+g)$. Given a discount rate *r*, the net present value (NPV) of the project is

$$NPV = -1{,}150 + \frac{CF_1}{(1+r)^1} + \frac{CF_1(1+g)}{(1+r)^2} + \frac{CF_1(1+g)^2}{(1+r)^3} + \ldots + + \frac{CF_1(1+g)^6}{(1+r)^7}.$$

The internal rate of return (IRR), *i*, is the rate at which the NPV equals zero:

$$0 - 1{,}150 + \frac{CF_1}{(1+i)^1} + \frac{CF_1(1+g)}{(1+i)^2} + \frac{CF_1(1+g)^2}{(1+i)^3} + \ldots + + \frac{CF_1(1+g)^6}{(1+i)^7}.$$

These calculations are easily done in Excel. In the following example the initial cash flow is 234, the growth rate *g = 10%*, and the discount rate *r = 15%*:

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | $CF_1$ | 234 | | | | | | | |
| 2 | Growth rate | 10% | | | | | | | |
| 3 | Discount rate | 15% | | | | | | | |
| 4 | | | | | | | | | |
| 5 | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6 | Cash flow | -1150.00 | 234.00 | 257.40 | 283.14 | 311.45 | 342.60 | 376.86 | 414.55 |
| 7 | | | | | | | | | |
| 8 | NPV | 101.46 | <-- =+B6+NPV(B3,C6:I6) | | | | | | |
| 9 | IRR | 17.60% | <-- =IRR(B6:I6,0) | | | | | | |

Note the cell addresses for the growth rate, the discount rate, the NPV and the IRR. They will be needed below.

## 26.3. Setting up a Data Table

Suppose we want to know how the NPV and IRR are affected by a change in the growth rate. The command **Data Table** allows us to do this simply. The first step is to set up the table's structure. In the example below, we put the formulas for the NPV and IRR on the top row and we put the variable we wish to vary (in this case the growth rate) in the first column. At this point the table looks like this:

| | F | G | H | I | J |
|---|---|---|---|---|---|
| 10 | | | | | |
| 11 | | =B8 | | | =B9 |
| 12 | | | | | |
| 13 | | | NPV | IRR | |
| 14 | | | 101.46 | 17.6% | |
| 15 | | 0 | | | |
| 16 | Growth | 5% | | | |
| 17 | rate | 10% | | | |
| 18 | | 15% | | | |
| 19 | | | | | |

The actual table (as opposed to the labels for the columns and the rows) is outlined in the dark border. The numbers directly under the labels "NPV" and "IRR" refer to the corresponding

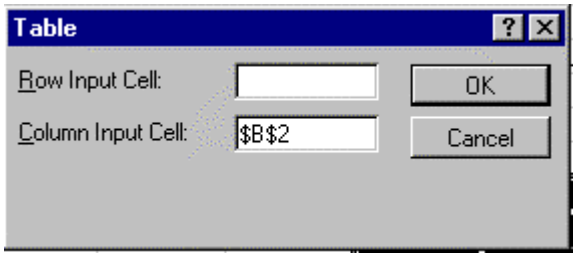
formulas in the previous picture. Thus, if the cell B8 contains the calculation for the NPV, then the cell under the letters "NPV" contains the formula "=B8". Similarly, if the cell B9 contains the original calculation for the IRR, then the cell under "IRR" in the table contains the formula "=B9".

We like to think of a data table spreadsheet as having two parts:

- A basic example.
- A table that does a sensitivity analysis on the basic example. In our example, the first row of the table contains references to calculations done in our basic example. While there are other ways to do Data Tables, this structure is both typical and easy to understand.

Now do the following:

- Highlight the table area (outlined in the dark border).
- Activate the command **Data|Table**. You will get a dialogue box which asks you to indicate a **Row Input Cell** and/or a **Column Input Cell**.




In this case, the variable we wish to change is in the left-hand column of our table, so we leave the Row Input Cell blank and indicate the cell B2 (this cell contains the growth rate in our basic example.) in the Column Input Cell box.

Here's the result:

| | F | G | H | I | J |
|---|---|---|---|---|---|
| 10 | | | | | |
| 11 | | =B8 | | | =B9 |
| 12 | | | | | |
| 13 | | | NPV | IRR | |
| 14 | | | 101.46 | 17.6% | |
| 15 | | 0 | -176.46 | 9.71% | |
| 16 | Growth | 5% | -47.82 | 13.67% | |
| 17 | rate | 10% | 101.46 | 17.60% | |
| 18 | | 15% | 274.35 | 21.50% | |
| 19 | | | | | |

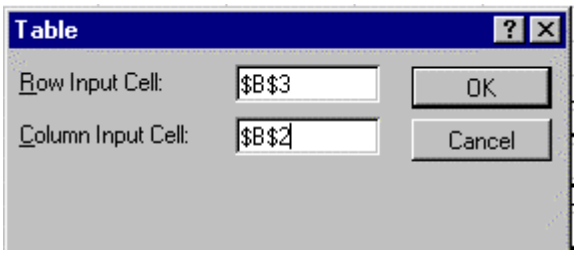
## 26.4. Building a two-dimensional Data Table

We can also use the **Data Table** command to vary *one* formula while changing *two* parameters. Suppose, for example, that we want to calculate the net present value (NPV) of the cash flows for different growth rates and different discount rates. We create a new table which looks like this:

| | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|
| 19 | | | | | | | |
| 20 | =B8 | | | | | | |
| 21 | | | | Discount rate | | | |
| 22 | | | 101.46 | 7% | 10% | 12% | |
| 23 | | Growth | 0 | | | | |
| 24 | | rate | 5% | | | | |
| 25 | | | 10% | | | | |
| 26 | | | 15% | | | | |
| 27 | | | | | | | |

The upper left-hand corner of the table contains the formula "=B8" as a reference to the basic example.

We now use the **Data Table** command again. This time we fill in both the **Row Input Cell** (indicating cell B3, the site of the discount rate in our basic example) and the **Column Input Cell** (indicating B2).

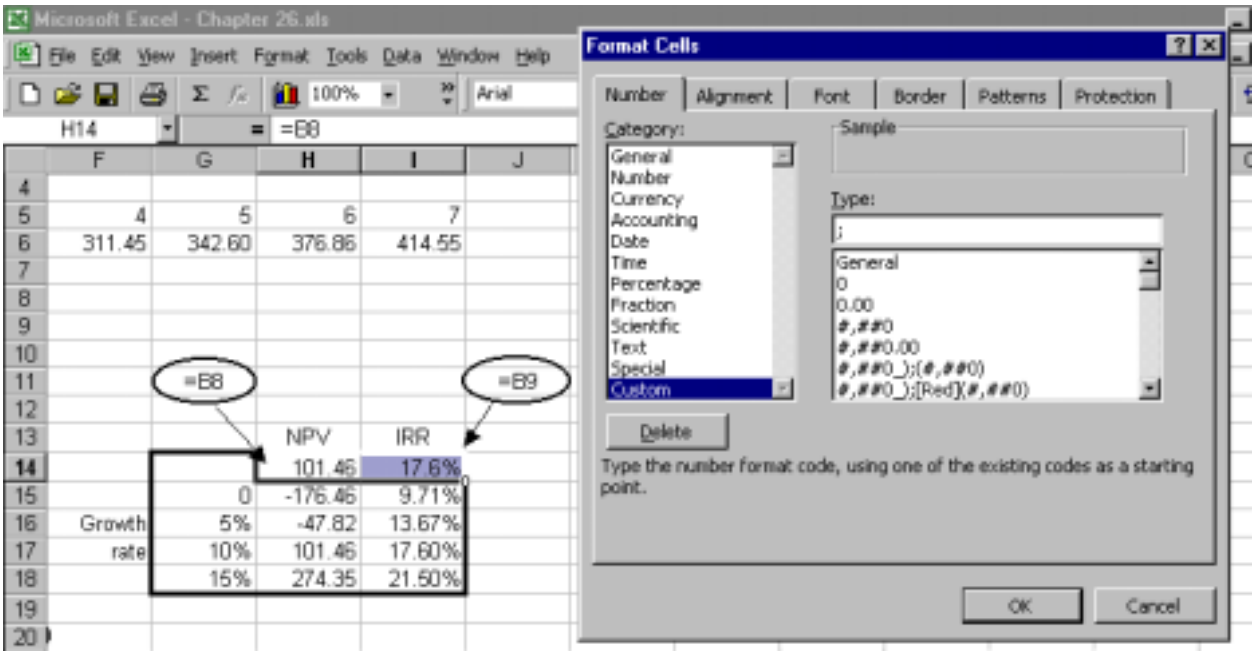



Here's the result:

| | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|
| 19 | | | | | | | |
| 20 | =B8 | | | | | | |
| 21 | | | | Discount rate | | | |
| 22 | | | 101.46 | 7% | 10% | 12% | |
| 23 | | Growth | 0 | 111.09 | -10.79 | -82.08 | |
| 24 | | rate | 5% | 297.62 | 150.74 | 65.13 | |
| 25 | | | 10% | 515.79 | 339.09 | 236.44 | |
| 26 | | | 15% | 770.34 | 558.25 | 435.41 | |
| 27 | | | | | | | |

## 26.5. An aesthetic note: hiding the formula cells

Data tables tend to look a bit strange, because the formula being calculated shows up in the data table (in our examples: in the top row of the first data table, and in the left-hand top corner of the second data table). You can make your tables look nicer by *hiding* the formula cells. To do this, mark the offending cells and use the **Format Cells** command (or press the right mouse button and go to the **Number|Custom**). In the dialog box go to the box marked **Type** and insert a semicolon into the box. Here's the way this looks for the previous example:




The cell contents will now be hidden. This gives the following result.

| | F | G | H | I | J |
|---|---|---|---|---|---|
| 10 | | | | | |
| 11 | | =B8 | | | =B9 |
| 12 | | | | | |
| 13 | | | NPV | IRR | |
| 14 | | | | | |
| 15 | | 0 | -176.46 | 9.71% | |
| 16 | Growth | 5% | -47.82 | 13.67% | |
| 17 | rate | 10% | 101.46 | 17.60% | |
| 18 | | 15% | 274.35 | 21.50% | |
| 19 | | | | | |

## 26.6. Excel data tables are arrays

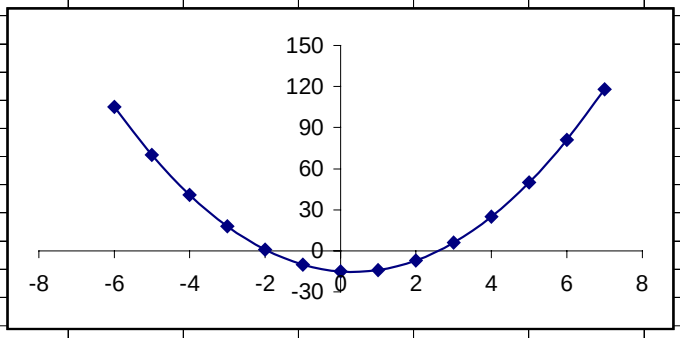
This means that Excel data tables are dynamically linked to your initial example. When you change a parameter in the original example, the corresponding column or row of the data table changes. For example, if we change the initial cash flow from 234 to 300, here's what will happen in the data table pictured above:

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $CF_1$ | 300 | | | | | | | | |
| 2 | Growth rate | 10% | | | | | | | | |
| 3 | Discount rate | 15% | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 6 | Cash flow | -1150.00 | 300.00 | 330.00 | 363.00 | 399.30 | 439.23 | 483.15 | 531.47 | |
| 7 | | | | | | | | | | |
| 8 | NPV | 454.43 | <-- =+B6+NPV(B3,C6:I6) | | | | | | | |
| 9 | IRR | 26.01% | <-- =IRR(B6:I6,0) | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | =B8 | | | =B9 |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | NPV | IRR | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | 0 | 98.13 | 17.80% | |
| 16 | | | | | | Growth | 5% | 263.06 | 21.92% | |
| 17 | | | | | | rate | 10% | 454.43 | 26.01% | |
| 18 | | | | | | | 15% | 676.09 | 30.07% | |

# EXERCISES FOR CHAPTER 26

1. a. Use **Data|Table** to graph the function $f(x) = 3x^2 - 2x - 15$, as illustrated below

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **USING DATA TABLE TO GRAPH A FUNCTION** | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | x | 3 | | | | | | | | |
| 4 | f(x) | 6 | <-- =3*B3^2-2*B3-15 | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | x | 6 | <-- =B4: The data table header | | | | | | |
| 8 | | -6 | 105 | | | | | | | |
| 9 | | -5 | 70 | | | | | | | |
| 10 | | -4 | 41 | | | | | | | |
| 11 | | -3 | 18 | | | | | | | |
| 12 | | -2 | 1 | | | | | | | |
| 13 | | -1 | -10 | | | | | | | |
| 14 | | 0 | -15 | | | | | | | |
| 15 | | 1 | -14 | | | | | | | |
| 16 | | 2 | -7 | | | | | | | |
| 17 | | 3 | 6 | | | | | | | |
| 18 | | 4 | 25 | | | | | | | |
| 19 | | 5 | 50 | | | | | | | |
| 20 | | 6 | 81 | | | | | | | |
| 21 | | 7 | 118 | | | | | | | |




b. Use **Solver** or **Goal|Seek** to find two values of $x$ for which $f(x) = 0$.

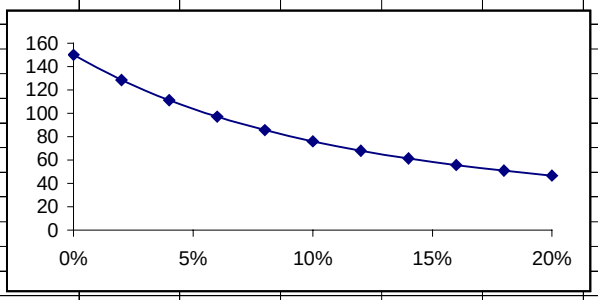
2. As explained in Chapter 29, the Excel function **PV(rate, number_periods, payment)** calculates the present value of a constant payment. Thus in the spreadsheet example below,

$$\text{PV}(15\%,15,-10)=\sum_{t=1}^{15}\frac{10}{(1.15)^t}=58.47\,.$$

(Note that we have put the payment as a negative number, since otherwise Excel returns a negative value! This little irritation is discussed in Chapters 1 and 29).

Use **Data Table** to graph the present value as a function of the discount rate, as illustrated below:

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **DATA TABLE AND PV** | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | Rate | 15% | | | | | | | | | |
| 4 | Number of periods | 15 | | | | | | | | | |
| 5 | Payment | -10 | Note that in order to get a positive PV, we let the payment be negative (see Chapters 1 & 29) | | | | | | | | |
| 6 | Present value | $58.47 | <-- =PV(B3,B4,B5) | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | Rate | $58.47 | <-- =B6 . This is the data table header | | | | | | | |
| 10 | | 0% | 150.00 | | | | | | | | |
| 11 | | 2% | 128.49 | | | | | | | | |
| 12 | | 4% | 111.18 | | | | | | | | |
| 13 | | 6% | 97.12 | | | | | | | | |
| 14 | | 8% | 85.59 | | | | | | | | |
| 15 | | 10% | 76.06 | | | | | | | | |
| 16 | | 12% | 68.11 | | | | | | | | |
| 17 | | 14% | 61.42 | | | | | | | | |
| 18 | | 16% | 55.75 | | | | | | | | |
| 19 | | 18% | 50.92 | | | | | | | | |
| 20 | | 20% | 46.75 | | | | | | | | |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |




3. The spreadsheet fragment below shows a net present value and internal rate of return calculation for a project:

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | **NPV, DISCOUNT AND GROWTH RATES** | | | | | | |
| 2 | | | | | | | |
| 3 | Growth rate | 10% | | | | | |
| 4 | Discount rate | 15% | | | | | |
| 5 | Cost | 500 | | | | | |
| 6 | Year 1 cash flow | 100 | | | | | |
| 7 | | | | | | | |
| 8 | Year | 0 | 1 | 2 | 3 | 4 | 5 |
| 9 | Cash flow | -500.00 | 100.00 | 110.00 | 121.00 | 133.10 | 146.41 |
| 10 | | | | | | | |
| 11 | NPV | (101.42) | <-- =NPV(B4,C9:G9)+B9 | | | | |
| 12 | IRR | 6.60% | <-- =IRR(B9:G9) | | | | |

Use **Data Table** to do a sensitivity analysis on the NPV of the project, varying the discount rates from 0%, 3%, 6%, ..., 21% and varying the growth rates from 0%, 3%, ..., 12%.

4. Using **Data Table** graph the function *Sin(x*y)* for *x = 0, 0.2, 0.4, ...1.8, 2* and *y = 0, 0.2, 0.4, ...1.8, 2*. Use the "Surface" graph option to make a 3-dimensional graph of the function.