



COMPOUND ANNUAL GROWTH RATE

All tables and charts used in this article can be downloaded from

<http://www.chartrecipes.com/article-cagr.html>

USAGE & APPLICATION

Compound annual growth rate (CAGR) is frequently used in business presentations and reports to show how a particular part of the business has grown over time. CAGR takes growth rates from multiple periods and translates them into a consistent growth rate which represents the same growth.

For example, a business grew in its sales from \$2m in 2005 to \$29m in 2011. From the table below you can see that sales did not grow in a linear fashion and the year on year (YoY) growth rates varied between 17% to 216% per year.

Year on year growth of Division X sales between 2005 and 2011

	2005	2006	2007	2008	2009	2010	2011
Sales (\$m)	2.0	2.4	2.8	3.5	5.7	18.0	29.0
Growth YoY		20%	17%	25%	63%	216%	61%

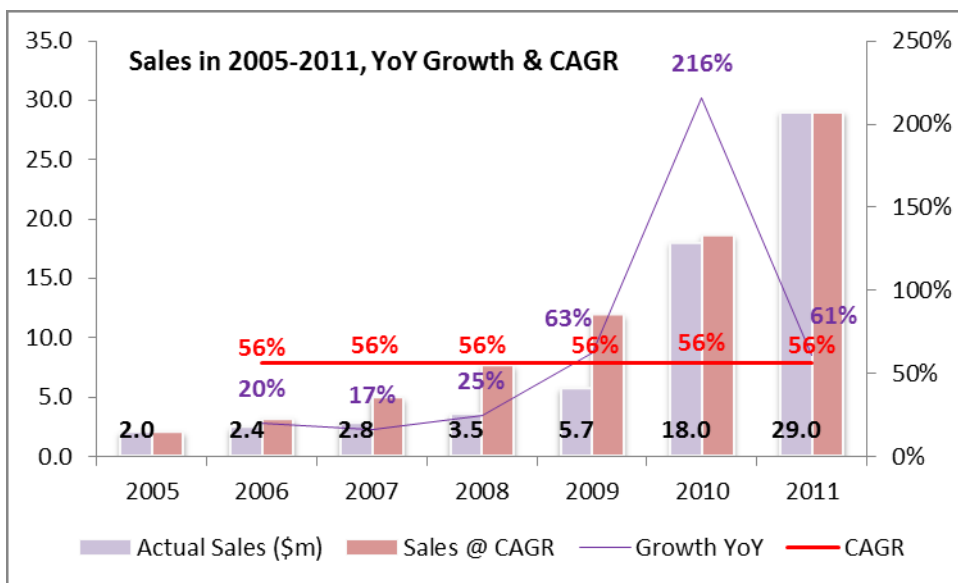
CAGR can be used to remove the volatility of the YoY growth and smooth out the growth rate. The table below shows CAGR as 56.2% which means that if you increased sales in Division X by 56.2% every year between 2005 and 2011, you would have grown from \$2m per year in 2005 to \$29m in 2011.

Year on year growth of Division X sales between 2005 and 2011

	2005	2006	2007	2008	2009	2010	2011
Actual Sales (\$m)	2.0	2.4	2.8	3.5	5.7	18.0	29.0
Growth YoY		20%	17%	25%	63%	216%	61%
CAGR	56.2%						
CAGR Check (grow at 56.2% p.a.)	2.0	3.1	4.9	7.6	11.9	18.6	29.0

The chart below is based on the figures from our example. Notice the difference between the *Actual Sales* and *Sales @ CAGR* data series.





CAGR can be useful to compare the performance of two different businesses or investments where volatility of their returns makes it difficult to grasp which one performed better. For example, the table below shows growth in cash returns from two investments. When you look at the YoY growth of cash returns from the two investments, you can almost certainly say that *Investment 2* cash returns grew faster. CAGR confirms that, and shows that *Investment 2* cash returns grew more than two times faster than the cash returns from *Investment 1*.

Year on year cash returns between 2005 and 2011

Cash Returns	2005	2006	2007	2008	2009	2010	2011
Investment 1 (\$m)	0.5	0.6	0.8	0.8	1.0	1.3	1.7
YoY		20%	33%	0%	25%	30%	31%
Investment 2 (\$m)	0.05	0.09	0.1	0.3	0.55	0.59	0.74
YoY		80%	22%	173%	83%	7%	25%
CAGR							
Investment 1 (\$m)		22.6%					
Investment 2 (\$m)		56.7%					

Higher CAGR does not necessarily mean that *Investment 2* from the table above is a better performing investment. We don't know how much capital was invested to produce the cash returns. If both investments required \$5m of capital then *Investment 1* is a much better performer despite lower CAGR. Thus, the compound annual growth rate is only useful to compare growth rates – that's it.





Anytime you see a snazzy report or presentation that shows an impressive CAGR, you should always find out how much was invested to produce that growth; ask how many people, dollars, buildings and pieces of equipment were used to produce the results.

FORMULA & CALCULATION

The formula to calculate CAGR is: $CAGR(t_0, t_1) = \left(\frac{V(t_1)}{V(t_0)}\right)^{\frac{1}{t_1-t_0}} - 1$.

The meaning of symbols is:

- t_0 – the first year of observations
- t_1 – the last year of observations
- $V(t_0)$ – the start value (or initial investment)
- $V(t_1)$ – the last value observed.

In other words, the formula states:

$CAGR(\text{from first year, to last year}) = \left(\frac{\text{The value at the end of the period}}{\text{The value at the start of the period}}\right)^{\frac{1}{(\text{last year} - \text{first year})}} - 1$.

Make sure that you follow the BODMAS acronym when calculating CAGR in Excel. It is very easy to misplace a bracket in the formula and come up with an incorrect result. BODMAS helps you remember the correct order of mathematical operations when you are working with complex formulas.

BODMAS stands for:

BRACKETS – first you need to calculate everything within the brackets

ORDER – then you calculate all exponentiation (e.g. three to the power of 2 or 3^2)

DIVISION – then you calculate all fractions

MULTIPLICATION – then you multiply anything that needs multiplying

ADDITION – then add all necessary components

SUBTRACTION – finally, perform all subtractions.

When using BODMAS keep in mind that it works in Excel and it might not work when solving formulas using other tools. In some cases division and multiplication are of equal precedence; subtraction and addition can also be of equal precedence.





Excel Example

The screenshot below shows how I calculated the CAGR for *Investment 1*. Pay careful attention to the number of brackets that I used. The formula will not calculate the correct result if you misplace a pair of brackets.

	A	B	C	D	E	F	G	H	I
1									
2									
3			Year on year cash returns between 2005 and 2011						
4		Cash Returns	2005	2006	2007	2008	2009	2010	2011
5		Investment 1 (\$m)	0.5	0.6	0.8	0.8	1.0	1.3	1.7
6		YoY		20%	33%	0%	25%	30%	31%
7		Investment 2 (\$m)	0.05	0.09	0.1	0.3	0.55	0.59	0.74
8		YoY		80%	22%	173%	83%	7%	25%
9		CAGR							
10		Investment 1 (\$m)	=(I4/C4)^(1/(I3-C3))-1						
		Investment 2 (\$m)	56.7%						

Check the calculation

If you grow the initial investment by the CAGR every year, you will get exactly the value at the end of the period.

The formula to check CAGR is:

$$Vt_n = Vt_0 * (1 + CAGR)^{(t_n - t_0)}$$

or using the example above the formula would be

$$1.7 = 0.5 * (1 + 22.6\%)^{(2011 - 2005)}.$$

