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Problems and Policies in World Population, Food and the Environment
Prof. Claudio Gonzalez-Vega

CALCULATING AVERAGE GEOMETRIC RATES OF GROWTH IN EXCEL

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An **average** geometric rate of annual growth is the rate of variation in a given variable or magnitude (such as the total population, the country's GDP or the demand for food) over a period of time, when each year the addition to the variable is proportional to the magnitude already present in the previous year. This type of growth is equivalent to that observed when there is compounding. This should be contrasted with arithmetic or linear growth (as Malthus assumed for the supply of food), where each year the addition to the variable is proportional to the magnitude observed in the initial year of the period. When a variable increases at a geometric rate, it grows larger than when a variable increases linearly. This is shown in the table below.

	Initial	Year 1	Year 5	Year 10	Year 15	Year 20
Linear Growth	100.0	101.0	105.0	110.0	115.0	120.0
Geometric Growth	100.0	101.0	105.1	116.1	134.8	164.5

To calculate the average geometric rate of annual growth of certain variable **X** (for instance population, arable land, GDP per capita and so on) you should use for your calculations the following formula:

$$x = \left[\left(\frac{X_{Final}}{X_{Initial}} \right)^{\frac{1}{t}} - 1 \right] * 100 \qquad (1)$$

Where:

- **x** : average geometric rate of annual growth of variable X
- $\mathbf{X_{Initial}}$: Value of variable X at the initial year of the period
- $\mathbf{X_{Final}}$: Value of variable X at the final year of the period
- **t** : Length of time (years) between the initial year and final year

If you are familiar with some math and remember that the basic equation for growth is:

$$X_{Final}=X_{Initial}*(1+x)^{t} \qquad (2)$$

Then it is straightforward to determine that equation (1) comes from equation (2) when solving for **x**.

Numeric example:

Imagine that you are analyzing an imaginary country named "Costa Pobre" and that you want to determine the average geometric rate of annual growth of the population between 1990 and 2003.

Suppose that you have these two values (*you find them on the internet or they are provided to you*):

Population of "Costa Pobre" in 1990: 2,123,456

Population of "Costa Pobre" in 2003: 4,567,890

Solution:

If you define **N** as the total population and **n** as the average rate of growth of the population:

$$n=\left[\left(\frac{N_{2003}}{N_{1990}}\right)^{\frac{1}{t}}-1\right]*100$$

Then:

N_{1990} = 2,123,456
N_{2003} = 4,567,890
t= 13 *(i.e. 2003-1990)*

Replacing these values in the formula:

$$n=\left[\left(\frac{N_{2003}}{N_{1990}}\right)^{\frac{1}{t}}-1\right]*100$$

$$n=\left[\left(\frac{2{,}123{,}456}{4{,}567{,}890}\right)^{\frac{1}{13}}-1\right]*100$$

If you had to solve this in paper:

$$n = \left[(2.151158)^{\frac{1}{13}} - 1 \right] * 100$$

$$n = \left[(1.060694) - 1 \right] * 100 = \left[0.060694 \right] * 100$$

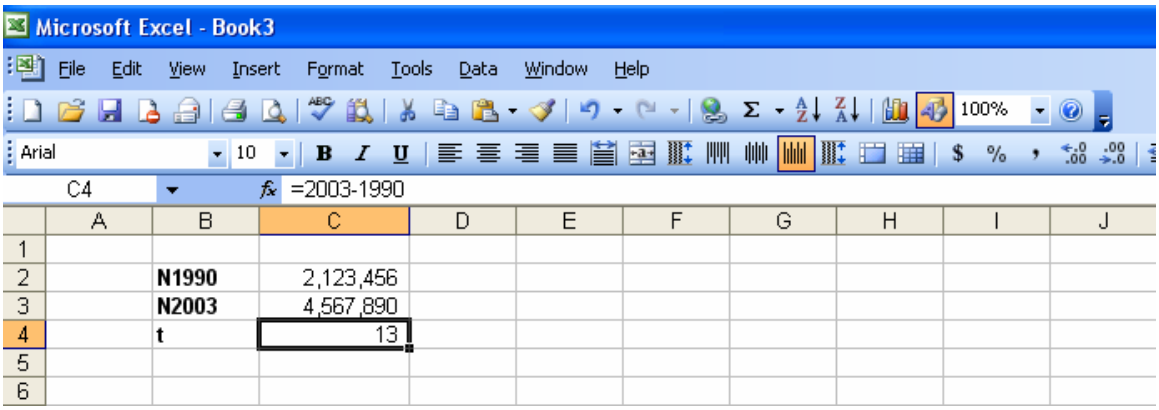
$$n = 6.0694$$

$$n \approx 6.07$$

Then the average population growth rate of Costa Pobre between 1990 and 2003 is **6.07 percent per year.**

Solving the problem using Excel:

To calculate this problem using Microsoft Excel, first introduce the data:



For the value of **t** you can just type **13** (the same way that you introduced $\mathbf{N_{1990}}$ and $\mathbf{N_{2003}}$). But if you want, you can also calculate **t** on cell *C4* by typing:

=2003-1990 *(like shown in the previous graph)*

When you type "**=**" at the beginning of something you are telling Excel "*I want you to calculate something*". If you forget to do that, Excel will think that you are introducing the *word* "1990-2003" and will not calculate anything.

Now to calculate:

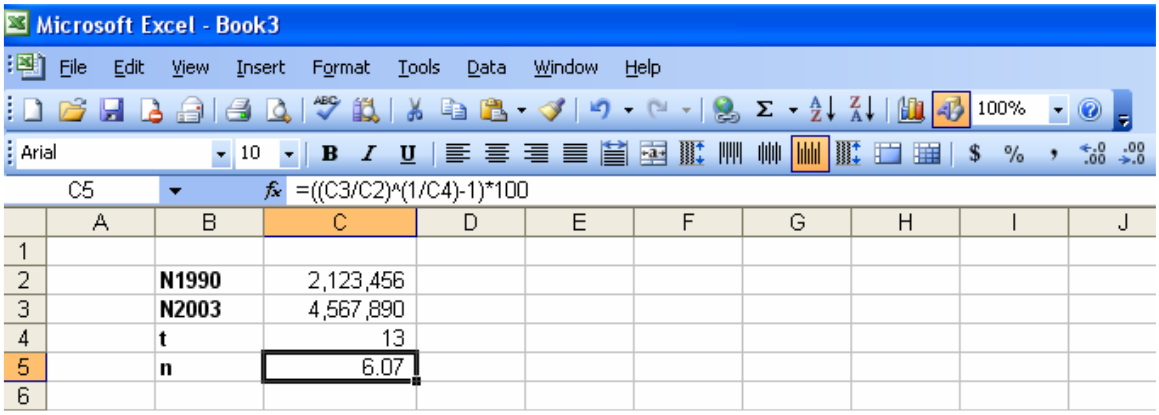
$$n = \left[\left(\frac{N_{2003}}{N_{1990}} \right)^{\frac{1}{t}} - 1 \right] * 100$$

you need to type in cell *C5*:

=((C3/C2)^(1/C4)-1)*100

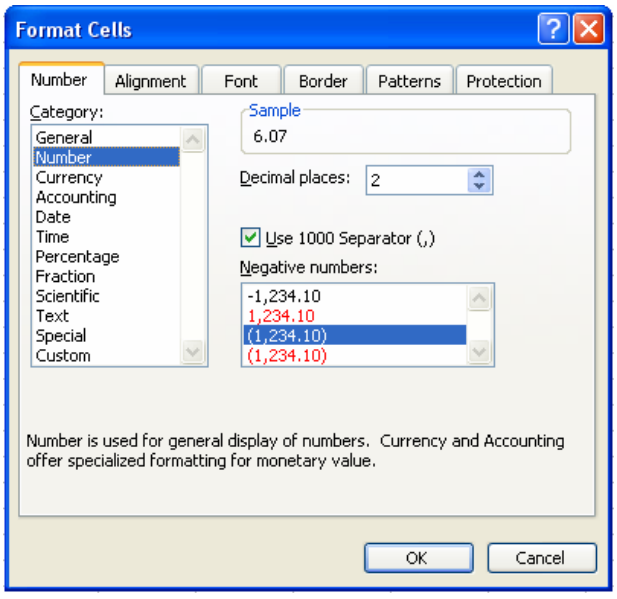
As you can imagine "***/***" stands for division, while "**^**" tells Excel "*to the power of*".

Then you get:



To adjust the number of decimals you can go though the menus (as Dr. Gonzalez did) or click  on the toolbar to reduce decimals or  to increase decimals.

If you prefer Dr. Gonzalez's way, go to option Format at the top of the screen, then Cells and in the menu that pops up define two decimal places like this:



And that's it!