

# 1 Homework 1 (Due October 18 at 11:59pm)

You must submit your homework using the link provided in the course website. Your submission should include a spreadsheet file with your data and graphs, and a file with your answers (either handwritten and scanned, or typed).

## Question 1: Growth Rules

- Suppose that a country or family's income is said to grow at a 1% annual rate. How long will it take to double its income? Give an approximate solution based on the seventy rule.
- What about if the interest rate doubles?
- What if the interest rate is 7%?
- Now fix the a rate at  $0.01\Delta$  where  $\Delta$  is some time interval. Give a formula for the growth rate as  $\Delta \rightarrow 0$ .
- Compare the results of the first question with those for continuous compounding.
- Open Table 2.2 in Piketty's popular book, *Capital in the 20th Century*. Compute the table using exponential formulas.

## Question 2: Simulations

- Open an Excel spread sheet.
- In two cells, define an initial condition  $x_0$  and an interest rate  $r$  ( $r = 0.05, x_0 = 100$ )
- In the first column write the sequence of numbers to refer to a time interval:  $0,1,2,3,4,\dots,N$  (pick some  $N=20$ )

- In the next column, write values for  $x_n$ . Then, set:

$$x_n = (1 + r) x_{n-1}$$

And fill in the next column.

- Plot the values of  $x_n$ .
- Now, in the following column switch to a higher frequency: (N=40). For that column, set the rate  $r = (0.05) / 2$ . Now construct  $x_n$  in the same way.
- Do it once more for N=80 and set  $r = (0.05) / 4$ . Follow the same logic.
- Plot all three columns for  $\{x_n\}$ . Do the figures look alike?
- Finally, employ the formula:

$$\exp(rt)$$

and compare your results.

### Question 3: Simulations

Working with some data.

- Go to the Penn World Tables website, or any other website.
- Import an excel spreadsheet that contains GDP per capita of two countries.
- One country must be the US. The other one you may choose.
- Plot the GDP of the US and of the other country next to each other.
- What patterns can you distinguish?
- Now plot the log of GDP for both countries.
- Compute the average annual growth rate of GDP in the US.
- Set a variable  $r$  to that rate.

- Does the US data fit the formula:

$$\log(x_t) = \log(x_0) + r \cdot t$$

where  $t$  is a particular year and  $x_0$  is GDP per capita in the first period of the sample?

- How about the other country?