

Econ 115: Fall 2009: Problem Set 1: Growth Accounting and the Coming of Modern Economic Growth: 8,000 B.C. – 1929

Due in your GSI's mailbox at 5 PM on September 11, 2009.
Please show all your work.

(1) Recall our rule of thumb for pre-industrial growth in the economy as a whole:

$$y + n = 0.5(n + e) + 0.2(k) + 0.3(r)$$

where y is the growth rate of output per person, n is the growth rate of population, k is the growth rate of capital, r is the growth rate of resources, and e is the growth rate of the *efficiency of labor*—of the degree to which advances in technology, work organization, and markets allow more workers to do the work that was previously done by fewer.

Suppose the growth rate of capital (k) is equal to the growth rate of output as a whole ($y + n$).

1. Solve for y .
2. Solve for e .

(2) Let's assume (these are guesses, but they are not bad guesses) that the earth's population was 5 million in 8,000 BC, 170 million in 1 AD, and 750 million in 1800. Let's further assume that the growth rate of output-per-capita (y) and the growth rate of resources (r) were zero from 8,000 BC to 1800:

1. How fast did e , the *efficiency of labor*, grow from 8,000 BC – 1 AD?
2. How fast did e grow from 1 AD - 1800?
3. Suppose that the population in 1 AD were actually not 170 but 330 million, as Durand (1977)[1] thinks may have been the case. Redo your calculations of the annual growth rate of e from 8000BC-1, and from 1-1800. What difference does it make?

(3) From 1790-1860, the U.S. population grew from 4 million to 31 million. Output per capita grew from \$1000 2008 dollars to \$2000 2008 dollars. Suppose *efficiency of labor* growth e was 0.5%/year.

1. How fast must natural resources (r) have grown?
2. Move into an alternate-history world in which the United States is penned east of the Appalachian Mountains by Tecumseh, Pontiac, and their British military advisors, so that natural resource growth r available to the United States were zero. If the population had still grown at the same rate it did historically, what then would per-capita income have been in 1860?

(4) After 1870 or so the frontier closes and capital takes on a much more important role in the production process. Now our rule of thumb for *industrial* growth becomes:

$$y + n = 0.5(n + e) + 0.5(k)$$

The difference between the rate of growth of capital k and the rate of growth of total production $y + n$ is called the rate of *capital deepening*. Let's use d to stand for the rate of capital deepening: from 1870 to 1929 it is about 1.2% per year. Furthermore, after 1870 the rate of growth of the efficiency of labor e is about 0.9%/year.

1. Manipulate the growth-accounting rule-of-thumb equation above to transform it into the more useful form: $y = d + e$. Show your work.
2. What, then, was the rate of growth of output per worker y over 1870-1929?
3. Suppose that we moved into an alternate-history world in which scientists like Nikola Tesla did not discover how to build reliable AC motors and continent-spanning electricity grids, in which states were allowed to and did put up tariffs to discourage imports from other states and the growth of large-scale industry, and in which foreigners were unwilling to finance investment in America—a world, in short, in which the rate of capital deepening over 1870-1929 was zero. What would have been the rate of growth in output per capita then?

[1] See Durand, John D. 1977. "Historical Estimates of World Population: An Evaluation." *Population and Development Review*, 3:3, pp. 253-296.