

# Problem Set 1 Answer Key

Economics 115, Fall '09

September 18, 2009

Note: In what follows I assume that growth rates are compounded annually. Alternatively, you could assume that growth rates compound continuously, so that  $x_s = e^{rt}x_{s-t}$ . In practice, this yields similar results.

## 1

We are given that

$$y + n = 0.5(n + e) + 0.2k + 0.3r. \quad (1)$$

1. Solve for  $y$ :  $y = -\frac{3}{8}n + \frac{5}{8}e + \frac{3}{8}r$ .
2. Solve for  $e$ :  $e = \frac{8}{5}y + \frac{3}{5}n - \frac{3}{5}r$ .

## 2

1. The population growth rate ( $n$ ) from 8000 BC to 1 AD is 0.044%. Using the equation from problem 1, and noting that  $y = r = 0$ , we see that  $e = \frac{3}{5}n = 0.026\%$ .

2. From 1 AD - 1800,  $n = 0.083\%$ , so  $e = 0.05\%$ .
3. If the population were 330 million in 1AD, then from 8000BC to 1AD,  $n = 0.052\%$ , so  $e = 0.031\%$ . And from 1 AD-1800,  $n = 0.046\%$ , and thus  $e = 0.027\%$ .

So using this population estimate, it does not look as if  $e$  rose after 1 AD.

### 3

1. From 1790-1860, these numbers imply that  $n = 2.97\%$ , and  $y = 1\%$ . Substituting these numbers into the pre-industrial rule-of-thumb, and assuming that  $k = y + n$ , we find that  $r = 4.8\%$ .
2. If  $r=0$ , then from problem 1, we know that  $y = -\frac{3}{8}n + \frac{5}{8}e$ , so  $y = -\frac{3}{8} * 2.97 + \frac{5}{8} * 0.5 = -0.8\%$ . We're asked to find the level of gdp-per-capita in 1860; this is  $1000 * (1 - 0.008)^{70} = \$569$ .

## 4

1. We're given that  $d = k - y - n$ . We want to rearrange the equation for industrial growth so that this expression for  $d$  appears:

$$y + n = .5(n + e) + .5k \quad (2)$$

$$\implies .5(y + n) = .5(n + e) + .5d \quad (3)$$

$$\implies y + n = n + e + d \quad (4)$$

$$\implies y = d + e. \quad (5)$$

2.  $y = 1.2 + 0.9 = 2.1\%$ .

3.  $y = 0 + 0.9 = 0.9\%$ .