

- a) (i) $\log(a) - \log(b) = \log(a/b)$
 (ii) $\log(a/b) = \log(1 + \frac{a-b}{b})$
 (iii) $\log(1+x) \approx x$ for small x

$$\begin{aligned}
 \Delta(\log(y_i)) &= \log(y_i) - \log(y_{i-1}) \quad \downarrow \text{(i)} \\
 &= \log\left(\frac{y_i}{y_{i-1}}\right) \quad \downarrow \text{(ii)} \\
 &= \log\left(1 + \frac{y_i - y_{i-1}}{y_{i-1}}\right) \quad \downarrow \text{(iii)} \\
 &= \log\left(1 + \frac{\Delta y_i}{y_{i-1}}\right) \\
 &\approx \frac{\Delta y_i}{y_{i-1}}
 \end{aligned}$$

- b) $b_3 = -0.347$ $\text{std} = 0.213$ $t = -1.630$ $p = 0.107$
 c) $b_3 = 0.048$ $\text{std} = 0.086$ $t = 0.563$ $p = 0.575$

- b) relationship not quadratic
 c) relationship might be stable
 over pre and post 1980 period.