Resampling lab 3

Load the `boot` library and have a look at the `city` dataframe. The dataframe has two variables, U and X, giving the population in 1920 and 1930 for various cities in the US. We are interested in the factor r by which US population grew from 1920 to 1930

1. Why is $r = \frac{\mathbb{E}X}{\mathbb{E}U}$ and not $\mathbb{E}\frac{X}{U}$?
2. Estimate r using $\hat{r} = \frac{\overline{x}}{\overline{u}}$.
3. Give a 95% CI for r
   (a) Assuming $\hat{r}$ is normal (use a student-t CI).
   To estimate $\operatorname{Var}\hat{r}$ use
   $$\widehat{\operatorname{Var}}\,\hat{r} = \frac{1}{\overline{u}^2}\left(s_x^2 - 2\hat{r}s_{xu} + \hat{r}^2 s_u^2\right).$$
   (b) Using bootstrap replicates. That is, if $\hat{r}^*_{(1)}, \ldots, \hat{r}^*_{(B)}$ are the ordered bootstrap replicates, then use
   $$\left(\hat{r}^*_{(0.025B)}, \hat{r}^*_{(0.975B)}\right).$$
4. Correct $\hat{r}$ for bias using
   (a) $\widehat{\operatorname{bias}}_B\hat{r}$
   Check whether or not the bias has a significant effect on the RMSE.
   (b) $\overline{\operatorname{bias}}_B\hat{r}$