1. Suppose we know the true population regression is given by:

$$wages_{it} = \beta_0 + \beta_1 married_{it} + \beta_2 ability_{it} + u_{it}$$

where $wages_{it}$ is the wage of individual i at time t, $married_{it}$=1 if individual i is married at time t and zero otherwise, and $ability_{it}$ measures the underlying ability level of the person. Suppose that $ability_{it}$ is unobserved, does not change over time, and is positively correlated with marital status (i.e. those of higher ability are more likely to be married). Given this set up, answer the following questions:

i. Suppose we proceed to estimate:

$$wages_{it} = b_0 + b_1 married_{it} + e_{it}$$

Will our estimate of β_1 be unbiased?

ii. Write down a fixed effects equation that we could estimate with observable data which will provide an unbiased estimate of β_1 under certain assumptions. List these assumptions. Explain how this regression captures the effect of unobserved ability.

iii. Suppose I want to add another covariate to the fixed-effects regression—education level—because I would really like to learn the effect of education on wages. Suppose education level does not vary over time. Can I include this variable in the model? Why or why not?

iv. Write down a first-difference equation that will provide an unbiased estimate of β_1. Does ability appear in this regression? Why or why not?

v. Suppose I learn that the error term uit is given by

$$u_{it} = u_{it-1} + \varepsilon_{it}$$

Would I prefer to estimate the regression using fixed-effects or first-differences?

vi. Suppose I have a 30-year panel. True or False: If I estimate a fixed-effect model, the unobserved characteristics that I am attempting to capture in the fixed effect must be constant over all 30 years.

vii. Suppose I have a 30-year panel. True or False: If I estimate a first-difference model, the unobserved characteristics that I am attempting to eliminate by taking first-differences must be constant over all 30 years.