	Midterm 1 - 2015 Answer Key
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6.) 
$$e = y - \hat{y} = y - Xb = (X\beta + \varepsilon) - X(X'X)^{-1}X'(X\beta + \varepsilon)$$
  
 $= X\beta + \varepsilon - X\beta - X(X'X)^{-1}X'\varepsilon$ 

 $= \varepsilon - X(X'X)^{-1}X'\varepsilon = M\varepsilon$ 

So, the residuals are a linear function of the (unobservable) error term. Hence, if E is Normally distributed, so is e, Need to assume that X is non-stochastic.

7.) a) R2=0 when the estimated regression has "no fit", i.e. when X has no predictive power for y.

This could occur if all of the estimated slope coefficients are equal to zero. In this case, the estimate for the intercept is  $\bar{y}$ , and 5SR=0, since  $\hat{y}=\bar{y}$ .

b)  $R^2 = 1$  if there is "perfect fit", i.e. if the regression "line" (or plane") passes through each data point. In this case, each OLS predicted value is equal to the actual value  $(\hat{y} = y)$ , and SSR = SST.

8.) a) 
$$b_1 = (X_1 X_1)^{-1} X_1 Y_1$$

= 
$$(X_1'X_1)^{-1}X_1'(X_1\beta_1 + X_2\beta_2 + u)$$

= 
$$\beta_1 + (x_1'X_1)^{-1}X_1'X_2\beta_2 + (x_1'X_1)^{-1}X_1'u$$
,

and

$$E(b_1) = \beta_1 + (X_1'X_1)^{-1}X_1'X_2\beta_2$$

by A.3. Since E(b.) 7 b, in general, b, is biased.

b) There are two situations in which b, will be unbiased, however. The term:

will disappear if X, and X2 are orthogonal  $(X, X_2 = 0)$ , or if  $\beta_2 = 0$ ,

9.) In order to get the squared sum of deviations-from—
-means, we can make use of the "residual maker"
matrix "M", but where the "X" variable in "M" is a column of 1'. That is, Mo = I - 1(1'1)-11', where 1 is an nx1 column of 1's. So, Mo = I - 111, and Moy = y - ynxi In order to get the sum of squares: y'Mo'Moy = y'Moy. Mo, and y'Moy, are in the formula sheet provided on the exam,

$$= \beta + (x'c'cX)^{-1}X'c'c\varepsilon,$$

If X is assumed to be non-random, then

$$E(\vec{\beta}) = \beta + 0$$
, and  $\vec{\beta}$  is unbiased.

b) The C matrix effectively eliminates half of the data from the data-set. For example, if n=4 and K=2:

and similarly

$$C_{y} = \begin{bmatrix} y_{1} \\ y_{2} \\ 0 \\ 0 \end{bmatrix}$$

Hence, B is essentially OLS, using half of the data. Since OLS is unbiased regardless of sample size, B should be unbiased.

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Lamina and the second s	) We would expect B to have higher variance than b (in a matrix sense) for similar arguments
	as in part (b).
	We know that the variability of our estimator, b, decreases as the sample size grows. B is like OLS, but with a smaller data set, so we would expect it to have higher variance.
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