1) ⓐ $narr86_i = .7061 - .1512\, pcnv - .0070\, avgsen_i + .0121\, tottime - .0393\, ptime86_i - .1031\, qemp86$

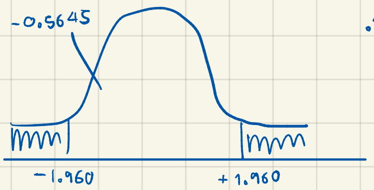
→ test the average sentence served

- Let $H_0 : \beta_3 = 0$, $H_1 : \beta_3 \neq 0$

- $t_{cal} = \dfrac{\hat{\beta}_3 - \beta_3}{se_{\beta_3}} = \dfrac{-.0070 - 0}{.0124} = -0.5645$

- critical values when degree of freedom is $2725 - 6 = 2{,}719$

$t_{0.05} = \pm 1.960$



∴ can not reject Ho which means we can make sure that average sentence served parameter is not zero 95 percent

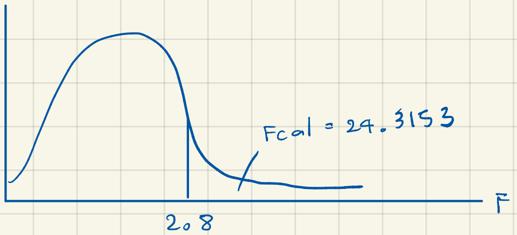
ⓑ Model (1.1)

→ Use F distribution to calculated

- Let $H_0 : \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$, H_1: otherwise

- $F_{cal} = \dfrac{R^2/(k-1)}{1-R^2/(n-k)} = \dfrac{0.0428/(6-1)}{(1-0.0428)/(2725-6)} = 24.3153$

- $F_{upper,\alpha}(6, 2719)$ when $\alpha = 0.01 = 2.64$

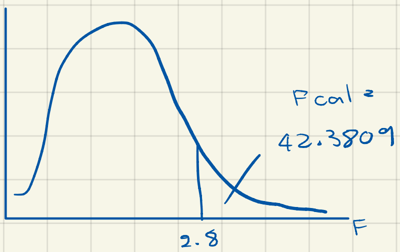


∴ $F_{cal} > F_{upper}(6, 2719)$
we can reject Ho, in other word, we can make sure that $\beta_2, \beta_3, \beta_4, \beta_5$ and β_6 are not simultaneously equal to zero, 99 times out of 100

Model 2

- $F_{cal} = \dfrac{0.0723/5}{(1-.0723)/2719} = 42.3809$

- $F_{upper}, (6, 2719) = 2.64$ when $\alpha = 0.01$



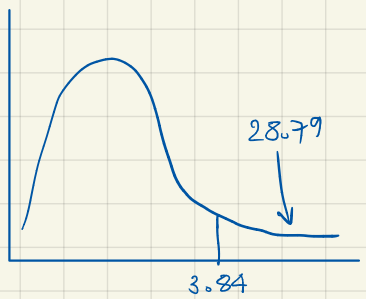
∴ $F_{cal} > F_{upper}(6, 2719)$
we can reject Ho, in other word, we can make sure that $\beta_2, \beta_3, \beta_4, \beta_5$ and β_6 are not simultaneously equal to zero, 99 times out of 100

(d) Use F test for marginal contribution of these two variables add in model 2

- Let H_0 : ethnic background and legal income has no marginal contribution to the model
  H_1 : otherwise

- $F_{cal} = \dfrac{R^2_{new} - R^2_{old} / m}{1 - R^2_{new} / (n - k_{new})} = \dfrac{(.0428 - .0723) / 3}{(1 - .0723) / (2725 - 8)} = 28.79$

- $F_{upper, \alpha}(3, 2716) = 2.6$ when $\alpha = 0.05$



∴ $F_{cal} > F_{upper}$

We can reject H_0, in other word, we can make sure two variables added have marginal contribution to the model.

2. (a)

- For β_1 $H_0: \beta_1 = 0$, $H_1: \beta_1 \neq 0$

For β_2 $H_0: \beta_2 = 0$, $H_1: \beta_2 \neq 0$

For β_3 $H_0: \beta_3 = 0$, $H_1: \beta_3 \neq 0$

For β_4 $H_0: \beta_4 = 0$, $H_4: \beta_4 \neq 0$

- $t_{cal}(\beta_1) = \dfrac{9.1748 - 0}{0.0035} = 2{,}621.3714 \rightarrow$ Reject Ho

$t_{cal}(\beta_2) = \dfrac{0.587 - 0}{0.0072} = 81.5278 \rightarrow$ Reject Ho

$t_{cal}(\beta_3) = \dfrac{-.0336 - 0}{0.005} = -6.72 \rightarrow$ Reject Ho

$t_{cal}(\beta_4) = \dfrac{.0444 - 0}{.0102} = 4.3529 \rightarrow$ Reject Ho

- $t_{\frac{\alpha}{2}=0.025} = \pm 1.960$ when $n-k = 97878 - 4 = 97{,}874$

$\therefore$ we can reject Ho for all test . In other word , we can make sure that 95 % of all of paremeter are signifiantly different from zero.

(b) If we consider effect of civil servant separately , The coefficient β_2 that represent difference between civil servants and other groups . As a result , the civil servants earned more than other group by $\times (e^{\beta_2} - 1) = 79.86$ %

(c) The pandemic affect the overall wage to drops by $100 \times (e^{\hat{\beta}_3} - 1) = 3.3$ percent for all groups

(d) The relationship between civil servant variable and year is positive and different from zero . Therefore , if we consider only yere 2020 the result is

$\ln \widehat{wage} = 9.1748 + 0.587(1) - 0.0336(1) + 0.0444(1)\cdot(1)$ while other groups are

$\ln \widehat{wage} = 9.1748 + 0.587(0) - 0.0336(1) + 0$

$\therefore$ In 2019 civil servant wage will decrease by 0.0336 , while in 2020 their wage will increase +0.0444

$\therefore$ In summary , The control group is still better-off during pandemic by $100 \times (e^{\hat{\beta}_3 + \hat{\beta}_4} - 1)$ = 1.09 % increase , while other group will worse off by $100 \times (e^{\hat{\beta}_3} - 1) = 3.3$ % decrease

→ This result is make sense in economic reason because the control group' wage didn't drop while the rest may earn less during pandemic .

3. (a) There is no evidence of multicollinearity in the data because in the multicollinearity their should have correlation between each variable with coefficient exceeding 0.8. Moreover, according to the VIF and TOL, the multicollinearity model should have VIF not exceed 10 and TOL not closer to 1.

$$|r| < 0.8 \quad , \quad VIF < 10 \quad , \quad TOL \text{ closer to } 1$$

→ Set up $H_0 : \beta_K = 0$

$H_1 : \beta_K \neq 0$ when $K = 1, 2, 3, 4$

$$tacl\ (\beta_1) = \frac{\hat{\beta}_1 - \beta_1}{se(\hat{\beta}_1)} = \frac{-34.1349 - 0}{15.6763} = 2.18 \rightarrow \text{Reject } H_0$$

$$tcal\ (\beta_2) = \frac{\hat{\beta}_2 - \beta_2}{se(\hat{\beta}_2)} = \frac{1.5386 - 0}{3.0005} = 0.51 \rightarrow \text{Reject } H_0$$

$$tcal\ (\beta_3) = \frac{\hat{\beta}_3 - \beta_3}{se(\hat{\beta}_3)} = \frac{3.9152 - 0}{1.1557} = 3.4 \rightarrow \text{Reject } H_0$$

$$tcal\ (\beta_4) = \frac{\hat{\beta}_4 - \beta_4}{se(\hat{\beta}_4)} = \frac{18.8025 - 0}{8.3425} = 2.25 \rightarrow \text{Reject } H_0$$

→ critical value $= \pm 2.056$ when $\alpha = 0.05$, $(n-k) = 26$

∴ We can sure that R^2 is 0.6552 and almost all parameters are significantly different from 0. So we can conclude that the conflicting test is not found here and multicollinearity also not present here

(b) Property of BLUE are linear, unbiased, and have the least variance among the class of all linear and unbiased estimators

And the OLS estimator is retain the property of BLUE, because BLUE is not affected by multicolinearity.

4. (a) - Intercept of this cofficient is 1.0108 which mean when the unemployment rate is 0 the inflation rate will be 1.0108 percent.

- Slope of this cofficient is .5055 which mean when unemployment rate increase by 1 percent the inflation rate will increase .5055 percent.

(b) - White's test

- Let H_0 : Heteroscedsticity
  H_1 : otherwise

- $LM_{cal} = n \cdot R^2_{\hat{u}_i^2} \sim \chi^2_{k-1} = 1.0266$

- critical value χ^2_1 and $\alpha = 0.05$ is 3.84146

$\therefore$ $LM_{cal} < \chi^2_1$, so we cannot reject H_0 of hemoscedasticity

(c) Since we cannot reject H_0 in (4.b), there fore, we can make sure that BLUE property is not violated