Question 1. (12 points) Economic model of Crime.

1.a) Based on the regression results provided, write out the estimated coefficients in the form of regression equation (1.1). Interpret the estimated coefficients associated with *avgsen*. Based on Model (1.1), test whether the average sentence served from prior convictions has an impact on the number of arrests in the current year (1986). Show your work. (Use α = 0.05)

1.a $narr86 = 0.7061 - 0.1512\, pcnv - .0070\, avgsen + 0.0121\, tottime - 0.0993\, ptime86 - 0.1031\, qemp86$

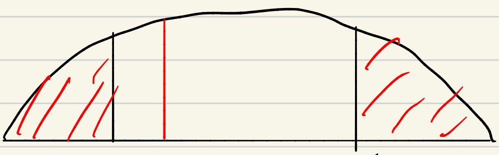
- Number of arrested convict in current year 1986 decreased 1 time, corresponding with average sentence served from prior convictions increase by .0070 month.

$H_0: B_3 = 0$

$H_1: B_3 \neq 0$

t cal for avgsen

$= t_{cal}(\hat{B}_3) = \dfrac{\hat{B}_3 - B_3}{se(\hat{B}_3)} = \dfrac{-0.0070 - 0}{0.0121} = -0.5785$



−1.96 −0.5785 1.96

Critical value = ± 1.96, α = 0.05

$(n-k) = 2{,}725 - 6 = 2{,}719$

Ans ∴ tcal fall outside of rejection zone, so we cannot say that average sentence served from prior convictions don't have significant impact to number of arrestion at current year 1986 at level of coefficient = 0.05 / α = 0.05.

∴ Cannot make sure that parameter ≠ 0 #

Show your work. (Use $\alpha = 0.05$)

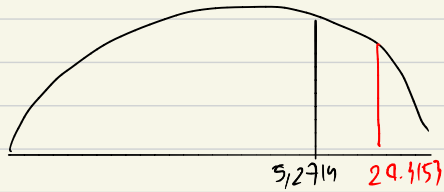
1.b) What is the overall significance of the regression from Model (1.1) and Model (1.2)? What test do you use? (Use $\alpha = 0.01$)

1.c) If we are interested in testing whether "ethnic background and legal income" has

Model 1.1 1.b F-test, using R^2,

$H_0: B_2 = B_3 = B_4 = B_5 = B_6 = 0$

H_1: otherwise



$F_{cal} = \dfrac{R^2/K-1}{(1-R^2)/n-K} = \dfrac{.0428/5}{(1-.0428)/2719} = 24.3157$, $F_{cri\,(5,2719)}^{0.02} = 3.02$

Ans Fcal > Fcri, 24.3153 fall in reject zone, reject H_0 at least one B is not equal to zero, at 99% confidence level.

Model 1.2 F-test, using R^2

$H_0: B_2 = B_3 = B_4 = B_5 = B_6 = B_7 = B_8 = B_9 = 0$

H_1: otherwise

$F_{cal} = \dfrac{R^2/K-1}{(1-R^2)/n-K} = \dfrac{0.0723/8}{(1-0.0723)/2716} = 26.9588$, $F_{cri\,(8,2716)} = 2.51$

Ans fcal > Fcri, reject null hypothesis for model 1.2. at least one B is not equal to 0 at 99% confidence level.

What test do you use? (Use α = 0.01)

1.c) If we are interested in testing whether "ethnic background and legal income" ha
an impact on the number of arrests in the current year (1986), what kind c
null/alternative hypothesis would we be testing? Perform the test and discuss you
finding. (Use α = 0.05)

F-test, marginal contribution

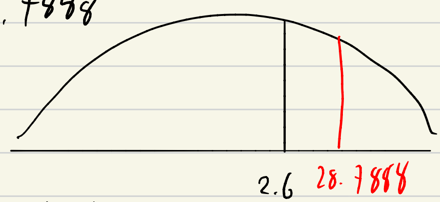
H_0: ethic background and legal income have no marginal contribution.

H_a: otherwise

formula $F_{cal} = \dfrac{R^2_{1.2} - R^2_{1.1} / (K \text{ of new regression})}{1 - R^2_{1.2} / (n - K_{1.2})}$

$F_{cal} = \dfrac{0.0723 - 0.0428/3}{(1 - 0.0724 / (2{,}725 - 9))} = 28.7888$

$F_{cri\,(3,2716)} = 2.6$, at $\alpha = 0.05$



Ans: Fcal > Fcri, we can reject null hypothesis, and conclude that ethic background and legal income have marginal contribution.

2.a) Test all the parameters individually if each of them is significantly different from zero of not.

formula, $t_{cal}(\hat{B}_i) = \frac{\hat{B}_i - B_i}{se(\hat{B}_i)}$ / Set hypothesis, $K = 1, 2, 3, 4$

$H_0: B_1 = 0$ $\quad t\text{-cal} = \frac{9.1798 - 0}{.0035} = 2621.3714$

$H_1: B_1 \neq 0$

$H_0: B_2 = 0$ $\quad t\text{-cal} = \frac{0.587 - 0}{.0072} = 81.5278$

$H_1: B_2 \neq 0$

$H_0: B_3 = 0$ $\quad t\text{-cal} = \frac{-0.0336 - 0}{.0005} = -6.72$

$H_1: B_3 \neq 0$

$H_0: B_4 = 0$ $\quad t\text{-cal} = \frac{0.0444 - 0}{0.0102} = 4.1529$

$H_1: B_4 \neq 0$

Critical value$_{97,874}$ = ± 1.96, $(n-k) = 97,878 - 4 = 97,874$

Ans All t-cal exceed critical value so reject all the hypothesis, all parameter are significantly different from 0, at $\alpha = 0.05$

zero of not.

same

2.b) How much on average does a civil servant and state employee earns more or less than the others disregarding the year?

2.b Consider B_2, which is representing coefficient of different between civil servants and the other group.

It is positive coefficient, so civil servant earn more than other group by

Ans $= e^{\hat{\beta}_2} - 1 = e^{0.587} - 1 = 0.7986 \times 100 = 79.86$ percent

2.c) How much on average does the pandemic affect wage overall?

2.c B_7 represent the pandemic effect.

This is negative coefficient, in 2020 wage drops

Ans by $= e^{B_7} - 1 = e^{-0.0316} - 1 = 0.031 \times 100 = 3.1\%$ of all groups

civil servant
2.d) Are the control group and the treatment group better-off or worse-off during the pandemic. Discuss each group separately, show your work and explain with economic reasons according to the intention of this model.

2.d Civil servant have positive effect and significantly different from zero in 2020

$$\ln \widehat{wage}_i = \underset{(0.0035)}{9.1748} + \underset{(0.0072)}{0.587}\, civil_i - \underset{(0.005)}{0.0336}\, year_i + \underset{(0.0102)}{0.0444}\, civil_i \cdot year_i + u_i$$

Civil servant group in 2020 (control)

$$\ln \widehat{wage}_i = 9.1748 + 0.587(1) - 0.0336(1) + 0.0444(1)\cdot(1)$$
$$= 9.7726$$

other group (treatment)

$$\ln \widehat{wage} = 9.1748 + 0.587(0) - 0.0336(1) + 0.0444(0)(1)$$
$$= 9.412$$

civil servant wage, down -0.0336 in 2020 of coefficient and bounce back by $+0.0444$.

The civil group better-off during the pandemic by

$$e^{\hat{\beta}_3 + \hat{\beta}_4} - 1 = e^{-0.0336 + 0.0444} - 1 = 0.0109 \times 100 = 1.09\,\%$$

The other group worse-off by

$$e^{\hat{\beta}_3} - 1 = e^{-0.0336} - 1 = 0.033 \times 100 = 3.3\,\%$$