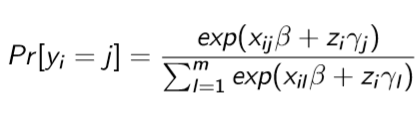
**EXERCISE 3**

**3a)**



I = 1,2,3,4

**3b)**

**Summary statistics: N mean sd min max by(mode\_travel)   
MODE\_TRAVEL**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | mean | sd | min | max |
| **AIR**  gc | 210 | 102.648 | 30.575 | 56 | 197 |
| ttme | 210 | 61.01 | 15.719 | 5 | 99 |
| hinc | 210 | 34.548 | 19.711 | 2 | 72 |

**BUS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| gc | 210 | 115.257 | 44.934 | 45 | 222 |
| ttme | 210 | 41.657 | 12.077 | 5 | 60 |
| hinc | 210 | 34.548 | 19.711 | 2 | 72 |

**CAR**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| gc | 210 | 95.414 | 46.827 | 30 | 238 |
| ttme | 210 | 0 | 0 | 0 | 0 |
| hinc | 210 | 34.548 | 19.711 | 2 | 72 |

**TRAIN**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| gc | 210 | 130.2 | 58.235 | 42 | 269 |
| ttme | 210 | 35.69 | 12.279 | 1 | 99 |
| hinc | 210 | 34.548 | 19.711 | 2 | 72 |

**3c)**

According to the model, the coefficient associated with corresponds to . On our STATA output, this corresponds to the coefficient on the 2nd row (AIR), associated with *hinc*.

From the class materials, we can see that, in principle, only the signs for “alternative-varying” regressors are directly interpretable. *hinc* is an “alternative-invariant regressor” i.e. it only varies by individual and not by alternative.

As such, I would say there is no direct interpretation possible for the coefficient .

Marginal effect calculation and interpretation is possible, but as question 3e) asks exactly that, we are assuming that there is no further explanation required here.

**3d)**

We can see that the relative frequencies of the choice of travel and the predicted probabilities are very close to each other, for all modes of travel. This is an indicator that we have estimated a good model.

**3e)**

As the household income variable is associated only with the AIR mode of travel, the interpretation is only due on that coefficient. However, for completion sake, all coefficients will be interpreted.

When choice=AIR, the marginal effect of *hinc* is 0.004085.

This means that an increase in 1 unit ($1000) in income increases by 0.004085 the probability to travel by air rather than by bus, train or car, with regard to the mean values of the independent variables.

When choice=BUS, the marginal effect of *hinc* is -0.000952.

This means that an increase in 1 unit ($1000) in income decreases by -0.000952 the probability to travel by bus rather than by air, train or car, with regard to the mean values of the independent variables.

When choice=CAR, the marginal effect of *hinc* is 0.00686.

This means that an increase in 1 unit ($1000) in income increases by 0.00686 the probability to travel by car rather than by air, train or bus, with regard to the mean values of the independent variables.

When choice=TRAIN, the marginal effect of *hinc* is -0.009993.

This means that an increase in 1 unit ($1000) in income decreases by -0.009993 the probability to travel by train rather than by air, bus or car, with regard to the mean values of the independent variables.

**3f)**

First of all, by looking at the table, we see that only two of the three coefficient estimates of household income are statistically significant at the 5% level, but the results of individual testing may vary with the base outcome/omitted category. As such, we’ll perform a Wald test to be more certain that household income has significance.

The result clearly shows us the significance of household income in explaining the travel mean choice.

Keeping in mind that our base category is travel by car, we have negative coefficients for all other means of travel. This lets us interpret that as household income increases, individuals are more likely to travel by car than by bus, train, or air. This, however, is not completely coherent with our previous interpretations on the Conditional Logit model. One might reason that the transformation of the model has made the Multinomial Logit not totally equivalent to the Conditional Logit previously estimated.

Transforming into relative risk-ratio for interpretation is also interesting.

With this transformation, we can see that with a one-unit ($1000) increase in household income, the relative odds of choosing to travel by air, bus, or train rather than car decline – because the coefficients are smaller than one. However, they are only marginally smaller than one, which points that a big household income variation is needed for an actual relevant change in the odds to occur.

**3g)**

Based on the Hausman test for the Independence from Irrelevant Alternatives (IIA), this assumption does not hold. As such, with this assumption violated, our estimates of the coefficients are inconsistent – both for the Multinomial Logit and for the Conditional Logit.