Econ 613 Assignment 2

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Exercise 1:

(1)

Table1: Mean and dispersion in price

	PPk_Stk	PBB_Stk	PFl_Stk	PHse_Stk	PGen_Stk	PImp_Stk	PSS_Tub	PPk_Tub	PFl_Tub	PHse_Tub
Mean	0.518	0.543	1.015	0.437	0.345	0.781	0.825	1.077	1.189	0.569
SD	0.151	0.120	0.043	0.119	0.035	0.115	0.061	0.030	0.014	0.072

(2)

Table1: Market share

	PPk_Stk	PBB_Stk	PFl_Stk	PHse_Stk	PGen_Stk	PImp_Stk	PSS_Tub	PPk_Tub	PFl_Tub	PHse_Tub
All	0.395	0.156	0.054	0.133	0.070	0.017	0.071	0.045	0.050	0.007
Above	0.411	0.183	0.080	0.125	0.074	0.024	0.050	0.037	0.011	0.007
Below	0.377	0.126	0.025	0.142	0.067	0.009	0.096	0.055	0.096	0.008

(3)

In my code, I add an “index” column to connect the customer choice with the butter brand.

```
CP$index<-CP$choice+2
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I add a column “name” to restore the name of each butter brand.

Then, I linked “index” with “name” to get everyone’s choice brand name.

Exercise 2:

I use conditional logit model in exercise 2.

The probability is calculated as:

$$p_{ij} = \frac{\exp(x_{ij}\beta)}{\sum_{l=1}^{m} \exp(x_{il}\beta +)} \quad j = 1, \dots, m$$

The log-likelihood function is calculated as:

$$\mathcal{L} = \sum_{i}^{n} \log(p_{ij})$$

I minimize the negative log-likelihood function using “nloptr” in R. The coefficient is:

conditional_logit$solution:

(Intercept):2	-0.954
(Intercept):3	1.297
(Intercept):4	-1.717
(Intercept):5	-2.904
(Intercept):6	-1.515

(Intercept):7	0.252
(Intercept):8	1.465
(Intercept):9	2.358
(Intercept):10	-3.897
price	-6.657

The coefficient of price is -6.657. The negative sign means that an increase in the price of one alternative decreases the probability of choosing that alternative and increases the probability of choosing other alternatives.

Exercise 3:
I use a multinomial model in this exercise.
The probability is calculated as:

$$p_{ij} = \frac{\exp{(w_i \gamma_j)}}{\sum_{l=1}^{m} \exp{(w_i \gamma_l)}} \quad j = 1, \dots, m$$

The log-likelihood function is calculated as:

$$\mathcal{L} = \sum_{i}^{n} \log{(p_{ij})}$$

I minimize the negative log-likelihood function using "nloptr" in R. The coefficient is:

(Intercept):2	-0.845
(Intercept):3	-2.400
(Intercept):4	-1.201
(Intercept):5	-1.691
(Intercept):6	-4.140
(Intercept):7	-1.531
(Intercept):8	-2.848
(Intercept):9	-2.576
(Intercept):10	-4.282
Income:2	-0.003
Income:3	0.015
Income:4	0.004
Income:5	-0.001
Income:6	0.031
Income:7	-0.007
Income:8	0.023
Income:9	0.018
Income:10	0.011

Income 2, 5 and 7 have negative sign. It means the high-income families are less likely to choose brand 2, 5 and 7 compared with brand1. Income 3, 4, 6, 8, 9, 10 have positive sign. It means the high-income families are more likely to choose brand 2, 5 and 7 compared with brand1.

Exercise 4:
The marginal effect of conditional logit is:

	1	2	3	4	5	6	7	8	9	10
Change in 1	-1.29	0.30	0.12	0.30	0.16	0.04	0.15	0.10	0.11	0.02
Change in 2	0.30	-0.75	0.06	0.13	0.07	0.02	0.07	0.05	0.05	0.01
Change in 3	0.12	0.06	-0.34	0.05	0.03	0.01	0.03	0.02	0.02	0.00
Change in 4	0.30	0.13	0.05	-0.71	0.06	0.02	0.06	0.04	0.04	0.01

Change in 5	0.16	0.07	0.03	0.06	-0.43	0.01	0.04	0.03	0.03	0.00
Change in 6	0.04	0.02	0.01	0.02	0.01	-0.11	0.01	0.01	0.01	0.00
Change in 7	0.15	0.07	0.03	0.06	0.04	0.01	-0.42	0.03	0.03	0.00
Change in 8	0.10	0.05	0.02	0.04	0.03	0.01	0.03	-0.28	0.02	0.00
Change in 9	0.11	0.05	0.02	0.04	0.03	0.01	0.03	0.02	-0.31	0.00
Change in 10	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-0.05

There is greatest substitution between butter 4 and butter1. When the price of butter 4 increases, it will lead the customer switch from butter4 to butter 1.

The marginal effect of multinomial logit is:

1	2	3	4	5
-0.0010674	-0.000897956	0.000628508	0.00016944	-0.0002773
6	7	8	9	10
0.00044368	-0.000680239	0.000887599	0.00073562	0.0000581049

The 1$ increase in income is associated with changes of these numbers in the probabilities of butter1 to other butter. This indicates the little positive change in income, movement out of butter 2, 5, 7 and movement to 3, 4, 5, 8, 9, 10.

Exercise 5:

(1)
In this question, I write the mixed logit model.
The probability is calculated as:

$$p_{ij} = \frac{\exp\,(x_{ij}\beta + w_i\gamma_j)}{\sum_{l=1}^{m} \exp\,(x_{il}\beta + w_i\gamma_l)} \quad j = 1, \dots, m$$

The log-likelihood function is calculated as:

$$\mathcal{L} = \sum_{i}^{n} \log\,(p_{ij})$$

I minimize the negative log-likelihood function using “nloptr” in R. The coefficient is:

(Intercept):2	-0.841
(Intercept):3	0.889
(Intercept):4	-1.828
(Intercept):5	-2.873
(Intercept):6	-2.457
(Intercept):7	0.497
(Intercept):8	0.803
(Intercept):9	1.864
(Intercept):10	-4.142
price	-6.660
Income:2	-0.004
Income:3	0.014
Income:4	0.004
Income:5	-0.001
Income:6	0.030
Income:7	-0.009
Income:8	0.022
Income:9	0.017
Income:10	0.009

(In my code, the mix2$solution contains all these coefficients. mix2$solution[1:9] are the constants, [10:18] is the coefficients of income, [19] is the coefficients of price.)

(2)
I drop all the choice 1 observations and create a subsample called “new” in my code.
Similarly, I use mixed logit to estimate the coefficients.

(Intercept):3	1.636

(Intercept):4	-0.943
(Intercept):5	-1.969
(Intercept):6	-1.648
(Intercept):7	1.223
(Intercept):8	1.555
(Intercept):9	2.576
(Intercept):10	-3.244
price	-6.422
Income:3	0.018
Income:4	0.008
Income:5	0.003
Income:6	0.034
Income:7	-0.004
Income:8	0.026
Income:9	0.021
Income:10	0.013

(In my code, the mix2_new$solution contains all these coefficients. mix2$solution[1:8] are the constants, [9:16] is the coefficients of income, [17] is the coefficients of price.)

(3)
I drop the constant1 and beta1 in β_f and put it back to part 2's likelihood function.

$$\mathcal{L}(\beta_r) = 7420.2$$
$$\mathcal{L}(\beta_f) = 5112.1$$
$$||\beta_r|| = 8.5$$
$$\mathrm{X}^2(||\beta_r||) = 15.51$$

MTT=4616.2
MTT > Chisq
We reject the IIA hypothesis. This indicates that $\mathcal{L}(\beta_f)$ and $\mathcal{L}(\beta_r)$ are significant different from each other. Our data does not satisfy IIA hypothesis. We should consider other model like generalized extreme value model.