**Sorting**

Q21

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ramp | restroom | walleye | salmon | panfish | travel cost |
| 0.04317931 | -0.1829115 | 1.73617037 | 4.60050988 | 0.38598481 | -0.1030538 |

Q22

|  |  |  |  |
| --- | --- | --- | --- |
| ramp | -0.4118052 | pan\_kids | -0.1632873 |
| restroom | -0.2778554 | ramp\_boat | 0.98189017 |
| walleye | 1.29926908 | rest\_kids | 0.34420128 |
| salmon | 4.55619843 | wall\_boat | 0.69610354 |
| panfish | 0.43786032 | travel cost | -0.1030564 |

Q23

|  |  |  |  |
| --- | --- | --- | --- |
| first-stage | | second-stage | |
| travel cost | -0.1230494 | ramp | -0.5155342 |
| pan\_kids | -0.1417162 | restroom | -0.716345 |
| ramp\_boat | 1.40180429 | walleye | 2.08662266 |
| rest\_kids | 0.50974749 | salmon | 2.37740146 |
| wall\_boat | 0.59025622 | panfish | 0.52493195 |

Q24

|  |  |  |  |
| --- | --- | --- | --- |
| first-stage | | second-stage | |
| travel cost | -0.1259389 | ramp | -0.4549932 |
| pan\_kids | -0.1163891 | restroom | -0.6864818 |
| ramp\_boat | 1.21014815 | walleye | 2.06815862 |
| rest\_kids | 0.35312091 | salmon | 2.33897709 |
| wall\_boat | 0.57489549 | panfish | 0.52715314 |

a.

From the above four models, we could conclude that travel costs negatively impact utility. This impact varies from -0.10 to -0.13, which is relatively stable and consistent. Plus, improvements in other site attributes except ramp and restroom always make the site more attractive, but the magnitudes of their influences are different in different models. In terms of magnitude of influences, salmon is always the most significant attribute and walleye is the second. The impact of Ramp on utility seems unstable. Specifically, it is positive in the first model, but it turns to be negative in other models. In fact, the estimated coefficient of ramp is very small in the first model, so I believe the negatively estimated coefficients of ramp may be more compelling. In addition, the above four models show that having a restroom can cause utility to decrease.

b.

Firstly, the coefficient of ramp is insignificantly positive in the first model, but it turns to be significantly negative in the second model. The coefficient of ramp\_boat is 0.98 in the second model, which means having a ramp increases the utility of boat owners by (0.98- 0.41) but it decreases the utility of people who don’t own a boat by 0.41. This result is reasonable. For people who own a boat, a paved boat ramp can improve their convenience a lot, but for people without a boat, ramp is useless and could cause noise or pollutions.

Secondly, whether individuals have a kid could cause the effect of restroom on utility to vary dramatically. For people who have a kid, having a restroom can increase their utility by (0.344-0.278), while for people who have no kid, having a restroom can decrease their utility by 0.278. From life experience, individuals who have children need restrooms more, because their children like to get dirty or go to the restroom more times.

Plus, the coefficient of pan\_kids is -0.14. This coefficient may tell us the environment where panfishes live is not friendly to children or children are not favorable factors in fishing panfishes. Meanwhile, the coefficient of wall\_boat is 0.696. This coefficient may tell us having a boat is a favorable factor in fishing walleye. Maybe people can enjoy more when they fish walleye in a boat.

c.

The difference between the first two models shows us the importance of accounting for observable heterogeneity in models. Site attributes influence different kinds of people differently. After adding observable individual attributes to the model, coefficients changed significantly. At the same time, the difference between the second model and the third model shows accounting for an unobserved site attribute is important. For example, the estimated coefficient of travel cost changed from -0.1031 in the first two models to -0.1230 in the third model. The coefficient of salmon changed from 4.56 to 2.38, which means there are some unobserved attributes influence both utility and salmon and consequently bias the estimated effect of salmon upwards, so the results of models which ignore unobserved attributes are not precise.

d.

After accounting for the unobserved site attribute, the magnitude of many coefficients changed significantly.

Firstly, the estimated coefficient of travel cost changed from -0.1031 to -0.1230, which means some unobserved attributes may bias the magnitude of this coefficient downwards. For example, faraway suburbs may cause people to cost more in travel, but there is always a more beautiful environment in such suburbs.

Secondly, the estimated coefficient of ramp\_boat changed from 0.98 to 1.40 and the coefficient of ramp changed from -0.41 to -0.52, which means some unobserved attributes may bias this coefficient downwards. For instance, sites with ramp may have more shops or be more developed, and this unobserved attribute may relieve some disutility of people who don’t have a boat. However, for boat owners ramp may also cause traffic jams, so the difference between the utility of boat owners and non-owners is decreased by this unobserved attribute.

Thirdly, the estimated coefficient of restrooms changed from -0.2776 to -0.7163. There are always some public seats or vendors around restrooms, and those amenities may bias the negative effect of restrooms towards 0.

Fourthly, the estimated coefficient of salmon changed from 4.56 to 2.38, while the estimated coefficient of walleye changed from 1.299 to 2.087. It is possible that salmons like to live in a good environment, so people can enjoy the environment when they fish. Walleyes may like to live in an extreme environment, and the extreme environment decreases people’s utility.

Q311

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ramp | restroom | walleye | salmon | panfish | shares | travel cost |
| -0.0077523 | -0.2249889 | 0.17327711 | 0.23815207 | 0.23074979 | 0.69403381 | -0.1044365 |

Q312

|  |  |  |  |
| --- | --- | --- | --- |
| ramp | -0.5094311 | ramp\_boat | 1.04810743 |
| restroom | -0.3200702 | rest\_kids | 0.37443 |
| walleye | -0.2055657 | wall\_boat | 0.59476281 |
| salmon | 0.18408804 | travel cost | -0.10444 |
| panfish | 0.26785615 | shares | 0.69396783 |
| pan\_kids | -0.1266355 |  |  |

Q313

|  |  |  |  |
| --- | --- | --- | --- |
| first-stage | | second-stage | |
| travel cost | -0.1230494 | ramp | -0.5415535 |
| pan\_kids | -0.1417162 | restroom | -0.7585338 |
| ramp\_boat | 1.40180429 | walleye | 0.95381641 |
| rest\_kids | 0.50974749 | salmon | -0.9765883 |
| wall\_boat | 0.59025622 | panfish | 0.38354736 |
|  |  | shares | 0.69978917 |

Comparing section 3(i) with section 2, we can find that the estimates of the parameters on many non-congestion attributes changed. The most significant changes happened to the coefficients of walleye, salmon and panfish, and all of these coefficients declined. Since shares is positively correlated to utility, shares must also be positively correlated to walleye, salmon and panfish, and then these positive correlations biased the estimated coefficients of walleye, salmon and panfish upwards (people prefer to fish the three kinds of fishes, so there are always a lot of people in the sites with high rate of walleye, salmon and panfish.). Thus, congestion is an important factor in utility, and if we ignore it, other non-congestion attributes will be endogenous and the estimated coefficients will be biased upwards. In these models, congestion positively influences people’s utility, which means people love to go to some crowded places.

Q32

|  |  |  |  |
| --- | --- | --- | --- |
| first-stage | | second-stage | |
| travel cost | -0.1230494 | ramp | -0.3800148 |
| pan\_kids | -0.1417162 | restroom | -0.4965576 |
| ramp\_boat | 1.40180429 | walleye | 7.99057023 |
| rest\_kids | 0.50974749 | salmon | 19.8552907 |
| wall\_boat | 0.59025622 | panfish | 1.26169065 |
|  |  | shares | -3.6466515 |

According to section 3 (ii), the estimated coefficient of shares is negative, which means congestion influence people’s utility negatively so people dislike congestion. Catch rates may be positively correlated with congestions, which means people like to fish walleye, salmon and panfish and there are always a lot of people in the sites with high catch rate of walleye, salmon and panfish. Since congestion is negatively correlated with utility, the correlations between congestion and catch rates biased the estimated coefficients of catch rates towards 0 in OLS-without-shares models.

Q4

|  |  |  |  |
| --- | --- | --- | --- |
| PE | | GE | |
| CV\_ai | 0.19332423 | CV\_aii | 0.00014455 |
| CV\_bi\_affected | 0.19831947 | CV\_bii\_affected | 0.03190544 |
| CV\_bi\_unaffected | 0.0838395 | CV\_bii\_unaffected | 0.0149217 |
| CV\_ci\_affected | -6.8404787 | CV\_cii\_affected | -8.8033433 |
| CV\_ci\_unaffected | -4.4085127 | CV\_cii\_unaffected | 3.17306372 |
| CV\_di\_affected | -4.568256 | CV\_dii\_affected | -3.818486 |
| CV\_di\_unaffected | -2.3429387 | CV\_dii\_unaffected | -3.8184653 |

When we examine the partial welfare impacts, we use estimated indirect utility function, assuming that nobody changes their optimizing decisions. By contrast, when we examine the general welfare impacts, we get a new equilibrium. In the process of getting a new equilibrium, people may change their preference for attributes. Therefore, we get a smaller welfare impact of GE in scenario a and b. In scenario c, people have less choice, so in general their welfares decrease.

People who chose sites that have more than 1.5% of observed visits have less aversion to congestion and more aversion to other attributes(like travel cost) than other people. Thus welfare impacts differ between people who chose one of the affected sites and people who did not.