Problem Set 3 Solutions

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Directions: Answer all questions. Clearly label all answers. Show all of your code. Compute standard errors for all parameter estimates. Turn in the following to me via your dropbox (in a folder labeled 'MatlabPS2.3') in Sakai by 11:59 p.m. on Thursday, August 9, 2012:

- m-file(s)
- .sh shell script file that executes your m-file(s)[1]
- a log file (from off the cluster)
- shell_name.oXXXXX file
- pdf version of your writeup with its LaTeXsource code

Put the names of all group members at the top of your writeup (each student must turn in his/her own materials). As usual, set the seed for `rand` and `randn` to 1234.

1. Simulation of a definite integral with no closed form. In this question, compute the integral of $f(x)$ from -10 to 1, where $f(x) = \exp\left(-x^2\right)$. This integral has no closed form solution, so we will approximate its value by two methods:

   (a) With quadrature, the integral computes to 1.6331

   (b) See my m-code and Table 1 for complete solution. To get close to the quadrature solution, I had to do 2 million draws. The quadrature time was .046 seconds. The simulation time with 20 million draws was 2.737 seconds. Surprisingly, the results with 2 million draws performed better than with 20 million.

2. Bootstrapping, using the dataset `nlsw88.mat`.

   (a) The bootstrapped sample mean of `ttl_exp` is 12.5374 with standard error of .0968. The mean taken from the data is 12.5350 with standard error of .0973. In this case, the bootstrapping slightly overestimates the mean, and slightly underestimates the standard error.

   (b) The boostramped sample median of ln(wage) is 1.8384 with standard error of .0150. The population analogs are 1.8361 and .0152. Again, the bootstrapping slightly overstaded the median and slightly understated the dispersion.

[1] Name your job something other than "matsub," and have it send you an email upon completion.

(c) See Table 2 for the comparison between bootstrap and regular OLS. The results are exactly the same for the coefficients, but that's because this wasn't a full bootstrap (since I followed the example in `bootstrp`, which only bootstrapped the standard errors and not the coefficients). The standard errors are no more than .0006 different, which makes sense. We shouldn't expect any difference, because the OLS standard errors are the true standard errors. In most applications of the bootstrap, there's something about the estimation method that prevents recovery of the correct standard errors, so bootstrapping is used as a way of recovering them.

(d) See Table 3 for the comparison between bootstrap and regular OLS. The standard errors are exactly the same, regardless of which bootstrap method was employed. The coefficients were off by as much as .026, but the differences are proportional to the standard errors of the estimates, which makes sense.

3. Examining heterogeneity methods in a binomial probit model.

   (a) See Table 4 for a comparison of (a), (b), and (c)

   (b) See Table 4 for full details. $\hat{\pi} = .7334$. This is interpreted as the proportion of people with $\alpha_i = 1$. This can also be estimated as a type-specific intercept, where the coefficient on the intercept is constrained to 1.

   (c) See Table 4 for full details. I used a step size of .03 for my grid. Comparing the three estimation results, the slope parameters are much more similar between the random effects specifications than the no-heterogeneity specification. Across the board, controlling for unobserved heterogeneity amplifies the estimates for each of the slope parameters. The finite mixture specification has a higher log likelihood than the continuous random effects specification. However, it is unclear which random effects specification should be preferred.

Table 1: Simulated Integral Results

Draws	Time	Estimate	Bias
20	0.001	1.6500	0.0169
200	0.000	1.4850	-0.1481
2,000	0.000	1.6665	0.0334
20,000	0.005	1.6258	-0.0073
200,000	0.045	1.6250	-0.0080
2,000,000	0.448	1.6331	0.0000
20,000,000	2.737	1.6317	-0.0013

Table 2: Bootstrap Comparison: `bootstrp` function

Draws	OLS	OLS SE	Bootstrap	Bootstrap SE
constant	0.6292	1.6618	0.6292	1.6622
age	0.0003	0.0845	0.0003	0.0845
black	-0.1077	0.0238	-0.1077	0.0239
other race	0.0310	0.0834	0.0310	0.0829
college grad	0.0445	0.0372	0.0445	0.0366
education	0.0647	0.0064	0.0647	0.0064
married	-0.0350	0.0231	-0.0350	0.0228
south	-0.1352	0.0203	-0.1352	0.0204
central city	0.0853	0.0217	0.0853	0.0216
union	0.1229	0.0225	0.1229	0.0226
experience	0.0333	0.0026	0.0333	0.0026
tenure	0.0089	0.0021	0.0089	0.0020
age^2	-0.0001	0.0011	-0.0001	0.0011
hours	0.0030	0.0010	0.0030	0.0010
never married	-0.1070	0.0347	-0.1070	0.0348

Table 3: Bootstrap Comparison: by hand

Draws	OLS	OLS SE	Bootstrap	Bootstrap SE
constant	0.6292	1.6618	0.6548	1.6622
age	0.0003	0.0845	-0.0010	0.0845
black	-0.1077	0.0238	-0.1076	0.0239
other race	0.0310	0.0834	0.0309	0.0829
college grad	0.0445	0.0372	0.0444	0.0366
education	0.0647	0.0064	0.0647	0.0064
married	-0.0350	0.0231	-0.0354	0.0228
south	-0.1352	0.0203	-0.1351	0.0204
central city	0.0853	0.0217	0.0852	0.0216
union	0.1229	0.0225	0.1230	0.0226
experience	0.0333	0.0026	0.0333	0.0026
tenure	0.0089	0.0021	0.0089	0.0020
age^2	-0.0001	0.0011	-0.0001	0.0011
hours	0.0030	0.0010	0.0030	0.0010
never married	-0.1070	0.0347	-0.1072	0.0348

Table 4: Heterogeneity Methods with Binomial Probit

(a) Point Estimates

	(No Heterogeneity)	(Finite Mixture)	(Continuous RE)
constant	-0.2339	-0.7765	0.0611
male	0.1270	0.1495	0.1629
AFQT	-0.1170	-0.1349	-0.1464
mother educ	-0.0089	-0.0112	-0.0129
education	-0.1041	-0.1297	-0.1408
experience	0.5769	0.6292	0.6422
grad HS	0.5763	0.6480	0.6953
grad 2yr college	0.4479	0.5349	0.5997
grad 4yr college	1.3609	1.5903	1.7309
log likelihood	—	-12,715.81	-12,732.96
$\hat{\pi}$	—	0.7334	—
$\hat{\sigma}_\alpha$	—	—	0.5841

(b) Standard Errors

	(No Heterogeneity)	(Finite Mixture)	(Continuous RE)
constant	0.0926	0.1113	0.1215
male	0.0177	0.0221	0.0248
AFQT	0.0108	0.0134	0.0151
mother educ	0.0034	0.0043	0.0048
education	0.0071	0.0084	0.0094
experience	0.0066	0.0075	0.0086
grad HS	0.0295	0.0359	0.0407
grad 2yr college	0.0405	0.0499	0.0535
grad 4yr college	0.0344	0.0428	0.0467
$\hat{\pi}$	—	0.0181	—
$\hat{\sigma}_\alpha$	—	—	0.0181