

# Econ 21410 - Problem Set V

## Paper Replication\*

May 9, 2015

This homework should be done in LaTeX. The homework will be graded on correctness, but will also heavily weight clarity and professionalism. It's better to not do some of the harder parts than to turn in an incomprehensible document. Your R script as well as a log-file should be submitted. Alternatively, use knitr to print your code inline in your latex document.

**SUBMISSION:** The homework must be emailed to Oliver and myself by 5p.m. Thursday, May 14th. The email must include a pdf with the filename `lastname_pset6.pdf` and R code called `lastname_pset6_code.R` where "lastname" should be replaced with your last name. The subject of your email should be [ECON 21410: pset6 submission]

If you are struggling, please use the github page to ask for help!\* Remember that asking and answering questions on our github page, coming to office hours to ask questions, and contributing to the class wiki are all worth participation credit, which is 10% of your grade in this class.

In this homework we will be replicating a classic paper from Industrial Organization: Bresnahan and Reiss (1991) "Entry and Competition in Concentrated Markets". It can be downloaded here: <http://pages.stern.nyu.edu/~acollard/bresnahan-reiss.pdf>

The data from the paper can be downloaded from my site.

### Replicating Bresnahan and Reiss 1991

Using the provided data, replicate Table 4, Table 5-A, and Figure 4 from the paper but only for tire dealers (only occupation in the data). Describe how you performed the replication, what your calculations were, how they were implemented, etc. Your write-up should be written as if you were performing this replication as part of your research, or part of your Job. Include clear details of what you did, but do not be overly verbose.

To calculate your standard errors, use the "hessian()" command in the "numDeriv" library. This command will give a reasonably accurate numerical approximation to the matrix of second derivatives. Note that your maximum likelihood standard errors will be the square-root of the diagonal terms of the inverted Hessian evaluated at your estimated parameter values.

#### Some hints and suggestions:

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\*Please email [johneric@uchicago.edu](mailto:johneric@uchicago.edu) and [obrowne@uchicago.edu](mailto:obrowne@uchicago.edu) if you have questions.

1. Solve the problem using maximum likelihood. Make a function that takes data and parameter values as inputs and returns the negative log-likelihood.
2. Make sure you have the likelihood written down and well understood prior to trying to implement it. I am happy to have people ask broad questions about the likelihood on github.
3. To test your log-likelihood function, try using the parameter values reported in their paper. You should get roughly the same log-likelihood (differences larger than 1 may indicate a problem in your code).
4. In the paper, the  $\alpha$  and  $\gamma$  parameters are constrained to be greater than or equal to 0 (except  $\gamma_L$ ). These constraints are “Bound Constraints” and should not be too difficult to impose (but will force you to use a particular optimizer in `optim()`).
5. This problem is solvable with `optim()`, but you will need to give it smart starting values. You can make sure it works by starting with the parameters from the paper, but then you should find alternative starting values that may be what you would have used if writing this paper yourself and did not know the true solutions.
6. Your function will most likely produce some values of ”-Inf”. These can cause problems and produce NaNs in later steps. You may wish to replace -Inf values with large negative numbers like -1000000000000000000 to avoid this problem.
7. It should be possible to write a relatively short log-likelihood function. Without comments or trying to make my code particularly compact, mine is 19 lines long and references two other functions which are both 9 lines long (without comments).

## Side Projects

- Write a function above that returns the analytic gradient. Use it in the step above and report the timing (up to 3 points).
- Program some or all of this assignment in C++ using Rcpp or in Julia (up to 5 points, 3 points if you have already coded up a previous homework in that language as a past sideproject).
- Write down 3 research ideas. For each explain the idea in 4-10 sentences. Write 1-4 sentences on why it is interesting, write 1-4 sentences on what data you would use, write 1-4 sentences on what methods it would use. These ideas can be very rough. If you would like feedback on one or all of them, let us know (up to 1 point each, whole assignment can be done twice (total of 6 ideas))
- Find a paper that looks at market entry and write a 1-3 page report on it (up to 3.5 points).
- Find up to 4 articles in the news and generate a related research ideas. Explain the idea in 3-6 sentences and how you might execute the research idea (3-6 sentences) (up to 1 point per idea/article).
- Read any published academic article by Gary Becker and write a 2-3 page summary and response (up to 3 points).

- People really like maps. Figure out how to make me a map showing the city of Chicago with dots for each crime that occurred in March (this can be downloaded from the Chicago City Data portal). Make the dots different colors based on the type of crime (up to 3 points, must be done with R).
- Extend the map above by figuring out how to count the number of dots inside each zip code or census tract in the city and make a map of the zip codes (or census tracts) where the tracts are color-coded based on the number of crimes that occurred in them during March 2014 (up to 3 more points, must be done with R).