Supplemental Materials to Lab 5 of QM2

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`-margins-` command is very useful in `Stata`. In this supplemental document, we look at the maths behind this command.

1 Example: Marginal Effect, part 1

Consider the following model:

$$\log(fare) = b_0 + b_1 \log(dist) + b_2[\log(dist)]^2 + b_3(bmktshr) + b_4 \log(passen), \quad (1)$$

where *fare* is airfares, *dist* is distance, *passen* is the number of passengers, and *bmktshr* is market share of the largest carrier.

Exponentiating both sides,

$$fare = exp\left[b_0 + b_1 \log(dist) + b_2[\log(dist)]^2 + b_3(bmktshr) + b4 \log(passen)\right]$$

Taking partial derivative w.r.t. *bmktshr*, we obtain

$$\frac{\partial fare}{\partial bmktshr} = b_3 exp\left[b_0 + b_1 \log(dist) + b_2[\log(dist)]^2 + b_3(bmktshr) + b4 \log(passen)\right] \quad (2)$$

Say we want to obtain $\frac{\partial fare}{\partial bmktshr}$ when all variables are at their means. what do we do?

- First, transform relevant variables. For example, `gen lfare=log(fare)`
- Second, run a regression to estimate Equation (1): `reg lfare c.ldist##c.ldist bmktshr lpassen`
- We then use the `margins` command to esimate the marginal effect of *bmktshr* on *fare*. Note that we need to specify the response as an expressin, using `expression()` and `predict()` options.[1] For details, please check the codebook for `-margins-`. In particular, consider the following code: `margins, dydx(bmktshr) expression(exp(predict(xb))) atmeans`

[1] The reason that we need to do this is because we are interested in $\frac{\partial fare}{\partial bmktshr}$, not $\frac{\partial \log(fare)}{\partial bmktshr}$.

2 Example: Marginal Effect, part 2

We consider the same estimation as before:

$$fare = exp\left[b_0 + b_1 \log(dist) + b_2[\log(dist)]^2 + b_3(bmktshr) + b4 \log(passen)\right]$$

Now, suppose we are interested in $\frac{\partial fare}{\partial \log(dist)}$. First, let's derive the mathematical results:

$$\frac{\partial fare}{\partial \log(dist)} = exp\left[b_0 + b_1 \log(dist) + b_2[\log(dist)]^2 + b_3(bmktshr) + b4 \log(passen)\right] \times [b_1 + 2b_2 \log(dist)] \tag{3}$$

Plugging in respective values into the equation above, we obtain that $\frac{\partial fare}{\partial \log(dist)} \approx 71.4$. We can confirm that it is the same number as using `-margins-` in `Stata`.

Appendix: Stata Output

```
.  margins, dydx(*) expression(exp(predict(xb))) atmeans

Expression    : exp(predict(xb))
dy/dx w.r.t. : ldist bmktshr lpassen
at           : ldist          =    6.696482 (mean)
               bmktshr        =    .6101149 (mean)
               lpassen        =    6.017027 (mean)

----------------------------------------------------------------------
             dy/dx     Std. Err.     z     P>|z|     [95% Conf. Interval]
----------------------------------------------------------------------------
ldist   |   71.35893    1.42963    49.91   0.000     68.55691    74.16096
bmktshr |    47.2094   4.639724    10.18   0.000     38.11571     56.3031
lpassen |  -12.04473   .8782969   -13.71   0.000    -13.76616    -10.3233
-----------------------------------------------------------------------------
```