HW2 Econometrics 3

Matthew Aaron Looney

10/04/2017

Problem 2

Problem 2. Censoring/Truncation. Greene (2007) analyzed the de- fault behavior and monthly behavior of a large sample of credit card users (13,444).

(2.1)

Estimate the following model

$$\log spend = \beta_1 + \beta_2 \ln income + \beta_3 Age + \beta_4 Adepcnt + \beta 5 ownrent + \varepsilon$$

Table 1: Regression output used to answer Problem 2

	Dependent variable:		
	LOGSPEND		NA
	OLS	*censored regression*	*Heckman selection*
	(1)	(2)	(3)
Ln_income	1.121***	1.117***	0.907***
	(0.033)	(0.033)	(0.162)
AGE	−0.015***	−0.014***	−0.014***
	(0.001)	(0.001)	(0.002)
ADEPCNT	−0.027**	−0.027**	0.016
	(0.011)	(0.011)	(0.034)
OWNRENT	−0.203***	−0.201***	−0.281***
	(0.030)	(0.030)	(0.065)
logSigma		0.296***	
		(0.007)	
Constant	−3.363***	−3.340***	−1.419
	(0.243)	(0.246)	(1.458)
Observations	10,499	10,499	13,444
R^2	0.105		0.105
Adjusted R^2	0.104		0.104
Log Likelihood		−18,012.210	
Akaike Inf. Crit.		36,036.430	
Bayesian Inf. Crit.		36,079.980	
ρ			−0.608
Inverse Mills Ratio			−0.878 (0.646)
Residual Std. Error	1.330 (df = 10494)		
F Statistic	306.358*** (df = 4; 10494)		
Note:			*p<0.1; **p<0.05; ***p<0.01

(2.1.a)

Using OLS. What is the effect of 10% increase in income on credit card expenditure?

- Since we are dealing with log-log we can simply multiply the paramater estimate on income by ten, which gives 11.2120776. So a 10% increase in income is estimated to increase credit card spending by 11.2120776%.

(2.1.b)

Using Censored regression. What is the effect of 10% increase in income on credit card expenditure?

We will need to employ a Censored (Tobit) Regression and calculate the Partial Effects.

The general formulation for the Tobit Model (Greene 7th. ed., pg 848):

$$
\begin{aligned}
{y_i}^* &= {x_i}'\beta + \varepsilon_i \\
y_i &= 0 \\
y_i &= {y_i}^*
\end{aligned}
\begin{cases} \text{if } {y_i}^* \leqslant 0 \\ \text{if } {y_i}^* \geqslant 0 \end{cases}
$$

The censored regression model is a generalisation of the standard Tobit model. The dependent variable can be either left-censored, right-censored, or both left-censored and right-censored, where the lower and/or upper limit of the dependent variable can be any number:

$$
y_i^* = x_i'\beta + \varepsilon_i \tag{1}
$$

$$
y_i = \begin{cases} a & \text{if } y_i^* \leq a \\ y_i^* & \text{if } a < y_i^* < b \\ b & \text{if } y_i^* \geq b \end{cases} \tag{2}
$$

Here a is the lower limit and b is the upper limit of the dependent variable. If $a = -\infty$ or $b = \infty$, the dependent variable is not left-censored or right-censored, respectively.

Censored regression models (including the standard Tobit model) are usually estimated by the Maximum Likelihood (ML) method. Assuming that the disturbance term ε follows a normal distribution with mean 0 and variance σ^2, the log-likelihood function is

$$
\begin{aligned}
\log L = \sum_{i=1}^{N} \Bigg[& I_i^a \log \Phi\left(\frac{a - x_i'\beta}{\sigma}\right) + I_i^b \log \Phi\left(\frac{x_i'\beta - b}{\sigma}\right) \\
& + \left(1 - I_i^a - I_i^b\right)\left(\log \phi\left(\frac{y_i - x_i'\beta}{\sigma}\right) - \log \sigma\right)\Bigg],
\end{aligned} \tag{3}
$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ denote the probability density function and the cumulative distribution function, respectively, of the standard normal distribution, and I_i^a and I_i^b are indicator functions with

$$
I_i^a = \begin{cases} 1 & \text{if } y_i = a \\ 0 & \text{if } y_i > a \end{cases} \tag{4}
$$

$$
I_i^b = \begin{cases} 1 & \text{if } y_i = b \\ 0 & \text{if } y_i < b \end{cases} \tag{5}
$$

The log-likelihood function of the censored regression model~(3) can be maximised with respect to the parameter vector $(\beta', \sigma)'$ using standard non-linear optimisation algorithms.

The proper Partial Effects formula:

$$\frac{\partial E[y|x]}{\partial x} = \beta \Pr ob[a < y^* < b]$$

Where I compute the partial effect at each observation and then compute the mean.

The parginal effect of Ln_income on LOGSPEND is 1.1169911. Therefore, a 10% increase of income is estiimated to increase credit card spending by 11.169911.

(2.1.c)

Using Heckman Two-Step Estimator. What the is effect of 10% increase in income on credit card expenditure?

11.240879