Econometrics -2 PS5

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Discussed with Giacomo and Miriam.

Problem 1
This exercise is based on the seminal article Lung-Fei Lee (1978): "Unionism and wage rates: A simultaneous equations model with qualitative and limited dependent variables", International Economic Review, 19: 415-433. Based on the idea that [e]conomic considerations suggest that the propensity to join a union depends on the net wage gains that might result from trade union membership", Lee (1978) proposed the estimation of what is now known as a (parametric) switching regression model. Here, we consider a simplified version of his model. Assume that every worker has two different potential wages, depending on his union membership status

$$lnw_i^U = x_i'\beta^U + u_i^U, \quad u_i^U \sim Normal(0, \sigma_U^2)$$
$$lnw_i^N = x_i'\beta^U + u_i^N, \quad u_i^N \sim Normal(0, \sigma_N^2)$$

Where U stands for unionized, and N for non-unionized. A worker decides to join the union if

$$U_i^* = \delta_0 + \delta_1(lnw_i^U - lnw_i^N) + x_i'\delta_2 + z_i'\delta_3 - v_i > 0$$

and v_i is assumed to be distributed as $Normal(0, \sigma_v^2)$. For simplicity, assume that all the error terms are uncorrelated with each other $cov(\sigma_U^2, \sigma_N^2) = cov(\sigma_U^2, \sigma_v^2) = cov(\sigma_N^2, \sigma_v^2) = 0$. For every worker, only (lnw_i, x_i, z_i, d_i) is observed, where d_i is a union membership indicator equal to 1 if i is a member and 0 else; and $lnw_i = d_i lnw_i^U + (1 - d_i) lnw_i^N$

a. What is the expected union/non-union wage differential for a randomly chosen individual with characteristics x_i in this model? What is the expected wage differential for a union worker with traits x_i?
Hint: Normalize the selection equation to be a standard probit.

The expected union/non-union wage differential for a randomly chosen individual with characteristics x_i in this model is

$$E[lnw_i^U - lnw_i^N|x_i] = x_i'(\beta^U - \beta^N) + E[u_i^U|x_i] - E[u_i^N|x_i]$$

The expected wage differential for a union worker with traits x_i is

$$\begin{aligned}
&E[lnw_i^U - lnw_i^N|U^* > 0] \\
&= x_i'(\beta^U - \beta^N) + E[u_i^U - u_i^N|\delta_0 + \delta_1(lnw_i^U - lnw_i^N) + x_i'\delta_2 + z_i'\delta_3 - v_i > 0] \\
&= x_i'(\beta^U - \beta^N) + E[u_i^U - u_i^N|\delta_0 + \delta_1(lnw_i^U - lnw_i^N) + x_i'\delta_2 + z_i'\delta_3 - v_i > 0]
\end{aligned}$$

Let $D = v_i - \delta(u^U - U^N)$ and $c = \delta_0 + \delta_1(x_i'(\beta^U - \beta^N)) + x_i'\delta_2 + z_i'\delta_3$ obtaining $E[u_i^U - u_i^N|D < c]$.

We then perform the following regression

$$u_i^U - u_i^N = a_1 D + V$$

where V is orthogonal to D. We then have

$$a_1 = \frac{cov(u_i^U - u_i^N, D)}{Var(D)} = \frac{\delta_1(\sigma_U^2 + \sigma_N^2)}{\delta_1^2(\sigma_U^2 + \sigma_N^2) + \sigma_v^2}$$

We then have that

$$\begin{aligned}
E[u_i^U - u_i^N|D < c] &= E[a_1 D + V|D > c] = a_1 E[D|D < c] \\
&= a_1 \sigma E[\frac{D}{\sigma}|\frac{D}{\sigma} < \frac{c}{\sigma}] = \\
&= a_1 \sigma \lambda(-c)
\end{aligned}$$

Which implies

$$\begin{aligned}
E[lnw_i^U - lnw_i^N|x_i, U^* > 0] &= x_i'(\beta^U - \beta^N) + a_1 \sigma \lambda(-c) \\
&= x_i'(\beta^U - \beta^N) + \delta_1(\sigma_U^2 + \sigma_N^2)\lambda(-c)
\end{aligned}$$

b. Is it possible to obtain an unbiased estimate of β^U and β^N by running two linear regressions using the sample of union members and non-members, respectively?

No. As these are truncated samples leading to the problem that $E(u^U|d_i = 1) \neq 0$ and $E(u^N|d_i = 1) \neq 0$.

c. Sketch how both equations can be estimated jointly by maximum likelihood. Hint: Use the same specification for the reduced form error as Lee.

d. Describe a two-step method which estimates β^U and β^N consistently by including estimated sample selection correction variables in the structural wage equations.

$$lnw_i^U = x_i'^U \beta^U + \sigma_{1\epsilon^*}\bigg(- \frac{f(\psi)}{F(\psi)}\bigg) + \eta^U$$
$$lnw_i^N = x_i'^N \beta^N + \sigma_{2\epsilon^*}\bigg(- \frac{f(\psi)}{F(\psi)}\bigg) + \eta^N,$$

Where $E(\eta^U|d_1 = 1) = 0, E(\eta^N|d_1 = 0) = 0$. ψ can be estimated as $\psi_i = \hat{\gamma}_0 + \hat{\gamma}_1 x_i' \hat{\gamma}_2 z_i'$. That is, ψ is obtained from a probit regression in a). F is the cummulative distribution of a standard normal distribution and f is its density function.

e. How can the structural parameters of the union status equation, i.e. δ, be recovered after this estimation procedure?

The predicted wages from the wage equations can be substitued into the equation explaining U^* and this equation can be estimated by probit to recover δ_1.

Now consider Tables 1, 2, 6, and 7 from Lee (1978), which contain the estimation results.

f. Is the relative rate of return to education (ED ranges from 1 to 5, where 5 is the highest education level) higher in the unionized or the non-unionized sector?
What about the effects of market experience (ME, where ME2 is the square of labor market experience), female (sex = 0), blacks (race = 0), and health impediments (HLT) on wages?

The relative rate of return of education is higher for non-unionized sector than in the unionized sector. For example coefficient of ED5 in non-unionized group is 0.282 and in the unionized group is 0.139.

In the unionized sector, market experience has a larger effect on wage increment (0.016) than the non-unionized sector (0.012). Furthermore, the negative and significant coefficient of ME2 confirms the strict concavity of the earning profile. Males receive higher wages than females. The gender differential is larger in the unionized sector. The race differential in wage is lower in the unionized sector than in the nonunionized sector. Health impediments lowers wage. The decrease seems to be larger for non-unionized (-0.088) workers than for unionized workers (-0.055).

g. Interpret the sign of the selectivity variables in Tables 1 and 2.
Hint: Check how Lee (1978) defines the inverse Mills ratio.

The sign of the selectivty variables for union sector (–0.168) and non-unionized sector are positive (0.136). The positive truncation indicates that we observe the upper sections of the union wage distributions given the control variables. The positive value results from the individual's selection of the relevant sector that pays him better than the average operatives with the same characteristics and under the same working circumstances.

h. Judging from the presented evidence, how important would you say is the wage differential in explaining the probability of union membership?

In Table 6, the wage differential has a coefficient of 2.455 and is statistically significant. This is an indication that it is an important variable.

i. Compare Table 6 and Table 7. How can the reduced form estimates be interpreted?

The reduced form estimates can be interpreted as the effect of variables on joining a union (Table 7) or not joining a union (Table 6). The sign and significance level can be interpreted but not the magnitude since these are not marginal effects.

Problem 5.2: Application: Female labor supply using Altonji-Elder-Taber Bounds

Let's revisit the Panel Study of Income Dynamics from the 1987 study by Thomas Mroz:

T.A. Mroz (1987): "The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumption", Econometrica, 55:765-799.

The data set, mroz.dta, is available on OLAT. In the following, we want to assess the selection into the labot force inlf and motherhood kidslt6 (generate a dummy variable capturing if a women has more than one child below the age of 6).

a. Run two separate probit regression of inlf (and kidslt6) on nwifeinc educ exper expersq age.

Parameter estimates can be found in Table 1.

b. Use the biprobit command to estimate the probit regressions jointly. What is the advantage of estimating the models jointly?

An individual's decision to participate in the labor force and her decision to have more than one child may not be independent. A bivariate probit allows us to account for this interdependence. In particular, as can be seen in Table 2, we find $\rho = -0.50$ and this is significant at the 1% level based on the likelihood ratio test. This indicates that using a bivariate probit is better than using two seperate probit regressions as the former accounts for the negative correlation between the error terms of the two equations.

c. Now suppose that selection into the labor force depends on the selection into motherhood. Where should you include kidslt6 in your bivariate probit model? What assumptions are you making? What is the estimated correlation ρ between the error terms? Interpret.

Table 1: Paramater estimates from probit Question 2a

	(1) inlf b/se	(2) kidslt6_dum *b/se*
main		
nwifeinc	-0.011**	0.006
	0.005	0.006
educ	0.105***	0.027
	0.024	0.030
exper	0.125***	−0.056**
	0.018	0.029
expersq	-0.002***	0.001
	0.001	0.001
age	-0.029***	−0.106***
	0.007	0.011
_cons	-0.619	3.252***
	0.417	0.567
N	753	753

Table 2: Paramater estimates from biprobit question 2b

	(1) inlf		
	inlf b/se	*kidslt6_dum* *b/se*	*athrho* *b/se*
nwifeinc	-0.012**	0.004	
	(0.005)	(0.005)	
educ	0.108***	0.029	
	(0.024)	(0.029)	
exper	0.127***	−0.057**	
	(0.018)	(0.027)	
expersq	-0.002***	0.001	
	(0.001)	(0.001)	
age	-0.029***	−0.101***	
	(0.007)	(0.010)	
_cons	-0.633	3.074***	−0.559***
	(0.417)	(0.557)	(0.087)
N	753		

If selection in the labor force depends on the selection into motherhood, the variable kidslt6$_{d}umcanbeinclude$
Parameter estimates can be found in Table 3. We find $rho = 0.297$ which is not significant based on the likelihood ratio test. This implies that while the selection into motherhood and selection into labor force are correlated, the actualy decision into motherhood is exogenous and a good predictor of the decision into labor force participation. This is evidence by as significant coefficient on kidslt6$_{d}um$.

Table 3: Paramater estimates from biprobit question 2c

		(1)	
		inlf	
	inlf	*kidslt6_dum*	*athrho*
	b/se	*b/se*	*b/se*
kidslt6_dum	-1.491***		
	(0.442)		
nwifeinc	-0.011**	0.006	
	(0.005)	(0.006)	
educ	0.123***	0.027	
	(0.025)	(0.030)	
exper	0.107***	-0.055^{*}	
	(0.022)	(0.029)	
expersq	-0.001**	0.001	
	(0.001)	(0.001)	
age	-0.063***	-0.107^{***}	
	(0.011)	(0.011)	
_cons	1.019	3.265***	0.307
	(0.669)	(0.564)	(0.309)
N	753		

In the paper:
Joseph G. Altonji, Todd E. Elder, and Christopher R. Taber (2008): "Using Selection on Observed Variables to Assess Bias from Unobservables When Evaluating Swan-Ganz Catheterization", American Economic Review P&P, 98(2): 345-350. the authors develop a new approach to bound a treatment effect accounting for selection on unobservables.

d. Based on their reasoning, explain briefy how to assess the selection on unobservables.

The selection on unobservables can be assessed by estimating the bivariate probit for different levels of ρ and checking the when the coefficients looses it effect.

e. Find the value of ρ that eliminates the effect of more than one child on labor force participation. Hint: Use the constraint command if you use Stata.

We use the constraint option to set the coefficient of kidslt6 to 0 and the resulting value of ρ is -0.507.

f. In light of this article, is this value plausible? To answer this question, relate selection on unobservables to selection on observables.

The effect of motherhood on labor force participation is negative. If we exclude this variable, it is likely that the error term of the labor force participation equation is negatively correlated with the error term of motherhood equation. Essentially the unobserved factors that lead individuals into motherhood are different from the unobserved factors that lead individuals to work.

g. Using your estimate from f., compute the lower bound effect of having more than one child on labor force participation.

Lets set $\rho = \frac{cov(X'\beta, X'\gamma)}{var(X'\gamma)}$. We obtain $\rho = 0.519$ and the lower bound of kidslt6$_dumas$ -1.7474.