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A NESTED LOGIT MIGRATION MODEL WITH SELECTIVITY*

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1. INTRODUCTION

In this paper we specify a multiple choice migration model with selectivity. We estimate this model using observations on individuals drawn from the 1971 census of Venezuela. There are two main innovations in this paper: we apply a correction for the presence of selectivity in wage equations in the context of a multiple choice migration model; and we apply a less restrictive technique for modelling multiple discrete choices than in previous studies.

We study the choices of individuals among 23 states of Venezuela. Each individual is observed to have chosen one state, so one wage is observable per person. Our hypothesis is that individuals choose where to locate on the basis of an evaluation of costs and benefits associated with choosing each state. We measure the benefits associated with choosing a given state by means of the wage a person could earn in this state. Since we observe only one wage for each person, we have to impute the unobserved wages for the states this person did not choose in order to study the role of wages in migration. However, it is possible that unobserved factors which affect both an individual's choice of location and his wages may result in sample selection bias if we try to estimate state-specific wage equations by OLS on the basis of the self-selected samples. We apply an estimator proposed by Lee [1983] to estimate state-specific wage equations free from sample selection bias.

The wage equations permit us to investigate whether individuals who choose particular states earn different wages from observationally identical individuals drawn from the population at random. In the context of a developing country where internal migration flows are large, evidence on the selectivity of migration will enhance our understanding of an important labor market adjustment mechanism. Evidence that people who choose particular locations earn more in those locations than would observationally identical individuals drawn at random from the population (positive selection) will suggest that migration decisions are made according to the principle of comparative advantage.

In modelling the choice of location, we test whether subsets of states are more highly similar to each other than to other states. Unobserved similarities between states may arise because of similar amenities or economic conditions which are not otherwise explicitly controlled for in the model. We implement the

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nested logit model proposed by McFadden [1981] in conjunction with Lee's estimator to test for unobserved similarities.

Several previous studies model migration and control for sample selection bias in wage equations (Nakosteen and Zimmer [1980], Robinson and Tomes [1982], Tunali [1983]). These previous studies do not examine the choice among many specific locations. In contrast, the present study examines the choices of individuals among 23 Venezuelan states. Our main results are that there is evidence of positive selection in some state wage equations of Venezuela, that wages significantly influence migration, and that subsets of states have unobserved similarities compared to other states.

2. MODEL SPECIFICATION

We apply Lee's [1983] generalized polychotomous choice model with selectivity in conjunction with the nested logit model proposed by McFadden [1981]. Lee presents a conditional logit-OLS example of his method. His model can be estimated consistently in two steps. Trost and Lee [1984] apply the conditional logit-OLS estimator to study training and earnings. In the present application, it is likely that there will be unobserved similarities among subsets of states so that a straightforward generalization of Lee's approach for use with the less restrictive nested logit model is appropriate.

We assume that individuals have a stochastic utility function which we will write in reduced form:

$$U_{ijk} = x_{ijk}\gamma_{jk}\beta_{jk} + y_{ijk}\delta_{jk} + z_i\zeta_k + u_{ijk} \tag{1}$$

where i indexes individuals, j indexes states within a region, and k indexes composites of states (regions). Thus, each state is uniquely identified by a double index jk.

The last term in (1) is stochastic and it is assumed to have the generalized extreme value distribution (GEV). x, y, and z are vectors of characteristics of states, regions, and individuals. At each state each individual faces a wage equations:

$$w_{ijk} = x_{ijk}\gamma_{jk} + v_{ijk} \tag{2}$$

This is a censored regression in that for a given individual we observe w_{ijk} only if this person chooses state jk. The number of wage equations is equal to the number of states. The criterion for choosing state ls (for a given individual) is $U_{ls} > \max U_{jk}$, all $jk \neq ls$. Note that U_{ijk} is utility net of costs associated with choosing state jk.

We will omit the individual index, henceforth, to simplify the notation. We will assume that the marginal distributions of v_{jk} are normal $N(0, \sigma^2)$ and we will allow u_{jk} and v_{jk} to be correlated for a given state. We assume that they are uncorrelated across people and are also uncorrelated with the remaining right-hand-side variables in (1) and (2). Let P_{jk} denote the probability of choosing state j in region k. We know that $P_{jk}=P_{j/k}\cdot P_k$. Assuming additive separability of non-stochastic utility and that u_{jk} has the GEV distribution, McFadden derived the nested logit model:

$$(3)\qquad P_{j/k} = \frac{e^{\left(\frac{x_{jk}\gamma_{jk}\beta_{jk}+y_{jk}\delta_{jk}}{1-\psi}\right)}}{\sum_{m=1}^{J_k} e^{\left(\frac{x_{mk}\gamma_{mk}\beta_{mk}+y_{mk}\delta_{mk}}{1-\psi}\right)}}$$

$$(4)\qquad P_k = \frac{e^{z\zeta_k+\theta I_k}}{\sum_{n=1}^{K} e^{z\zeta_n+\theta I_n}}$$

where $I_k=\log \sum_{l=1}^{L_k} e^{\left(\frac{x_{lk}\gamma_{lk}\beta_{lk}+y_{lk}\delta_{lk}}{1-\psi}\right)}$ is called an inclusive value. $\theta=1-\psi$ is a parameter and ψ is an index of the similarity of the unobserved attributes of states in a given region. If $\psi=0$, the model is identical to conditional logit (the stochastic terms of the utility function are independent across states) while as $\psi\to 1$, we get a corner solution and choice takes place solely on the basis of non-stochastic utility. If $\psi\to 1$ and the non-stochastic utilities associated with two alternatives are equal, then these two alternatives are perfect substitutes in the eyes of decision-makers.

Having specified the marginal distributions of (1) and (2) as above, Lee shows that we can write the conditional mean of (2) as (again, omitting the individual index):

$$(5)\qquad w_{jk} = x_{jk}\gamma_{jk} + \sigma_{jk}\rho_{jk}\left(\frac{-\phi(J(P_{jk}))}{P_{jk}}\right)$$

where $J(P_{jk})=\Phi^{-1}(P_{jk})$ involves the inverse of the standard normal distribution. ϕ is the standard normal pdf.

The model to be estimated consists of (3), (4) and a stochastic version of (5). We estimate (3) by maximum likelihood using conditional data. We, then, form inclusive values to aggregate characteristics of states which belong to each region. We use the inclusive values to estimate (4), also by maximum likelihood. We use these estimates to calculate choice probabilities which we use to form the sample selection correction variables $\frac{-\phi(J(P_{jk}))}{P_{jk}}$ for each observation and estimate the stochastic version of (5) by OLS. This last step gives us consistent estimates of γ_{jk} and of $\sigma_{jk}\rho_{jk}$. Estimates of the last set of parameters which are different from zero will be evidence of sample selection in the wage equation of the relevant state.

Once we have obtained consistent estimates of the parameters of the wage equations, we can use them to calculate predicted (unconditional) wages for each individual for each state. We then replace $x_{jk}\gamma_{jk}$ in (1) by $x_{jk}\hat{\gamma}_{jk}$ (the predicted wages) and we estimate the structural version of (3) and (4) to obtain the estimates of the structural form of (1). From the structural equations we obtain estimates of β_{jk}. The structural equations permit us to study the role of wages as determinants of migration. So the estimation of the nested logit migration model with selectivity proceeds in five steps which results in some loss of efficiency. The computation of the estimates, however, is relatively simple.

We now, discuss the specific form of the model whose estimates are reported below. We assume that the natural logarithm of real wages depends on schooling, experience, and experience squared. We estimate the model with data on men and treat experience (defined as age-schooling-5) as exogenous. Non-stochastic utility (the structural form of (1)) depends on the logarithm of real wages, distance from an individual's origin, and a constant specific to the individual's origin state.[2,3] So the reduced form of stochastic utility depends on distance, the origin constant, schooling, experience, and experience squared.

Our measures of the characteristics of states as they relate to each individual are not extensive so it is likely that the unobserved attributes of some states may be correlated. In other words there may be unobserved similarities between some states. By specifying the discrete choice model to be nested logit, we can test whether such unobserved similarities are present. If we had specified the discrete choice model to be conditional logit (as in Lee's example or in Trost and Lee) we would be gaining some computational simplification but conditional logit imposes independence of the unobserved attributes of states which may be unrealistic and result in specification error. To see how this may come about let us consider the relative probability of choosing two specified states for a given individual. The conditional logit model implies that this relative probability is independent of the existence of a third state. Therefore, if this third state which was initially available now becomes unavailable, an implication of the conditional logit model is that its choice probability will be allocated among the two specified states in a way that their relative choice probability will remain unchanged. This, however, will be unrealistic if this third state is a close substitute for one of the two other states: we expect that most of the probability of choosing the now-unavailable state will be allocated to its close substitute.

The form of the nested logit model which we have estimated reflects the choice pattern depicted by the utility tree in Figure 1. We assume that individuals choose first one of the seven level 1 alternatives (regions). Then, conditional on region, they choose one of the states which constitute this region (level 2). The regions and their component states are listed in Table 1. A map of the country appears in Figure 2.

We test the hypothesis that the states below each of the level 1 nodes of the

[2] People were asked to report their previous state of residence and their duration of residence at the current state. This is the same as the state of current residence for those who did not move over the past four years and another specified state for those who did move sometime during the past four years. The previous state of residence is the origin state referred to above.

[3] More variables measuring state characteristics could be included in the non-stochastic utility function but doing so would increase the computation cost. Still, the migration model whose estimates are reported below has a very good fit.

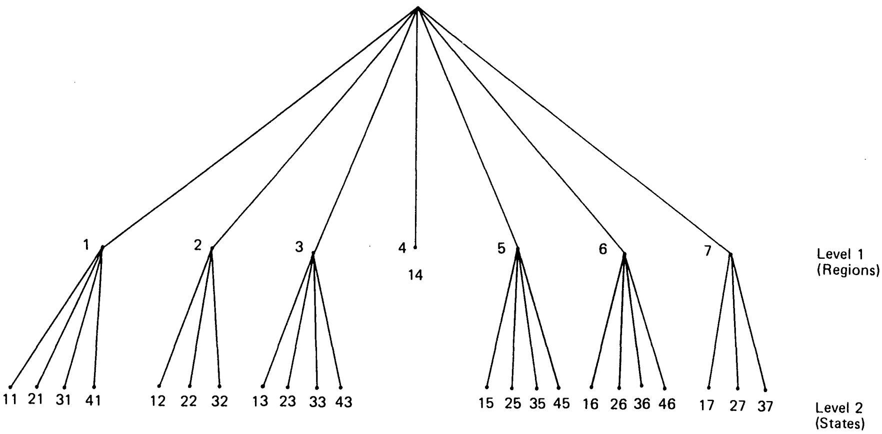

FIGURE 1

TABLE 1
REGIONS AND STATES OF VENEZUELA

Region	Components (States)
1. Capital	Federal District (11), Aragua (21), Carabobo (31), Miranda (41)
2. Central Highlands	Apure (12), Cojedes (22), Guarico (32)
3. West Central	Falcon (13), Lara (23), Portuguesa (33), Yaracuy (43)
4. Zulia	Zulia (14)
5. Andean	Barinas (15), Merida (25), Tachira (35), Trujillo (45)
6. Eastern	Anzoategui (16), Monagas (26), Nueva Esparta (36), Sucre (46)
7. Southern	Bolivar (17), Federal Territory Amazonas (27), Federal Territory Delta Amacuro (37)

utility tree have unobserved similarities which are not otherwise controlled for in the model. This is accomplished by estimating the similarity parameter ψ. As noted above, the finding that the estimate of the similarity parameter is zero implies that the discrete choice model is equivalent to conditional logit. McFadden [1981] has shown that a necessary and sufficient condition for the nested logit model to be consistent with stochastic utility maximization is that $0 \leq \psi < 1$.

The utility tree depicted in Figure 1 follows closely the official grouping of

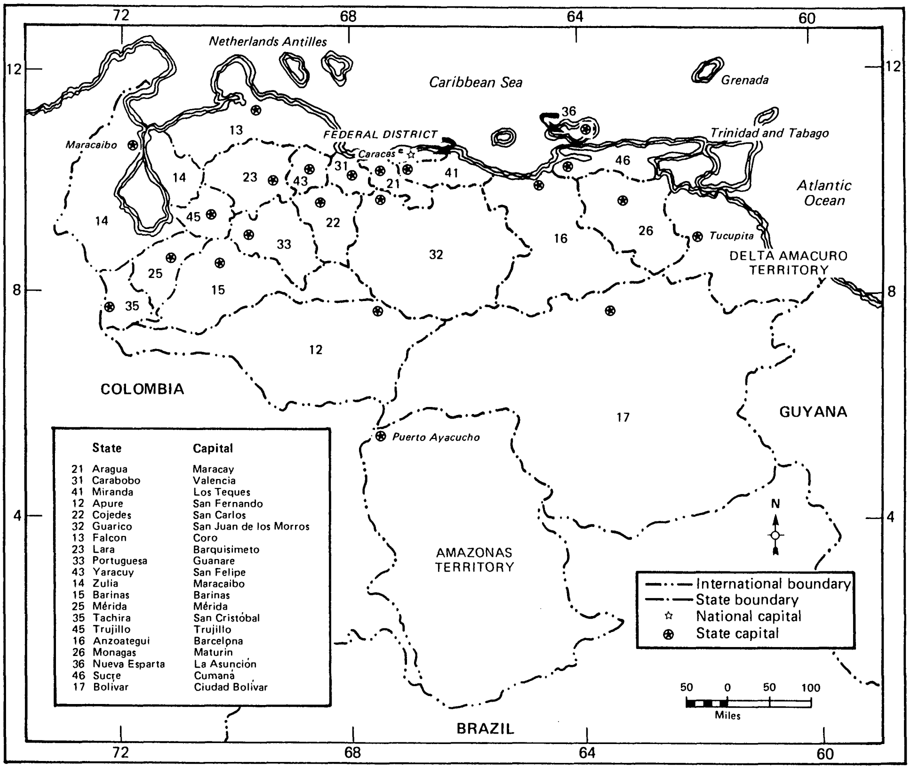

FIGURE 2

* BASED ON BLUTSTEIN ET AL. [1977, p. XIV].

Venezuelan states into regions.[4] This official grouping of states is based in large part on similarities in the economic structures of subsets of states. For example the capital city of Caracas, in and around which a large proportion of the manufacturing and government sectors are concentrated, spills over from the Federal District into three neighboring states. The region of Zulia which consists of one state only contains both a major urban area and most of Venezuela's oilfields. The remaining regions consist of states which have other similarities in their agriculture, mining, and other sectors of their economies. So the official grouping of Venezuelan states into regions provides us with an a priori plausible structure of a utility tree. We test the presence of unobserved similarities between

[4] Venezuela, Direccion de Cartografia Nacional [1979, p. 127]. The utility tree in Figure 1 departs from the official classification of states into regions in two instances: a sparsely populated state (Amazonas) and a small island (Nueva Esparta) are incorporated into their neighboring regions in Figure 1 rather than being treated as separate regions because there are too few observations on individuals choosing these two states for the reliable estimation of a nine region model.

states in each region by estimating the nested logit model which corresponds to the utility tree in Figure 1.

3. DATA

We estimated the nested logit migration model with selectivity using a subset of the 1971 Venezuelan census. We use data on men who reported positive wages and whose previous location was one of the 24 states of Venezuela. For one state (Federal Dependencies), which consists of a group of small islands in the Caribbean, there were only two men who reported positive wages so it was not feasible to include this state in the estimation of the model. To reduce computation cost, we selected a random sample of 10,898 men from all those reporting positive wages and a previous location in Venezuela; we used this sample to estimate the model.

The labor force participation rate of women in Venezuela in 1971 was relatively low (22.8%). We therefore, would have to model the labor force participation decision of women to study their migration decisions.[5] We examined only the migration of men in order to avoid this complication.

The internal migration rate in Venezuela is fairly high. About 10 percent of all people lived in a different state in 1971 from their previous state over a four year period. So the phenomenon to be studied is easily observable. The country is fairly large and heterogeneous which is advantageous for the study of migration.

The wage data are not ideal: these are reported for each individual in seven intervals of monthly wages. The midpoints of the intervals and the minimum of the open-ended interval[6] are used as measures of wages of individuals.[7] It is not feasible to convert the monthly wages into hourly wages. The wage data were deflated by a regional price index. The price index is based on a specified commodity bundle (food and drink only) and is available for 1970.[8]

4. ESTIMATES

In order to estimate the reduced form of the migration model, (3) and (4), we need to address an identification problem. The coefficients of variables that do not differ across alternatives (locations) for a given person are not identified. To achieve identification of such coefficients, we restrict the coefficients of such

[5] In contrast, the labor force participation rate for men (15 years of age or older) was 80.1%.

[6] It is unfeasible to use Pareto's extrapolation procedure to estimate mean wages for the open-ended interval since the frequency of the open-ended interval exceeds the frequency of the preceding interval.

[7] The frequencies of all men reporting positive wages are:

Nominal Wage:	125	375	625	875	1250	1750	2000 (Bs. per month)
%	22.06	23.10	19.23	11.41	10.68	4.50	9.02

The 1971 exchange rate was 4.50 Bolivares per U.S. dollar.

[8] Source: Banco Central de Venezuela [1971, Table 41].

variables in the reduced form to be zero for the state for which the fewest observations are available (within each region). These variables (schooling, experience, and experience squared) also appear in the wage equations. To preserve symmetry we restrict the coefficients of these variables to be zero for six wage equations. So we estimate 17 wage equations. The identifying restrictions amount to assuming that the structural nonstochastic utilities of six states do not depend on wages. These identifying restrictions are imposed on one state in each region. These six states are Aragua (Capital region), Cojedes (Central Highlands), Yaracuy (West-Central region), Barinas (Andean region), Nueva Esparta (Eastern region), and Federal Territory Amazonas (Southern region).

We first estimated the reduced form of the nested logit migration model. These estimates are reported in Tables 2 and 3 and were obtained in two stages. It should be noted that one region (Zulia) consists of only one state. The reduced form parameters which are specific to this state are obtained from (4). The

TABLE 2

MAXIMUM LIKELIHOOD ESTIMATES OF THE NESTED LOGIT MIGRATION MODEL, ESTIMATES OF THE REDUCED FORM OF THE MODEL, CHOICE AMONG STATES CONDITIONAL ON REGION

Variable	1. Capital	2. Central Highlands	3. West Central	5. Andean	6. Eastern	7. Southern
Origin	3.169	4.351	4.224	3.189[a]	4.039	3.250
(t-statistic)	(36.890)	(6.946)	(11.180)	(8.594)	(11.590)	(2.809)
Distance	−0.0079	−0.0032	−0.0063	−0.0176	−0.0061	−0.0101
	(8.821)	(1.434)	(2.986)	(10.590)	(2.342)	(2.359)
Experience	0.0112	0.0596	0.0348	0.0041	0.0307	0.2295
	(0.994)	(1.805)	(1.176)	(0.143)	(0.910)	(1.147)
Experience^2	−0.0002	−0.0010	−0.0005	0.0001	−0.0004	−0.0035
	(0.785)	(1.690)	(0.792)	(0.184)	(0.537)	(0.970)
Schooling	0.0560	0.0538	0.0531	0.1279	0.1362	0.3635
	(2.970)	(0.612)	(0.890)	(2.038)	(1.800)	(1.168)
Constant 13*			−0.6405			
			(2.453)			
Constant 25*				−0.7150		
				(2.247)		
Constant 45*				−1.367		
				(3.914)		
Log-Likelihood	−1879.0	−60.28	−206.2	−209.1	−205.0	−36.85
Likelihood Ratio Index	0.7171	0.9031	0.8958	0.8845	0.8832	0.9086
Likelihood Ratio Statistic	9525.0	1123.0	3547.0	3203.0	3100.0	732.7
Number of Individuals	4791	566	1428	1306	1266	367
Number of Alternatives	4	3	4	4	4	3

* Constant specific to the state indicated.

[a] Parameter specific to states 15, 25, 45; zero for state 35.

variable "distance" is the distance of a state from an individual's origin state. Distance is a measure of the direct and opportunity cost of moving. It is calculated (in km.) as the distance between the centroids of the two states and takes the value zero for the origin state. The variable "origin" takes the value one if a state is the individual's origin and zero otherwise. The specific form of the model was arrived at on the basis of likelihood ratio tests.

The t-statistics reported in Table 3 are corrected to take account of the fact that the inclusive values (I_k) are estimated. We have calculated the correct standard errors derived by Amemiya [1978]. In the calculations of the estimates in Table 3, the available data (observations on 10,898 individuals) exceeded the computer's capacity. To overcome this constraint without modifying the software or discarding data, we implemented Duncan's [1980] method which consists of dividing the data into subsets (two in this case), estimating the model with each

TABLE 3

MAXIMUM LIKELIHOOD ESTIMATES OF THE NESTED LOGIT MIGRATION MODEL, ESTIMATES OF THE REDUCED FORM OF THE MODEL, CHOICE AMONG SEVEN REGIONS*

Variable	
Regional Inclusive Value**	0.887
(t-statistic)	(28.712)
Constant 2	−1.962
	(7.214)
Constant 5	1.335
	(5.865)
Constant 7	−2.573
	(5.429)
Origin[Δ]	2.155
	(6.123)
Distance[Δ]	−0.007
	(7.800)
Experience[Δ]	0.062
	(2.930)
Experience[2Δ]	−0.0009
	(2.486)
Schooling	0.047
	(1.647)
Log-Likelihood	−4142.0
Likelihood Ratio Index	0.805
Likelihood Ratio Statistic	34136.0
Number of Individuals	10,898
Number of Alternatives	7

* Six composite regions and region 4 (Zulia).

Δ Parameters specific to region 4.

** Parameter specific to the six composite regions (1–3, 5–7).

subset of the data, and averaging the various sets of estimates.

The parameter estimates of the reduced form are used to obtain state choice probabilities for each individual. These probabilities are obtained by multiplying the predicted probabilities of choosing a state conditional on region (from (3)) with the predicted probability of choosing a region (from (4)). The predicted (joint) probabilities P_{jk} are used to construct the sample selection correction variables.

The next step was to estimate the seventeen wage equations by OLS. We use information on people who chose the respective states and the constructed sample selection correction variables. These estimates are reported in Table 4. The

TABLE 4

WAGE EQUATIONS

DEPENDENT VARIABLE: NATURAL LOGARITHM

State	11	31	41	12	32
Constant	5.186	4.902	5.046	4.157	4.669
(t-statistic)	(98.842)	(46.574)	(59.392)	(14.639)	(27.975)
Schooling	0.097	0.114	0.107	0.170	0.127
	(25.991)	(14.627)	(21.050)	(7.229)	(8.929)
Experience	0.066	0.062	0.067	0.080	0.051
	(20.437)	(9.578)	(13.174)	(4.543)	(5.463)
Experience^2	−0.0009	−0.0008	−0.0009	−0.0011	−0.0006
	(15.653)	(7.833)	(11.309)	(4.230)	(4.623)
Selection Correction $\left(-\frac{\phi}{P}\right)$	0.025	−0.016	−0.078	−0.236	−0.170
	(1.837)	(0.614)	(3.272)	(2.652)	(2.028)
R^2	0.291	0.274	0.377	0.329	0.241
F	250.48	68.93	146.19	17.39	24.91
N	2446	735	973	147	319

TABLE 4.
(continued)

State	14	25	35	45	16
Constant	4.691	4.656	4.353	4.528	4.342
(t-statistic)	(49.528)	(27.511)	(23.373)	(24.196)	(30.102)
Schooling	0.132	0.143	0.163	0.144	0.154
	(21.237)	(11.397)	(11.752)	(9.338)	(13.897)
Experience	0.060	0.036	0.053	0.054	0.070
	(10.219)	(3.802)	(4.849)	(4.942)	(7.869)
Experience^2	−0.0007	−0.0004	−0.0006	−0.0007	−0.0009
	(7.872)	(3.183)	(3.962)	(4.451)	(6.412)
Selection Correction $\left(-\frac{\phi}{P}\right)$	−0.093	−0.054	−0.030	0.090	−0.109
	(2.408)	(1.083)	(1.043)	(1.643)	(1.952)
R^2	0.294	0.284	0.276	0.242	0.331
F	121.86	36.52	36.25	23.71	59.40
N	1174	374	387	302	486

means of the selection correction variables for each state are reported in the appendix. The coefficients of the selection correction variables are significant in six of the seventeen wage equations. The t-statistics reported in Table 4 are corrected to take into account the fact that the selection correction variables are estimated. We implement with appropriate modifications the expression for the correct standard errors derived by Lee [1981]. The coefficients are negative as are the means of the selection correction variables. This is evidence of positive selection in the six wage equations. This result is comparable to the result of Willis and Rosen [1979] on education (binary choice) and earnings.

As an example let us consider the wage equation for Zulia (state 14) where the

BY STATE
OF REAL MONTHLY WAGES

13	23	33
4.454 (26.264)	4.406 (36.789)	5.198 (22.866)
0.156 (10.908)	0.156 (17.248)	0.113 (7.266)
0.062 (6.451)	0.056 (7.416)	0.037 (2.648)
−0.0007 (5.414)	−0.0006 (5.506)	−0.0005 (2.529)
−0.185 (2.045)	−0.178 (3.129)	−0.069 (1.160)
0.299	0.360	0.193
34.83	88.42	14.43
332	635	247

TABLE 4.
(continued)

26	46	17	37
4.558 (20.167)	4.633 (27.466)	4.628 (24.420)	3.991 (8.859)
0.161 (10.552)	0.128 (9.955)	0.165 (11.942)	0.195 (5.466)
0.044 (3.205)	0.048 (5.008)	0.055 (5.238)	0.092 (3.687)
−0.0005 (2.584)	−0.0006 (4.421)	−0.0007 (4.623)	−0.0012 (3.545)
0.024 (0.311)	−0.152 (1.640)	−0.047 (1.146)	−0.075 (0.554)
0.305	0.218	0.360	0.452
28.17	27.74	41.81	8.88
262	403	302	48

oilfields are located and which has experienced heavy in-migration from other states. The estimate of the selection correction parameter implies that people who chose to go to Zulia earn on average higher wages in Zulia than would observationally identical people drawn at random from the population (the conditional mean predicted real wage exceeds the unconditional mean predicted real wage). Similar evidence of positive selection is found for states 41, 12, 32, 13, and 23. As noted above this is evidence that is consistent with the hypothesis that migration choices take place according to the principle of comparative advantage.

We used the wage equations to obtain predicted unconditional real wages for each person and for each of the seventeen states. We, then, estimated the structural form of the nested logit migration model by maximum likelihood and in two stages. The estimates are reported in Tables 5 and 6. The *t*-statistics reported in Tables 5 and 6 are corrected in light of the fact that wages and inclusive values are estimated variables. We follow the principles of Amemiya [1978], Lee, Maddala, and Trost [1980], and McFadden [1981]. In addition, estimates of the regional choice model in Table 6 are calculated using Duncan's [1980] method — in a similar fashion as the estimates in Table 3.

The main results of the structural estimates are that wages and distance are

TABLE 5

MAXIMUM LIKELIHOOD ESTIMATES OF THE NESTED LOGIT MIGRATION MODEL, ESTIMATES OF THE STRUCTURAL MODEL, CHOICE AMONG STATES CONDITIONAL ON REGION

Variable	1. Capital	2. Central Highlands	3. West Central	5. Andean	6. Eastern	7. Southern
Origin	3.167	4.278	4.247	3.264	4.009	3.071
(*t*-statistic)	(36.990)	(6.862)	(11.380)	(8.985)	(11.544)	(2.541)
Distance	−0.008	−0.003	−0.006	−0.017	−0.006	−0.011
	(8.860)	(1.526)	(2.995)	(10.806)	(2.361)	(2.301)
Wage	0.070	0.155	0.125	0.167	0.178	0.873
	(5.899)	(2.404)	(3.032)	(2.886)	(3.657)	(2.517)
Constant 13			−0.669			
			(2.544)			
Constant 25				−0.928		
				(3.098)		
Constant 45				−1.617		
				(4.657)		
Log-Likelihood	−1880.0	−60.45	−205.8	−208.4	−205.2	−36.36
Likelihood Ratio Index	0.717	0.903	0.896	0.885	0.883	0.910
Likelihood Ratio Statistic	9524.0	1123.0	3548.0	3204.0	3100.0	733.7
Number of Individuals	4791	566	1428	1306	1266	367
Number of Alternatives	4	3	4	4	4	3

TABLE 6

MAXIMUM LIKELIHOOD ESTIMATES OF THE NESTED LOGIT MIGRATION MODEL, ESTIMATES OF THE STRUCTURAL FORM OF THE MODEL, CHOICE AMONG SEVEN REGIONS

Variable	
Regional Inclusive Value**	0.882
(t-statistic)	(29.870)
Constant 2	−1.899
	(6.889)
Constant 5	1.198
	(5.477)
Constant 7	−2.813
	(7.716)
Origin[Δ]	2.169
	(4.176)
Distance[Δ]	−0.007
	(5.398)
Wage[Δ]	0.177
	(2.158)
Log-Likelihood	−4062.0
Likelihood Ratio Index	0.808
Likelihood Ratio Statistic	34296.0
Number of Individuals	10,898
Number of Alternatives	7

[Δ] Parameters specific to region 4.
** Parameter specific to the six composite regions (1–3, 5–7).

important determinants of migration(with positive and negative coefficients, respectively, as expected). If a state is the individual's origin, this increases the relative probability of choosing it over another state. This, very likely, reflects fixed costs of moving which may include the loss of returns to specific human capital. The differences in the coefficient estimates for the origin variable across regions may reflect regional differences in such costs. The differences in the coefficient estimates for wages and distance across regions are likely to arise from non-linearities in the effects of these variables. The notable result in Table 6 is the estimate of θ which is 0.88. This parameter is significantly different from one.[9] The implied estimate of the similarity index ψ is 0.12 which is evidence that the states below each of the level 1 nodes of the utility tree have unobserved similarities. This finding implies that the relative probabilities of choice of two states which are under different level 1 nodes of the utility tree depend on characteristics of the other states under these same level 1 nodes. This is evidence that the nested logit model is a more realistic way of modelling migration than the simpler

[9] H_0: $\theta=1$, $\chi^2(1)=116.0$ (the critical value is 3.84).

conditional logit model. Our estimate of ψ is in the unit interval as required for consistency of the nested logit model with stochastic utility maximization.

One of the issues not addressed in this paper is the effect of past migration decisions of individuals on their current migration decisions. Addressing this issue is not feasible with the Venezuelan census data because only one cross section of wage information is available and only each individual's place of birth is known in addition to his last previous place of residence.

5. CONCLUSION

We have found evidence of selectivity in some state wage equations of Venezuela. The evidence suggests that there is positive selection. We have found that wages influence migration within Venezuela. A similar result was found for this country by studies which used 1961 data [Schultz, 1982]. We have also found that some states of Venezuela have unobserved similarities such that they are neither perfectly distinct nor perfect substitutes in the eyes of individuals. The techniques applied in the paper allow a less restrictive modelling of migration than in previous studies.

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APPENDIX

MEANS AND STANDARD DEVIATIONS OF THE SELECTION CORRECTION VARIABLES

State	Mean	Standard Deviation
11	−0.617	0.894
31	−0.736	0.954
41	−0.720	0.901
12	−0.398	0.676
32	−0.560	0.477
13	−0.189	0.444
23	−0.204	0.506
33	−0.417	0.836
14	−0.244	0.548
25	−0.303	0.779
35	−0.345	0.371
45	−0.450	0.796
16	−0.248	0.624
26	−0.236	0.621
46	−0.155	0.409
17	−0.492	1.012
37	−0.379	0.783

REFERENCES

AMEMIYA, T., "On a Two-Step Estimation of a Multivariate Logit Model," *Journal of Econometrics*, 8 (January, 1978), 13–21.

Banco Central de Venezuela, *Estudio Sobre Presupuestos Familiares e Indices de Costo de Vida Area Metropolitana de Maracaibo* (Caracas: Banco Central de Venezuela, 1972).

BLUTSTEIN, H. I., ET AL., *Area Handbook of Venezuela* (Washington, D.C.: U.S. Government Printing Office, 1977).

DUNCAN, G. M., "Approximate Maximum Likelihood Estimation with Data Sets That Exceed Computer Limits," *Journal of Econometrics*, 14 (October, 1980), 257–264.

LEE, L.-F., "Generalized Econometric Models with Selectivity," Center for Economic Research Discussion Paper 81–140 University of Minnesota, (February, 1981).

LEE, L.-F., "Generalized Econometric Models with Selectivity," *Econometrica*, 51 (March, 1983), 507–512.

LEE, L.-F., G. S. MADDALA AND R. P. TROST, "Asymptotic Covariance Martices of Two-Stage Probit and Two-Stage Tobit Methods for Simultaneous Equations Models with Selectivity," *Econometrica, 48 (March, 1980), 491–503.*

MCFADDEN, D., "Econometric Models of Probabilistic Choice," in, C. F. Manski and D. MCFADDEN, eds., *Structural Analysis of Discrete Data with Econometric Applications* (Cambridge: MIT Press, 1981), 198–272.

NAKOSTEEN, R. A. AND M. ZIMMER, "Migration and Income: The Question of Self-Selection," *Southern Economic Journal*, 46 (January, 1980), 840–851.

ROBINSON, C. AND N. TOMES, "Self-Selection and Interprovincial Migration in Canada," *Canadian Journal of Economics*, 15 (August, 1982), 474–502.

SCHULTZ, T. P., "Lifetime Migration within Educational Strata in Venezuela: Estimates of a Logistic Model," *Economic Development and Cultural Change*, 30 (April, 1982), 559–593.

TROST, R. P. AND L.-F. LEE, "Technical Training and Earnings: A Polychotomous Choice Model with Selectivity," *Review of Economics and Statistics*, 66 (February 1984), 151–156.

TUNALI, I., "A Common Structure for Models of Double Selection," University of Wisconsin-Madison, Social Systems Research Institute Discussion Paper, 8304 (March, 1983).

Venezuela, Direccion de Cartografia Nacional, *Atlas de Venezuela* (Caracas: Direccion de Cartografia Nacional, 1979).

WILLIS, R. J. AND S. ROSEN, "Education and Self-Selection," *Journal of Political Economy*, 87 (October, 1979), S7–S36.