Comment

A Mixed Logit Model of the Relationship between Unionization and Right-to-Work Legislation

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I. Introduction

In a recent paper in this *Journal,* Lumsden and Petersen (1975) presented a model of the supply and demand for union services in which the presence of a right-to-work law (RTW), which imposes costs on union organizing, adversely affects the equilibrium quantity of union membership. In order to disentangle the effects of community tastes and preferences (as reflected in the passage or nonpassage of a RTW law) and the law itself on the extent of union membership, Lumsden and Petersen estimated separate cross-section regressions for time periods before and after the adoption of the law by 13 states. Direct impact of RTW laws on unionization required significantly different coefficients on the RTW variables across the two time periods—a result which they rejected.

The relationship between the extent of unionization and the presence or absence of RTW legislation has been the subject of several previous statistical inquiries. For example, Palomba and Palomba (1971) used one-way analysis of variance to investigate the influence

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of union membership and the debtor-creditor status of a state (a proxy for stage of economic development) on the passage of RTW laws. Tollefson and Pichler (1974) employed a linear probability model and discriminant analysis to explore further the determinants of the enactment of RTW legislation. Moore, Newman, and Thomas (1974) used multiple discriminant analysis to expand the scope of earlier studies and to investigate the role of factors other than unionization and stage of economic development in explaining the existence of RTW legislation. All of these studies were very much in the spirit of the argument advanced by Stigler (1973) that the passage of legislation is not an exogenous event.

Inspection of the literature cited above suggests that plausible theories can be constructed in which the extent of unionization affects the presence or absence of a RTW law; conversely, the existence or nonexistence of such a law influences the degree of unionization. Nevertheless, previous research on this topic has focused on one or the other of the two specifications of the observed relationship, while neglecting the possibility of simultaneous determination. The purpose of this paper, then, is to specify and estimate (with an appropriate procedure) a model of the relationship between unionization and RTW legislation which can accommodate the joint determination of these two variables.

The plan of the paper is as follows: Section II briefly describes the estimation technique and our specification of the unionization–RTW relationship; in Section III, maximum likelihood estimates of the coefficients of this model are reported and compared with the corresponding single-equation estimates; Section IV provides some summary and concluding remarks. To summarize our main results, we find that inferences concerning the relationship between unionization levels and the presence or absence of RTW legislation are sensitive to the choice of estimation technique. Specifically, the evidence obtained from a simultaneous equations model implies a statistically significant effect of unionization on the probability of a state having a RTW law, whereas the corresponding single-equation results do not.

II. A Mixed Logit Model of the Unionization–RTW Relation

To determine jointly unionization levels and the existence of RTW legislation, we use the "mixed logit" model developed by Schmidt and Strauss (1976).[1] Let X_t be the tth observation on the dichotomous dependent variable; let Y_t be the tth observation on the continuous

[1] See Schmidt and Strauss (1976, pp. 205–6) for a more detailed exposition. Heckman (1976) has also proposed a method for handling this situation.

dependent variable; t indexes the observations from 1 to T. The model, then, is

$$\log_e\left[\frac{P(X_t = 1 \mid Y_t)}{P(X_t = 0 \mid Y_t)}\right] = Q_t\gamma + \alpha Y_t, \tag{1}$$

$$Y_t \mid X_t \sim N(Z_t\beta + \delta X_t, \sigma^2), \tag{2}$$

where Q_t and Z_t are the tth observations on row vectors of exogenous explanatory variables, γ and β are vectors of parameters, and α, δ, and σ^2 are scalar parameters. In addition, Olsen (1978) has shown that $\alpha\sigma^2 = \delta$ in this model, which implies $\text{sgn}(\alpha) = \text{sgn}(\delta)$ since $\sigma^2 > 0$.[2]

Schmidt and Strauss (1976, pp. 205–6) have demonstrated that the likelihood function for equations (1) and (2) is

$$L = \prod_{t\epsilon\Theta_0} f(X_t = 0, Y_t) \prod_{t\epsilon\Theta_1} f(X_t = 1, Y_t), \tag{3}$$

where $\Theta_0 = (t \mid X_t = 0)$, $\Theta_1 = (t \mid X_t = 1)$.[3] This can be maximized numerically with respect to γ, β, α, δ, and σ^2 subject to the restriction $\alpha\sigma^2 = \delta$ to obtain the maximum likelihood estimates. Asymptotic variances of the estimates can be obtained from the inverse of the information matrix, which in this case is most conveniently found by numerical differentiation.

Application of the mixed logit procedure to the problem of estimating a simultaneous equations model of the relationship between unionization and RTW legislation is straightforward. Definitions of variables and sources of the cross-section data from 1970 used to implement the model are listed in table 1. Using the notation developed above, X_t is a dichotomous variable which takes the value 1 if the state had a RTW law and 0 if it did not. The continuous dependent variable Y_t is the percentage of nonagricultural employment in a union. The exogenous explanatory variables which comprise the vectors $Q_t = Z_t$ are typical regressors previously used in the studies discussed in Section I: percentage employed in white-collar occupations, per capita income, industry mix (percentage of total employment in mining, construction, manufacturing, public utilities, and transportation), percentage of the civilian labor force that is female,

[2] The presence of this constraint makes the mixed logit model appropriate only when prior theoretical considerations suggest that α and δ have the same sign. However, this requirement would seem to be satisfied in the context of the application pursued in this paper. Note that the imposition of the constraint amounts to a priori information that X and Y are jointly dependent. Nevertheless, comparisons of the t-ratios on the efficient mixed logit estimates of α and δ with their single-equation counterparts are informative.

[3] In eq. (3), $f(\cdot)$ is the joint density function for X and Y.

TABLE 1
DEFINITIONS OF VARIABLES AND SOURCES OF DATA

Variable	Definition and Source
WC	% total employment in white-collar occupations. U.S. Bureau of the Census 1972*a*, table 141.
IND MIX	% total employment in mining, construction, manufacturing, public utilities, and transportation. U.S. Bureau of the Census 1972*a*, table 171.
INC	Per capita income. U.S. Bureau of the Census 1972*c*, p. 319, table 519 (in thousands).
FEM	% civilian labor force that is female. U.S. Bureau of the Census 1972*a*, table 161.
NW	% civilian labor force that is nonwhite. U.S. Bureau of the Census 1972*b*, table P-6 (Population and Housing Characteristics by State, 1970, Suppl. Report).
RTW	Presence or absence of a right-to-work law (= 1 if present, = 0 if absent). U.S. Bureau of the Census 1972*c*, p. 242, table 390.
UNION	% nonagricultural employment that is unionized. U.S. Bureau of the Census 1972*c*, p. 242, table 390.

NOTE.—The sample data are obtained from the 50 states for the year 1970, unless otherwise indicated in the source.

and percentage of the civilian labor force that is nonwhite.[4] The means and standard deviations of the variables are presented in table 2.

III. Empirical Results

The resulting maximum likelihood estimates are displayed in the first column of table 3. The numbers to the right of the coefficient esti-

TABLE 2
MEANS AND STANDARD DEVIATIONS OF VARIABLES

Variable	Mean	SD
WC	46.600	4.888
IND MIX	37.774	7.832
INC	3.678	.566
FEM	37.788	1.806
NW	7.564	7.900
RTW	.38	.49
UNION	23.784	8.722

SOURCES.—See table 1.

[4] In the interest of brevity, an extended discussion of our specification of Q_t and Z_t is not presented here. The interested reader is referred to Moore et al. (1974), Tollefson and Pichler (1974), and Lumsden and Petersen (1975).

TABLE 3

EMPIRICAL RESULTS

A. RIGHT-TO-WORK EQUATION

	MIXED LOGIT		LOGIT	
VARIABLE	Coefficient	t-Ratio	Coefficient	t-Ratio
Constant	15.270	1.21	6.001	.52
WC	−.332	−2.15	−.246	−1.78
IND MIX	−.209	−2.40	−.220	−2.22
INC	1.539	.96	.435	.27
FEM	.145	.42	.397	1.04
NW	.144	1.88	.109	1.72
UNION	−.212	−2.25	−.203	−1.82

B. UNIONIZATION EQUATION

	MIXED LOGIT		OLS	
VARIABLE	Coefficient	t-Ratio	Coefficient	t-Ratio
Constant	18.510	.62	82.410	4.32
WC	−.246	−.80	−.402	−1.45
IND MIX	.163	1.03	.294	1.95
INC	7.515	2.84	10.436	4.55
FEM	−.372	−.45	−2.314	−4.35
NW	−.065	−.44	.006	.04
RTW	−6.901	−3.09	−5.195	−2.33

SOURCES.—See table 1.

mates are "asymptotic t-ratios," which are the ratios of the estimated coefficients to the estimated asymptotic standard errors.

Of particular interest are the coefficient (and associated t-ratio) of the union variable in the RTW equation and the coefficient (and t-ratio) of the RTW variable in the unionization equation. Both of these coefficients are negative as expected and significantly different from zero at the .05 level.[5] Since it would appear legitimate to view unionization levels and RTW legislation as jointly determined, one can infer that states with high levels of unionization are, ceteris paribus, less likely to have passed RTW laws and that states which have passed such laws tend, other things equal, to have less unionized work forces.

To highlight the importance for statistical inference of considering the simultaneous nature of this relationship, the corresponding single-equation coefficients and t-ratios are presented in the second column of table 3. Ignoring the simultaneity between unionization

[5] For reference purposes, the critical values for a (two-tailed) test of the null hypothesis that the regression coefficient is zero at the 5 percent level of significance are ±1.96.

and RTW legislation would lead one to estimate the RTW equation by a simple logit or probit technique and to estimate the unionization equation by ordinary least squares (OLS). Hence, logit and OLS results for these two equations are reported. A glance at the unionization equations reveals little difference between the signs and magnitudes of the estimated coefficients of the mixed logit and OLS results, although the estimates obtained from OLS may in several instances seem more significant statistically. Nevertheless, there would be no change in inference concerning the effect of RTW laws on unionization levels based solely on choice of estimation procedure. However, in the RTW equation estimated by the simple logit method, the coefficient of the unionization variable is not significant at the .05 level. Consequently, one might have been led, on the basis of single-equation estimates, to conclude that there was not especially strong evidence in favor of a negative effect of union membership on the presence or absence of RTW legislation. Such a conclusion would not have been warranted, however, when evidence obtained from a simultaneous equations framework was considered.

Of further interest is a comparison of these results with those reported from previous single-equation studies. Using analysis of variance, Palomba and Palomba (1971, p. 479) found that, other than stage of economic development, *only* the degree of unionization was significantly related to the passage of a RTW law, while they dismissed the importance of factors such as the level of manufacturing employment, the size of the agricultural labor force, and the level of urbanization. In contrast, we find that the occupational and industrial compositions in a state exert a significant influence on the legal environment. In addition, there is a marginally significant impact of the racial composition of the labor force and the previously discussed influence of unionization level. Tollefson and Pichler (1974) confirmed the effect of the level of unionization on the presence or absence of RTW legislation with the use of a linear probability model and discriminant analysis and at the same time minimized the importance of the Palombas's "debtor-creditor" status variable. Our findings are, of course, consistent with their results, while being considerably more broad in scope, as well as having been obtained by a more appropriate estimation technique. Moore et al. (1974), employing multiple discriminant analysis, indicated that—in addition to the degree of unionization—the occupational composition of the work force, the level of agricultural employment, region (i.e., South), degree of urbanization, and population density were important determinants of RTW law passage. While these findings and our results were obtained from rather different model specifications and statistical techniques, the signs and significance levels of the occupational

and industrial work-force-composition variables are consistent between the two studies. Finally, we note that Lumsden and Petersen (1975) reject the notion that RTW laws per se significantly influence the level of unionization. This inference contrasts with our finding that, after explicitly allowing for the endogeneity of RTW legislation, such laws diminish unionization levels.

IV. Concluding Remarks

This paper has presented a simultaneous equations model of the relationship between the level of unionization and RTW legislation. Since the dependent variables in this model were continuous and qualitative, respectively, the mixed logit estimation technique especially developed for this case was applied. A comparison of the mixed logit results with corresponding single-equation estimates indicated that inferences concerning the effect of unionization levels on the presence or absence of RTW laws are different when the two variables are viewed as being jointly determined. Thus, previous studies which have estimated single-equation models may have incompletely characterized the nature of the relationship between unionization levels and RTW laws.

There has been a growing interest in the endogeneity of legislation in recent years. Aside from the specific inquiry conducted in this paper, the estimation method used would seem to be applicable to any conceptual framework in which it was desirable to "endogenize" political outcomes within a more conventional system of equations. Hence, it is hoped that this study will evoke further experimentation with modeling economic and political interdependencies.

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