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A FIXED EFFECT LOGIT MODEL OF THE
IMPACT OF UNIONISM ON QUILTS

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ABSTRACT

There are two possible reasons for unionized workers to have lower quit rates than otherwise comparable nonunion workers: unions could organize employees with innately lower propensities to quit or they could reduce propensities by offering disgruntled workers alternatives to quitting in the form of grievance arbitration and related industrial jurisprudence systems. This paper uses a fixed effect logit model based on the conditional likelihood function to disentangle these two effects.

The paper finds that the observed union-quit tradeoff is due largely to the impact of unionism on worker behavior rather than to the propensity of stable workers to be organized, supporting the notion that unions have important nonwage effects along the lines suggested by the "exit-voice" model of union activity.

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With wages and other characteristics held fixed, unionized workers have been found to have significantly lower quit and permanent separation rates and greater job tenure than nonunion workers.¹ Why?

There are two possible explanations for the observed inverse relation between unionism and quit or exit behavior. One possibility is that the trade union institution reduces the propensity to leave an enterprise by providing disgruntled workers with alternatives to quitting such as grievance/arbitration and regular contract negotiations, and by providing especially desirable nonwage work conditions. Another very different possibility is that the union-quit relation reflects selectivity in union membership, with organized employees differing from nonorganized workers in unobserved characteristics that lead to lower quit rates. Whether the inverse relation between unionism and exit is due to the effect of unionism on behavior or to selectivity is central to understanding the "exit-voice tradeoff" in the labor market and what unions do in an industrial economy.

This paper seeks to disentangle the two possible causes of the lower quit rate² of union workers using G. Chamberlain's fixed effect logit model that is based on the conditional likelihood function. The fixed effect logit eliminates selectivity bias by comparing the likelihood of quitting by the same worker in union and nonunion settings, thereby isolating the behavioral impact of the institution. Maximizing the likelihood function conditional on the number of quits has desirable asymptotic and computational properties that make the model a valuable research tool.

The paper finds that the observed union-quit tradeoff is due largely to the impact of unionism on worker behavior rather than to the propensity of stable workers to be organized, supporting the notion that unions have important nonwage effects along the lines suggested by the "exit-voice" model of union activity.³

The paper is divided into four sections. The first sets out the reasons for expecting unionism to reduce quits. The second describes the methodology of the empirical analyses. The third presents the empirical results. The paper concludes with a brief evaluation of the economic consequences of the union-induced decrease in exit and of the implications for further analysis of trade unionism.

I. Unionism and Exit Behavior

With wages and other measured characteristics of workers held fixed, the quit propensities of union and nonunion employees can be expected to differ for two basic types of reasons.

First, unionism is likely to reduce quits through its functioning as a "voice" institution that offers workers a substitute mode of protesting and potentially changing work conditions to classical exit behavior. Perhaps the most important aspect of unionism likely to have significant effects on quit behavior is the grievance/arbitration system, which enables workers who feel themselves unfairly treated or who believe their supervisors erred in interpreting work rules to seek a resolution through the formal grievance procedure. Ninety-nine percent of major U.S. collective bargaining contracts contain grievance clauses and 95% contain arbitration clauses (U.S. Department of Labor, 1977, p. 92), while by contrast, in the nonunion sector, at most 30% of large firms have formal grievance procedures and only 11% allow for outside arbitration (Bureau of National Affairs, 1968, p. 2). The likely impact of a grievance system on quits is clear: disgruntled workers will generally raise a grievance before invoking the more drastic quit remedy; if successful they will stay with the firm; even if unsuccessful the delay in quits will reduce

the overall level of exit.⁴ The regular process of collective bargaining can also be expected to reduce exit by providing the possibility of changing contractual arrangements through negotiation rather than mobility. If, as seems reasonable, unions are especially effective in altering conditions and rules that are 'public' to the enterprise, where standard public goods arguments suggest that considerable mobility would be needed for firms to obtain information about preferences, the bargaining process might substantively reduce the quits needed for provision of the desired conditions. Finally, unionism may reduce exit by creating particular work rules and conditions of employment that are desired by workers, including the industrial jurisprudence method of setting rules. If, with pay and other pecuniary benefits held fixed, union work places are more desirable to employees, compensating differential analysis suggests that unionists will quit less.

The second possible reason for the observed reduction in quits under unionism is that unions tend to organize workers with lower quit propensities. Such selectivity is to be expected if unionism can be viewed as an investment with longterm returns, which will attract relatively stable workers likely to be more willing to invest in organizing than are short-term workers, especially given the long delays in obtaining NLRB representation elections in recent years. The selectivity effect differs fundamentally from the behavioral effect in that it implies that unions have no real impact on behavior but merely serve to sort out more and less stable workers. Since the reduction in exit under unionism has been heralded as one of the major nonwage effects of the institution, with considerable cost-saving advantages due to the cost of turnover, it is important to control for the potential impact of selectivity bias on the results.

II. The Econometric Model

Longitudinal data on the quit behavior of the same person over time provides a means of differentiating between the effects of unionism as an institution that influences behavior and of selectivity in the union-exit relation. The use of longitudinal data to control for unobserved personal factors can be most readily demonstrated with a linear probability model. Let Q_{it} = 0-1 dummy variable which measures whether the i th person quits in period t ; UN_{it} = 0-1 dummy variable for whether or not the person is a union member, h_i = unobserved personal characteristics which raises the propensity to quit; and e_{it} be a residual uncorrelated with unionism. For simplicity, the effect of other variables will be ignored, implying that the coefficients and error terms are partial with respect to other variables. Then, the linear probability representation of the quit decision is:

$$(1) \quad Q_{it} = -aUN_{it} + h_i + e_{it}$$

If $E(h_i | UN_{it}) \neq 0$, the regression of Q_{it} on UN_{it} will yield a biased estimate of a . When, as seems reasonable, union workers are innately more stable, $E(UN_{it} | h_i) < 0$ so that the bias is downward, the effect of unionism on quits will be overstated. With data on several time periods, however, the effect of h_i can be eliminated by including individual constants in the regressions. In the linear model this is equivalent to taking deviations from means for all the variables. With data on two periods, the analysis simplifies to a simple difference equation

$$(2) \quad Q_{it} - Q_{it-1} = -a(UN_{it} - UN_{it-1}) + e_{it} - e_{it-1}$$

Since the h_i terms have been eliminated from (2), there is no problem in estimating a by least squares.

As is well-known, however, the linear probability model is not entirely appropriate: it fails to bound the probabilities between 0 and 1 and has non-normal error terms. A widely used alternative is the logistic, which makes the probability (P) a nonlinear function of the explanatory variables.

$$(3) \quad P_{it} = \Pr(Q_{it}=1) = \frac{\exp(-aUN_{it} + h_i)}{1 + \exp(-aUN_{it} + h_i)}$$

where $dP/dUN_i < 0$. The logistic is bounded between 0 and 1 and can be estimated by maximum likelihood. When the model is expanded to include fixed person effects, however, the resultant estimates are not consistent, essentially because the number of individual parameters estimated in the nonlinear form rises as the sample increases, so that increasing the sample size does not produce desired asymptotic properties. While additional time periods on an individual will yield consistent estimates, standard data sets provide only limited longitudinal information, generally on large numbers of persons.

Chamberlain's fixed effects logit model provides an alternative procedure using a conditional likelihood function. The basic idea is that the number of quits provides a sufficient statistic for the omitted person factor h_i .⁵ Holding fixed the number of quits, h_i drops from the likelihood function, producing a nonlinear relation comparable to the linear probability fixed effects model. Since people who quit in every period or who never quit provide no information about the effect of unionism or other explanatory variables, the analysis focuses on persons who quit in one (or more) periods and who stay on a job for one (or more) periods. In the case of two periods, there are two possibilities: quit in period 1 [$Q_1 = 1$ and $Q_2 = 0$] or quit in period 2 [$Q_1 = 0$ and $Q_2 = 1$]. The conditional probability for the event 10 (i.e. $Q_1 = 1$ and $Q_2 = 0$) is:

$$(4) \frac{P_1(1-P_2)}{P_1(1-P_2) + P_2(1-P_1)}$$

where P_1 = logistic probability for quitting in period 1 and P_2 = logistic probability for quitting in period 2. Substituting for the P's with the logistic (3) yields

$$(5) \text{ Prob}(10) = \frac{\exp[a(\text{UN}_{i2} - \text{UN}_{i1})]}{1 + \exp[a(\text{UN}_{i2} - \text{UN}_{i1})]}$$

from which the h_i has been eliminated. Since there are only two events (10) and (01), this is a simple binary logit with explanatory variables in difference form, for which consistent estimates of a can be obtained using standard maximum likelihood packages.

The way in which the conditional logit model provides information on the effects of unionism on the quit behavior of individuals can be readily ascertained from (5). For a person who switches, say, from union status in period 1 to nonunion status in period 2, the explanatory variable $\text{UN}_{i2} - \text{UN}_{i1}$ takes on the value -1. This implies that the probability of the event quit/no quit is increased--a sensible pattern if unionism reduces the probability of quitting, since then moving from union to nonunion status should lower the conditional probability of quitting in the first period relative to the second period.

When there are more than 2 periods the Chamberlain fixed effect logit yields a multinomial model, with several possible outcomes. In the case of 3 periods, for example, there are six cases (001, 010, 100, 101, 011 and 110). This model can be estimated with standard multinomial packages. The Manski-McFadden conditional logit program provides an especially useful package for estimation, as it permits simultaneous estimation of the effect of variables conditional on one, two, three, or more quits.

The consistency of the estimates in the fixed effects logit and the properties of the information matrix are discussed in detail by Chamberlain. What is important for our purposes is that the model provides the appropriate statistical tool for dealing with the unobserved personal factor h_i in the union quit problem.

III. Empirical Results

The effect of unionism on quit behavior using fixed effects models has been estimated with longitudinal data for the period 1968-72 from the Michigan Panel Survey of Income Dynamics (PSID). Records on the Michigan tape were organized into a file giving wages and other characteristics of workers and unionism in a given year and quits in the ensuing year. Persons who left the labor force were excluded from the sample in order to focus on quits involving changes in employers as opposed to retirement or other movements out of the labor market. There were 4058 persons in the five year sample with information on 20,290 quit/no quit decisions.

As a first step in evaluating the effect of unionism on quit behavior and the importance of unobserved person factors, a linear probability model was estimated treating each of the 20,290 decisions as a separate dependent observation. The results of the linear analysis are given in table 1. Column 1 gives the mean and standard deviation of the key variables. Column 2 records the results of regressing the 0-1 dummy variable for a quit on unionism, hourly wages and year dummies, while column 3 adds various other control variables, such as education, age, and occupation. Column 4 replaces the control variables with individual constants to control for the omitted person factor h_i .

The calculations reveal a sizeable inverse union-quit relation, which is not seriously affected by the omitted person factor. In the first regression, the coefficient on unionism is $-.029$, with a standard error of $.004$,

Table 1: Linear Probability Model Estimates of the Effect
of Unionism and Wages on Quit Behavior

	mean & standard deviation (1)	Coefficient (2)	and (3)	Standard Error (4)
<u>Dependent Variable</u>				
Quit	.083(.276)			
<u>Independent Variables</u>				
Unionism	.276(.447)	-.029(.004)	-.036(.005)	-.029(.008)
Hourly Wages	3.40(2.50)	-.006(.0008)	-.005(.0009)	-.002(.001)
Individual Constants				✓
<u>Other Controls</u>				
Year dummies		4	4	4
Education			✓	
Age			✓	
Occupation Dummies			8	
Area Wage			✓	
Area Unemployment			✓	
Shortage of Workers in Area Dummy			✓	
Industry Dummies			5	
Sex			✓	
Race			✓	
Constant		✓	✓	✓
<u>Summary Statistics</u>				
S.E.E.		.275	.272	.263
F		23.5	26.3	1.5
N		20290	20290	20290

Source: Calculated from Michigan Panel Survey on Income Dynamics

Note: The SEE and F in column 4 relate to the full equation, adjusted for the degrees of freedom due to the individual constants. The F for the addition of the explanatory variables is 8.2.

implying that trade unionism is associated with a quit rate 35% below the average. The coefficient on wages is also highly significant negative but of more modest magnitude: to reduce quits by 35% would require a wage increase of \$4.83 or 142% above the average. Addition of diverse person, job, and area characteristics to the regression in column (2) modifies these findings modestly, raising the absolute value of the union coefficient and reducing that of the coefficient on wages. The impact of unionism is increased by addition of controls because organized workers are concentrated in blue collar occupations, where quit rates tend to be especially high. When individual constants are added to the regression (computationally, by taking each variable as deviation from its mean value), the coefficient on the union variable is $-.029$, which is identical to that in the first regression, while the coefficient on hourly wages declines in magnitude. The continued effect of unionism with the individual constants implies that in the linear model, at least, the bulk of the union effect is not the result of unions selecting more stable workers but rather of unions reducing the likelihood of quits by individual workers.

Table 2 turns to Chamberlain's fixed effects logit model, concentrating on the union and wage variables. Since persons who remained in their job over the whole period or who quit in each period are eliminated, the sample drops to 1232, consisting of 877 cases of a single quit, 276 cases of 2 quits, 67 cases of 3 quits, and 12 cases of 4 quits. Columns 1 and 2 record the estimated logistic parameter coefficients on unionism and wages in calculations which first exclude and then include the same set of controls used in the previous table. Without the controls the probability of a quit in the sample is significantly reduced by trade unionism, with a logistic parameter of $-.39$. At the mean level of quits in the sample this implies a drop in

Table 2: Logistic Probability Model Estimates of the
Effects of Unionism and Wages on Quit Behavior

<u>Independent Variables</u>	<u>Coefficient and Standard Error</u>			
	<u>Logistic Model</u>		<u>Fixed Effect Logit</u>	
	<u>Ignoring Person Effects</u>		<u>Single Quits</u>	<u>Single & Multiple Quits</u>
	(1)	(2)	(3)	(4)
Unionism	-.386(.065)	-.464(.070)	-.378(.174)	-.462(.151)
Hourly Wage ¹	-.111(.014)	-.105(.019)	-.032(.116)	.128(.104)
Individual Constant			✓	✓
<u>Other Controls</u>				
Year Dummies	4	4		
Education		✓		
Age		✓		
Occupation Dummies		8		
Area Wage		✓		
Area Unemployment		✓		
Shortage of Workers in Area Dummy		✓		
Industry Dummies		5		
Sex		✓		
Race		✓		
Constant	✓	✓	✓	✓
<u>Summary Statistics</u>				
N	20290	20290	877	1232

¹Hourly wage taken relative to the average in a year to allow for changes in wages over time.

the probability of quitting of .029 points due to unionism, identical to the value obtained from the linear model. Consistent with the preceding results, moreover, addition of the control raises the impact of unionism noticeably. Columns 3 and 4 give maximum likelihood estimates of the fixed effect conditional logit model. In 3 the calculations are conditional on a single quit while in 4 multiple quits are also taken into account. As with the linear probability calculations, the results are clear cut: the trade union effect is only modestly affected by correcting for the omitted person factor while by contrast, the coefficient on wages is significantly reduced by the correction. The differential effect of the individual constants on the union and wage coefficients may reflect the fact that wages are more person related than unionism, which is much more of a social phenomenon. As far as can be told by these calculations, the reduction of quits associated with unionism is due largely to the effect of the institution on individual behavior rather than union selectivity of persons with initially low quit propensities.

IV. Conclusion

This study has used the Chamberlain fixed effect logit model to eliminate unobserved person factors from the union quit equation. It has found that most of the observed union-exit tradeoff is due to the impact of the institution on quit decisions, as opposed to selectivity of more stable workers and thus lends general support to the view that trade unionism has significant nonwage effects on the behavior of workers, roughly in accord with the "exit-voice" model of unionism. Since reductions in quits lower turnover costs and raise the payoff to investments in specific human capital, the impact of unionism on quit behavior should raise productivity, contributing to the observed positive effect of unions on

productivity in some sectors (Brown-Medoff). In this case at least the impact of unionism does not masque an omitted selectivity factor but rather appears to reflect a true social effect.

Footnotes

¹See Freeman, Brown-Medoff, Viscusi, Kahn, among others.

²While the paper concentrates on the quit rate, the analysis could easily be extended to total separations. Unionism appears to lower quits but to have little impact on other permanent separations, so that the quit relation captures the principal impact of the institution.

³For discussion of the "exit-voice" approach see Hirschman, Freeman, Nelson, Hirschman (1976) and Freeman and Medoff.

⁴There are two conditions for the delay effect to operate. First, there must be some nonzero probability of redressing the grievance, so that the worker is willing to try the option. Second, the length of employment must be finite, for otherwise delays will not affect the steady state solution. If, on average, the length of employment were initially, say 10 years, then a delay in quitting for, say 1/2 year, would reduce the quit rate from 10% to about 9 1/2%, a non-negligible though by no means large effect.

⁵See Chamberlain, pp. 8-14. The basic idea is that the person effect predisposes an individual to quit a certain number of times but does not affect the timing of quits. The explanatory variables affect the timing.

⁶To obtain (5), substitute for P_1 and P_2 to get

$$\left[\left(\frac{1}{1 + \exp(-aUN_2)} \right) \left(\frac{\exp(-aUN_1)}{1 + \exp(-aUN_1)} \right) \right] / \left[\frac{1}{1 + \exp(-aUN_2)} \frac{\exp(-aUN_1)}{1 + \exp(-aUN_1)} \frac{\exp(-aUN_2)}{1 - \exp(-aUN_2)} \frac{1}{1 + \exp(-aUN_1)} \right]$$

which reduces to $\frac{\exp[a(UN_2 - UN_1)]}{1 + \exp[a(UN_2 - UN_1)]}$.

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