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**Uncertainty over the Quality of Labor Inputs:
A Nonmonopoly Theory of Union Wages
and Hours Worked**

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ABSTRACT

A theoretical model of labor demand under uncertainty which incorporates the propositions found in the union voice literature is presented. The model generates a positive union effect on wages and hours worked without union monopoly power. The model provides a more detailed conceptual framework for explaining why the union voice effect may improve efficiency within the firm than that currently found in the literature.

Uncertainty over the Quality of Labor Inputs: A Nonmonopoly Theory of Union Wages and Hours Worked

I. Introduction

While union wage effects have been studied extensively, union effects on employment and hours worked have received little attention. The basic underlying assumption is that if unions have sufficient power to increase wages via monopoly control of the labor market, then, given a downward sloping labor demand curve, union sector employment should fall. However, a study by Earle and Pencavel (1990) finds a positive association between unionization and annual hours and annual weeks worked.¹ Moreover, they find that the increase in hours worked is positively correlated with the size of the union wage differential (i.e., the larger the union wage effect, the greater the difference between union and nonunion hours worked). In combination with a positive wage effect, the positive employment effect in annual hours worked suggests that unionization may: 1) increase the efficiency of the firm (i.e., the labor demand shifts out); or 2) union bargaining power is strong enough to force unionized firms off their demand curve. Earle and Pencavel conclude that these findings merit further research.²

¹The association reflects cross-sectional estimates. Since Earle and Pencavel use CPS micro-data, an employee's hours worked per week times weeks worked per year gives annual hours worked. The union-nonunion annual hours worked differential is sensitive to industry and occupation. Craftworkers and operators have a negative union-nonunion differential for annual hours worked, and the magnitude of the negative differential increases for workers in the construction industry. Earle and Pencavel do find a negative relationship between union coverage and *weekly* hours worked for white males. This finding is generally consistent with the survey of studies in Lewis (1986) and generally reflects union restrictions on hours worked per week and overtime hours. Earle and Pencavel report a long-run finding of a negative relationship between unions and annual hours worked over time. This is consistent with the findings by Lewis (1963) and Pencavel and Hartsog (1984). It also reflects the Blanchflower *et al* (1991) results where union sector firms have a lower employment growth than nonunion sector firms by about 2% to 4% per year. Also, Brannon and Craig (1994) find that union firms respond to output fluctuation by varying hours of work or wages rather than employment (in response to the higher benefits and thus fixed costs of union workers). The time series studies, however, are unable to control for all variables that influence long-run employment effects.

²Ashenfelter (1978) and Raisian (1984) found similar results for union effects on annual hours worked using cross-sectional data. Raisian also finds a negative association between annual weeks

The monopoly view of unionism is prevalent in the literature. However, an alternative explanation of positive union effects on both wages and hours worked lies in the union voice literature developed by Freeman and Medoff (1984). They view unions as having two faces: 1) the desirable side is the collective voice-institutional response of unions, and 2) the undesirable side is union monopoly power. The union voice effect provides a nonmonopoly explanation for the results reported by Earle and Pencavel. Union workers have lower turnover and higher levels of tenure which help increase firm efficiency and could explain an increase in demand for unionized hours worked³. The union voice argument has been criticized since there is no formal model that explains how the presence of a union work force increases firm productivity relative to a nonunion work force.⁴ We address this issue by developing a theoretical model of labor demand under uncertainty which incorporates the propositions found in the union voice literature. The model extends the literature by providing a more detailed conceptual framework for explaining why the union voice effect may improve efficiency within the firm.

II. Monopoly Union Effect

The prevailing models of union effects on wages and employment are based on the theoretical premise of union and firm monopoly power. Unions are viewed purely as a labor cartel that uses monopoly power to increase the union sector wage. This view necessarily assumes that unionized firms must also have market power to share rents with the union workers. A unionized firm in a

worked and union status in time periods with relatively high unemployment, which suggests that the union-nonunion gap in annual weeks worked may be sensitive to the business cycle.

³Freeman (1980) finds that union members have a voluntary quit rate of 6 percent a year compared to 9 percent for nonunion workers, and Miller and Mulvey (1991) find voluntary turnover of 20 percent and 26 percent for Australian union and nonunion workers, respectively.

⁴ Addison (1985) and Reynolds (1986) criticize Freeman and Medoff for their lack of a formal model that explains the efficiency gain and resulting productivity effect from the union voice mechanism.

competitive environment would simply be driven out of business by nonunion firms with lower wage costs. Demand models argue that unions negotiate wages and fringe benefits at an optimal level and that management exercises control over the level of labor employment.⁵ The efficient contract model of McDonald and Solow (1981) argues that unions and management have joint control over the determination of wages, hours of work, and number of workers employed along a pareto-optimal contract curve. Both the demand and efficient contract models imply a trade-off between a union wage differential and annual hours of work and are theoretically inconsistent with Earle and Pencavel's finding of greater union wage and employment effects in the short-run relative to similar nonunion firms.

To offset the reduction in total hours worked, some unions are powerful enough to impose restrictive work rules that force unionized firms to hire more union workers than they desire. The recursive or semi-efficient bargaining model by Johnson (1990) argues that powerful unions may in fact push union firms far enough off their labor demand curves to increase both wages and hours worked.⁶ This model is theoretically consistent with the Earle and Pencavel findings. While there are famous cases of union featherbedding, it is not common since aggressive union bargaining de-stabilizes unionized firms and industries by inducing capital substitution and intensifying the threat of union busting.⁷ This model is not consistent with the long-run existence of a viable union sector, and

⁵For example, Dunlop (1944) hypothesizes that unions set wages to maximize the wage bill.

⁶Unions essentially bargain over the capital-labor ratio and work intensity by using restrictive work practices or featherbedding.

⁷Navarro (1983) argues that aggressive union bargaining and featherbedding are partially responsible for the decline of the union sector in the coal industry. Dertouzos and Pencavel (1981) discuss featherbedding in the International Typographical Union where advertisements had to be reset by union workers. Reynolds and Schansberg (1991) discuss featherbedding in railroads where firemen were still required after the introduction of diesel locomotives, and union carriers have three to five crew members while nonunion carriers have two-man crews. Rees (1977) discusses other notable examples which include musician locals that require a minimum number of orchestra musicians and a

featherbedding typically occurs in declining industries as unions attempt to maintain an existing level of employment. Moreover, Oswald (1993) argues that if there is an announced layoff rule (usually the inverse order of seniority) and democratic unions follow the median voter outcome, then the union will have no preference for employment levels (i.e., the union's indifference curve is horizontal with respect to employment). Given these assumptions, all efficient bargaining outcomes will lie on the demand curve, implying that union negotiated wage gains will have a *negative* impact on employment levels.

III. Union Voice Effect

With businesses downsizing in reaction to intensifying domestic and global competition, unions are venturing into collective bargaining contacts that emphasize cooperative union/management relationships, rather than engaging in contentious bargaining to maximize the wage bill. The "new era" union/management cooperation concentrates on collaborative efforts to increase economic efficiency. In this new era, "good" unions are willing to trade wage bill maximization for long-run employment stability. Management has lauded this new era of cooperativeness where unions have helped improve productivity by endorsing new technology and innovative production systems such as self-managed work-place teams (Bernstein, 1994).

Ford supported the UAW in a union organization strike against Ford's component supplier Johnson Controls, Inc. at the cost of shutting down production and losing \$5 million in net income per day. Ford's rejection of replacement worker produced parts in support of the UAW forced Johnson Controls to accept a union contract. John Devine, Ford's chief financial officer, argued that a cooperative relationship with the UAW has resulted in productivity gains that allow Ford to remain

longshoremen's union which requires repackaging of cargo containers.

competitive in the increasing global market (Simison and Rose, 1997).⁸

The Aluminum Company of American (ALCOA) has engaged in union/management team systems and a joint decision-making council with the International Association of Machinists in an effort to improve productivity. Allegheny-Teledyne and USX Corporation have also engaged in cooperative management agreements with the United Steel Workers. USX, however, has limited these agreements to its tubular steel plant (as opposed to its flat steel plants) which, interestingly, faces the greatest market competition. The Hotel Employees and Restaurant Employees Union has agreed with the large Las Vegas casinos to eliminate cumbersome work rules and allow more flexible staffing hours to satisfy customers. The International Association of Machinists has initiated a union/management training program on productivity gains from team systems. The Laborers union now supplies trained craft workers to nonunion employers willing to pay union scale. Contractors have availed themselves of this national foundation to alleviate labor shortages in skilled trades (Bernstein, 1997). This anecdotal evidence suggests that unions can potentially increase firm productivity by increasing the efficiency by which raw labor units are converted into effective labor inputs in the production process. Perhaps union efficiency gains or the "good face" of unionism can at least partially reconcile the finding of Earle and Pencavel.

The "union voice effect" as a source of efficiency gains was first hypothesized by Freeman and Medoff. They argue that the collective voice-institutional face of unions facilitates the stabilization of the worker-management relationship. Empirical evidence in support of the union voice effect has established that union sector workers have lower quit rates, giving union firms lower employee

⁸Automobile manufactory will also admit that they are attempting to improve relationships with their unionized work force to smooth over the resentment left from years of downsizing. While smoothing over union resentment can improve quality control and help avoid shutdowns due to strikes, it will not necessarily make union firms more productive than nonunion counterparts.

turnover. The lower probability of quits is attributed to the union voice versus nonunion exit tradeoff.⁹ Unions establish and enforce rules on grievance procedures, promotion, unsafe work conditions, etc., and provide a system of industrial jurisprudence through which workers voice their industrial relations problems. Nonunion workers, having no means (or power) to voice their labor-management disputes, must utilize a market response system and exit the firm.

Lower turnover rates in union firms suggest two efficiency implications. First, union firms should have higher retention rate of firm-specific skills. Since a lower quit rate reduces hiring and training of replacements, union workers should have greater firm-specific skills on average. Furthermore, if union workers are more willing than nonunion workers to facilitate the introduction of new production technologies (like self-managed work teams and cooperative management teams), union firms will realize a new form of firm-specific skills.¹⁰ Potentially, union firms could have greater labor productivity due to greater firm-specific skill levels.

Second, lower turnover in union firms should reduce the variance of firm-specific training below that of nonunion firms, which suggests greater certainty about the quality of labor inputs. Nonunion firms, conversely, must hire and train more new workers; at any given point, there is a greater uncertainty of the quality of effective nonunion labor inputs in production. If there is greater certainty over work force quality, then there will be a decrease in the variability of worker productivity, which in turn will increase productive efficiency. Additionally, unions may increase contract efficiency because workers have greater assurance of receiving fair compensation under the

⁹ Freeman controls for wages and other differences between union and nonunion workers and finds that the probability of union worker quits is about 3 percent lower. Also, see Freeman and Medoff, chapter 6, for a discussion of union turnover empirical results.

¹⁰ Union workers may be less resistant to the introduction of new management and production technologies if they are assured of capturing their portion of the productivity gain under a collective bargaining agreement.

explicit rules of a collective bargaining agreement. Consequently, unions may act to decrease uncertainty by decreasing asymmetric information about workers' true productive capabilities. Thus, potential productivity gains from the union voice effect have two sources: 1) higher average firm specific skills, and 2) lower variance in the flow of factor services.

The argument that union firms have greater productivity than nonunion firms is controversial. Studies support a positive effect of unions on productivity, but the effect is small at best and insufficient to offset the larger union wage rates. Brown and Medoff (1978) find a large union productivity effect, but the study is criticized for failing to control for output prices. Addison and Hirsch (1989) find evidence of small if any effect at all, and unions tend to reduce firm profitability, calling into question any union productivity effect. A small positive effect is found by Clark (1980a and 1980b) in the cement industry, which Clark attributes to more professional management. Allen (1984, 1986, 1987) finds greater union firm productivity in the construction industry. Boal (1990) also finds a positive effect in large, labor-intensive coal companies (small ones actually have a negative effect) which is attributed to a reduction in labor turnover. However, Mitchell and Stone (1992) find union sawmills to be less productive than nonunion mills. The studies that do find evidence of union sector productivity gain are based on firm level studies as opposed to studies based on aggregate industry level data. Firm level productivity gains may reflect that "good" union effects may be dependent on the level of union/management cooperation at each specific firm.

In this paper, we develop union productivity effects associated with a reduction in the uncertainty in the flow of labor factor services.¹¹ Production under uncertainty fundamentally affects

¹¹In this model we assume that the expected value of union and nonunion labor productivity is equal. Nonunion labor, however, is assumed to have greater uncertainty due to a mean preserving increase in the variance of nonunion factor services. We make this assumption in order to preserve a degree of simplicity in the model. We could have assumed that the expected value of union factor service flow was greater than the nonunion expected value (i.e., greater union sector productivity), but the added complexity would not substantially alter the uncertainty model's implications.

the relationship between factor inputs and productive output. We argue that the theoretical implications of a reduction in the variance in the flow labor factor service due to lower turnover and greater contract efficiency in the union sector are consistent with Earle and Pencavel's finding of positive union effects on wages and annual hours worked.¹² The reduction in variance of labor quality will be incorporated into a model of competitive firm behavior under production uncertainty. The firm is faced with hiring union or nonunion workers. It is assumed the union does not have monopoly power. Consequently, any union-nonunion differential in wages and employment must derive from increase in labor productivity due to the reduction in the uncertainty over the flow of labor services of union workers relative to nonunion workers.

IV. Assumptions and the Model

The analysis assumes a short-run time frame for the firm. The firm operates in a competitive setting in both the output and factor markets. All inputs are assumed to be fixed except labor. The firm can acquire its labor from one of two separate markets for labor inputs: 1) union; and 2) nonunion.¹³

Define L to be the quantity of labor acquired for current use and L_t to be the quantity of labor service actually supplied. It is assumed that L is a decision variable for the firm and L_t is a random variable. This assumption is based on arguments presented in Walter's (1960, p.325) lucid exposition of why labor supplied is a random variable: "...although the number of workers on the payroll is fixed, the flow of labor services does not stay at one value. It varies from day to day according to

¹²The exact magnitude of this argument remains an empirical issue and may not be sufficient to explain the entire observed union wage differential.

¹³ This assumption implies that firms are constrained to hiring from either the union or nonunion labor market. In reality, union coverage is determined by workers' demand for union coverage relative to a firm's resistance or cost of unionization. Thus, firms are union or nonunion by a union certification (or decertification) process which management typically opposes. This assumption is not critical as long as the union coverage rate is in equilibrium in the short run (which seems to be reasonable).

weather, sickness, whim, and other accidental influences."¹⁴

We are interested in the variability in the flow of labor services of union and nonunion labor. We shall assume that Walter's "accidental influences" are identical for both types of labor. However, we argue that the variability in the flow of labor services is higher for nonunion workers due to higher turnover rates, less efficiency in contracting, *et cetera*. Under this assumption, *ceteris paribus*, the flow of labor services from union labor is assumed, for simplicity in modeling, to be known with certainty. The flow of labor services from nonunion labor is assumed to be variable.

Following the modeling procedure developed by Ratti and Ullah, L and L_I are linked in the following way:

$$L_I = \nu L, \tag{1}$$

where ν is a strictly positive random variable with the variable's density function defined as $f(\nu)$ with a unit mean.¹⁵ The firm's short-run production function when it hires union or nonunion labor is defined as

$$Q = h(L_I) = h(\nu L), h'(L_I) > 0, h''(L_I) < 0. \tag{2}$$

The third derivative of the production function is assumed to exist, and the marginal product of the input is positive but declining.

If the firm hires union labor, then ν is assumed to be a constant with a value of one. If the firm hires nonunion labor, then ν is defined as a random variable, which implies output (Q) is also a random variable.

¹⁴ Baldwin (1991) develops a labor market discrimination model based on Walter's discussion of uncertainty over the flow of factor services. However, her discussion of the relationship between marginal productivity and average productivity of labor is flawed. The Baldwin model also does not investigate the issue of risk aversion. The risk aversion issue is addressed in this paper.

¹⁵ The model developed in this paper is a modified version of the model developed by Ratti and Ullah. Ratti and Ullah give credit to Walters and Roodman (1972) for the method of specification of the input variables.

Freeman and Medoff find that quit rates are lower among union workers than among nonunion workers with **comparable skills**. Comparable skills implies that the average flows of union and nonunion labor services are equivalent. The unit mean assumption is consistent with the comparable skills assumption. Imposing this assumption on the relationship between union and nonunion labor, we have $L = E[L_i]$ (E denotes the expectations operator).

Beginning with firm behavior under certainty with respect to the flow of labor services, it is assumed the firm's goal is to maximize profits (Π). The output price of final goods and the input price of labor services and the fixed cost of production are defined respectively as p , w , and C . The firm's profit function is defined as:

$$\Pi = p h(L) - wL - C. \quad (3)$$

The first order condition for profit maximization is:

$$d\Pi/dL = p h' - w = 0. \quad (4)$$

The second order condition for profit maximization is:

$$d^2\Pi/dL^2 = p h'' < 0. \quad (5)$$

Rearranging equation 4, the following equilibrium condition is arrived at:

$$p h' = w \text{ or } p = w/h'. \quad (6)$$

Equilibrium condition (6) is the standard result. The firm will pay the labor input its marginal value product (MVP), i.e., its marginal contribution to the production of output.

If the firm hires labor from the nonunion market, then there is uncertainty over flow of factor services from nonunion labor. Profits are now defined in terms of utility. Assuming that the firm's utility function conforms to characteristics of a von Neumann-Morgenstern utility function and its third derivative exists, the firm's expected utility from profits can be written as:

$$E[U(\Pi)] = E[U(p h(L_i) - wL - C)]. \quad (7)$$

It is assumed that the marginal utility of profit is positive $U'(\Pi) > 0$ and that the value of $U''(\Pi)$ is

negative if the firm is risk averse, 0 if the firm is risk neutral, and positive if the firm is risk preferring.

The first order condition for maximizing expected utility of profits is:

$$dE[U(\Pi)]/dL = E[U'(\Pi) \cdot (p \cdot h'(L_i) - w)] = 0. \quad (8)$$

The second order condition is:

$$d^2E[U(\Pi)]/dL^2 = E[U''(\Pi) \cdot (p \cdot h'(L_i) - w)^2 + p \cdot h''(L_i) \cdot U'(\Pi)] < 0. \quad (9)$$

V. The Effect of Uncertainty on Firm Behavior

The first question to be addressed in this section is, "how does uncertainty over the flow of labor services affect that firm's level of production as compared to the certainty case?" The certainty case is when the firm hires union labor. The uncertainty case is when the firm hires nonunion labor.

This question leads to the first proposition:

PROPOSITION I: *The firm's expected output when employing nonunion labor, ceteris paribus, is less than the firm's output when employing union labor.*

To establish the above proposition, Jensen's inequality and the definition of expected value are applied to the firm's production function, $h(L_i)$. Certainty in this situation means to replace (L_i) with its expected value, L . Then by the Jensen inequality,

$$E[h(L_i)] < h(L), \quad (10)$$

and proposition I is established.¹⁶ Thus, the implication of the introduction of production uncertainty into the firm's production function is that the mere presence of uncertainty, ceteris paribus, reduces the firm's output as compared to a world of certainty for a given fixed level of labor. Consequently, the model implies that the *MPP* of L_i in an uncertain environment is less than the *MPP* of L_i if production

¹⁶ The Jensen inequality states that if a function is strictly concave the following is true: $E[h(X)] < h[E(X)]$. See Rao (1973), page 58 for an explanation of Jensen's inequality. Proposition 1 is an established result in the economics of uncertainty literature.

had taken place at the expected value of the random variable, L_1 (i.e., L or the certainty environment).

The second issue to be discussed is how does input quality uncertainty in conjunction with the firm's attitude toward risk affect the wage paid to labor by the firm.¹⁷ The analysis begins with rewriting equation (8) in the following manner:

$$E[U'(\bar{I}) \cdot (p \cdot v \cdot h'(L_1))] = E[U'(\bar{I})] \cdot w. \quad (11)$$

Adopting Horowitz's (1970) alternative expression of equation (11),

$$p \cdot E[v \cdot h'(L_1)] = w - \{p \cdot \text{Cov}(U', v \cdot h') / E[U'(\bar{I})]\}. \quad (12)$$

From equations (11) and (12), the *MPP* and *MVP* of nonunion labor are now random variables given by $v \cdot h'$ and $p \cdot v \cdot h'$ respectively. Examining the covariance term in equation (12), it is clear that when $U''(\bar{I}) = 0$, the covariance term is also equal to zero. The implication of equation (12) is that the risk neutral firm hiring labor from the nonunion labor market sets wages equal to $w = E[MVP]$. However, when $U''(\bar{I}) \neq 0$, the sign of the covariance term can not be ascertained. If it is assumed that the input elasticity of the marginal product curve has an absolute value of less than one, then $\text{sign Cov} = \text{sign } U''(\bar{I})$:

$$\mathcal{E} = dh'(L_1)/dL_1 \cdot L_1/h'(L_1) = L_1 \cdot h''(L_1)/h'(L_1) > -1. \quad (13)$$

If equation (13) is true, then examining the derivatives of the two components of the covariance term with respect to v ,

$$d[v \cdot h'(L_1)]/dv = h'(L_1) \cdot [1 + \mathcal{E}] > 0, \quad (14)$$

and

$$dU'(\bar{I})/dv = U''(\bar{I}) \cdot p \cdot L \cdot h'(L_1), \quad (15)$$

verifies that $\text{sign Cov} = \text{sign } U''(\bar{I})$. That is, since the sign of equation (15) is dependent on $U''(\bar{I})$, and equation (14) is positive, sign Cov must equal $\text{sign } U''(\bar{I})$.

¹⁷ Input quality uncertainty refers to increased variability in the flow of labor services.

Applying this result to equation (12), the following condition is arrived at

$$p \cdot E[v h'(L_I)] \gtrless w, \quad (16)$$

depending on whether $U''(\bar{I}) \lessgtr 0$.

The economic interpretation of these results at the margin are: 1) the risk-neutral firm will hire nonunion labor at a wage equal to its $E[MVP]$; 2) the risk-averse firm will hire nonunion labor at a wage less than its $E[MVP]$; and 3) the risk-preferring firm will hire nonunion labor at a wage greater than its $E[MVP]$. The implications of these results are that a firm's input demand for nonunion labor is dependent on its attitude toward risk.¹⁸

VI. Labor Separation and Wage Differentials

In this section the analysis will begin with the assumption that the firm is risk neutral. As stated above, the supply of labor is segregated into two markets, union and nonunion, and the firm decides from which market it will hire labor. This market structure implies that there are actually two distinct labor markets facing the competitive firm. Thus, across the industry, some proportion of all firms will hire from the union labor market and the remaining firms will hire from the nonunion labor market. All firms will maximize profit by setting $MVP=MC$. Rearranging equations (6) and (12),

$$p = w/h', \quad (17)$$

and

$$p = [w - \{p \cdot \text{Cov}(U', v h') / E[U'(\bar{I})]\} / E[v h'(L_I)]]. \quad (18)$$

To simplify the analysis, replace w in equation (18) with w^* . Given that output price p is the same regardless of the input market the firm purchases in, the following equilibrium condition is derived from equations (17) and (18),

$$w/h' = [w^* - \{p \cdot \text{Cov}(U', v h') / E[U'(\bar{I})]\} / E[v h'(L_I)]]. \quad (19)$$

Equation (19) leads to the second proposition in the paper:

PROPOSITION II. *Risk neutral firms purchasing inputs from one of two (worker separated)*

¹⁸ These results concur with the results derived in the paper by Ratti and Ullah (1976).

distinct markets, where the two groups supply equal labor hours and differ only in the amount of information available on the flow of labor services, will purchase those inputs from the group with uncertainty about quality (flow of labor services) at a lower wage than from the group whose quality is known with perfect information.

To establish proposition II, it is assumed that the third derivative of the production function is negative. This implies that the marginal product function $h'(L_I)$ is itself a strictly concave function. This assumption is consistent with equation (13) and implies that $d^2\pi/dL_I < 0$. The implication of $h'''(L_I) < 0$ is that the *MPP* of L_I is a non-increasing function of L_I .¹⁹ Under the assumption that $h'''(L_I) < 0$ and employing Jensen's inequality the following result is attained:

$$E[h'(vL)] < h'(L). \quad (20)$$

Equation (20) implies that the risk-neutral firm's expected *MPP* generated by L_I is less than the *MPP* that would be achieved under conditions of certainty given the same factor combination. Certainty implies a situation where the random variable v is replaced by its expected value. Due to the greater *MPP* in the union sector, the union firm's labor demand curve is always greater than the nonunion firm's. Thus, the results derived in equations (19) and (20) imply that w must be greater than w^* for a risk-neutral firm facing a fixed level of labor input. Thus, proposition II is established.

Proposition II demonstrates that when an industry of perfectly competitive firms faces a competitive but segregated labor market structure where the two distinct factor markets vary only in the information available on quality, the result will be a *market* wage differential between union and nonunion labor. That is, all workers are paid their expected marginal value product. Consequently, union and nonunion workers receive unequal wage rates due to the uncertainty associated with the flow of labor services of nonunion labor. This proposition presents an interesting and plausible explanation for union wage differentials in the labor market without unions having market power.

If it is assumed that the firm is risk-averse, then equation (19) demonstrates that the degree of

¹⁹Ratti and Ullah note that this assumption is consistent with many of the common forms of production functions used in the economics profession.

wage differentials will increase. This last statement leads to the third proposition of the paper:

PROPOSITION III. *The size of union wage differential will vary positively with the degree of firm risk aversion.*

To establish proposition III, proposition II is reasserted. Proposition II established that w is greater than w^* for the risk-neutral firm. Then by equations (16 & 19), w^* must be greater than any w^{**} , the price that a risk-averse firm would pay for nonunion labor. Thus, proposition III is established.

VI. A Decrease in Uncertainty over the Flow of Nonunion Labor Services

In this section, the effect of a change in the amount of information available to the firm on the quality of labor services coming from the nonunion labor market is examined. A change in the amount of information available implies a change in the amount of uncertainty associated with nonunion labor. For example, the nonunion turnover rate in a specific industry converges to the union rate. To capture this effect of a marginal change in uncertainty, the distribution of v will undergo a mean preserving change in the dispersion of the distribution. The results developed below are only determinant in the risk-neutral case. A modification of equation (8) is now undertaken by replacing v with $v^* = (\alpha v + \beta)$, where α is a shift parameter and β is a function of α with the following properties:

1) $\beta' = -E[v] = -1$, and 2) $\beta(\alpha=1) = 0$. This transformation implies that $L_t = (\alpha v + \beta) \cdot L$.

Assuming the firm is risk neutral, equation (8) is now:

$$dE[\pi]/dL = E[p v^* h'(L_t) - w] = 0. \quad (21)$$

Replacing v^* with $(\alpha v + \beta)$, and renaming equation (21) $E[Z]$,

$$E[Z] = E[p(\alpha v + \beta) \cdot h'(L_t) - w] = 0, \quad (22)$$

the comparative static analysis can begin. Invoking the implicit function theorem around the equilibrium value of L and $\alpha=1$, then taking the total differential of $E[Z]$ and setting all of the differentials to zero except dL and $d\alpha$, the partial derivative $\partial L/\partial \alpha$ is:

$$\partial L / \partial \alpha = -E[\{p \cdot (v-1) \cdot h'(L_I) \cdot (1 + \mathcal{E})\} / \{p v^* h''(L_I)\}]. \quad (23)$$

The sign of the partial derivative derived above can be determined by examining the following relationship:

$$p \cdot E[(v-1) \cdot h'(L_I) \cdot (1 + \mathcal{E})] = \text{Cov}((v-1), h'(L_I) \cdot (1 + \mathcal{E})). \quad (24)$$

By ascertaining the sign of $\text{Cov}((v-1), h'(L_I) \cdot (1 + \mathcal{E}))$, the sign of the numerator of equation (24) can be determined. Examining the derivatives of the two components of the covariance term with respect to v ,

$$d[h'(L_I) \cdot (1 + \mathcal{E})] / dv < 0, \quad (25)$$

and

$$d(v-1) / dv = 1 > 0, \quad (26)$$

verifies that the sign of the covariance is negative. Thus, the sign of the partial derivative $\partial L / \partial \alpha < 0$.

This result leads to the last proposition of the paper:

PROPOSITION IV: *As uncertainty over the flow of labor services for nonunion labor decreases, the magnitude of the union wage differential in the industry declines.*

To establish the above proposition the implications of $\partial L / \partial \alpha$ are analyzed. The negative sign indicates that as quality uncertainty decreases, demand for L via the nonunion market increases. The implication is that, for a fixed level of **nonunion labor**, a decrease in uncertainty increases the expected *MPP* of **nonunion labor**. This indicates that $E[v h'(L_I)] < E[v^* h''(L_I)]$ when $\alpha < 1$. Examining this result in the context of equation (19), we can verify that an increase in the expected *MPP* of labor hired via the nonunion market will increase w^* relative to w . Thus, the degree of the union wage differential declines as uncertainty declines, and proposition IV is established.

VII. Wage and Labor Unit Effects

In this section we will discuss the effect of uncertainty over the flow of labor services on firm employment practices. Proposition I established that for a given level of labor input, the firm's output will be greater with union labor than for nonunion labor. This result is shown in figure 1a, a graphical

representation of equation (10). The graphical analysis demonstrates that the introduction of uncertainty reduces output from Q^c to Q^u .²⁰ Proposition II demonstrates that the marginal product of nonunion labor is less than the marginal product of union labor. This result is shown in Figure 1b. The graphical analysis shows that the introduction of uncertainty with a fixed level of labor input (L) reduces wages from w to w^* . If we assume an upward sloping market labor supply, w^* is not an equilibrium wage. To restore the equilibrium, the market wage for nonunion labor must rise to w_{r-a}^u , which reduces hours worked in the nonunion sector to L_{r-a}^u . The implication is that in the union sector the relative effects are higher wages and hours worked. Thus, proposition II supports Earle and Pencavel's finding of a positive association between unionization and wages and hours worked and the finding that the magnitude of the union-nonunion hours worked differential increases as the union-nonunion wage differential increases.

Proposition III demonstrates that for a risk-averse firm, the nonunion wage, w^{**} , given a fixed level of labor input, is even lower than the nonunion wage, w^* , for the risk neutral case. In Figure 1b, this effect is represented by the labor demand curve, MVP_{r-a}^u , which is farther to the left of the risk-neutral labor demand curve, MVP_{r-n}^u . Proposition III implies that the union wage differential and the hours worked vary positively with the level of firm risk aversion. Proposition III supports Earle and Pencavel's finding of a greater union effect on hours worked as the union wage effect increases (i.e., the more risk averse the firm the greater will be hours worked and wages paid). Hirsch and Morgan (1994) find evidence that union firms have a lower systematic risk component in their rate of return. This implies that risk-averse firms (which is consistent with lower beta values) may actually view union labor agreements as a management strategy to reduce risk exposure. A risk reduction strategy may explain the heavy concentration of unions in durable good manufacturing with much higher output

²⁰ The superscripts c and u denote the certainty and uncertainty cases, respectively. The subscripts r-a and r-n denote the risk averse and risk neutral cases, respectively.

fluctuation than other manufacturing industries.

Proposition IV establishes that the nonunion wage converges to the union wage as uncertainty over the flow of labor services declines. In Figure 1b, this convergence would cause a rightward shift in the risk neutral labor demand curve, MVP^u_{r-n} , toward the union labor demand curve, MVP^c . Proposition IV is consistent with empirical evidence indicating that progressive nonunion firms, through the use of innovative labor relation practices, can lower the rate of worker turnover and raise wages to near union scale (Foulkes 1980; Freeman and Medoff 1984, chapter 10). Thus, a nonunion firm's use of innovative labor relation practices acts much like an efficiency wage.

Also, proposition IV may provide an alternative explanation of the observed reduction in wage dispersion between skilled and unskilled workers in the union sector relative to the nonunion sector. Earle and Pencavel find the largest union hours worked differential for unskilled laborers. The next largest is for operatives, and the smallest hours worked differential is for skilled craftsmen. Thus, the change in the magnitude of the hours worked union-nonunion differential matches the change in the magnitude of the union-nonunion wage differential as the occupational categories increase in skill. Proposition IV suggests that as the uncertainty about labor quality declines, wages and hours worked will increase. Thus, the union voice mechanism may result in a greater reduction in the uncertainty of labor service flows for less skilled workers than for skilled workers, if it is easier to monitor skilled worker labor service in the nonunion sector than it is to monitor unskilled labor services.

VIII. Conclusion

A model of a competitive firm under uncertainty facing competitive output and factor markets is presented. The model assumes nonmonopoly union activity. The model incorporates the union voice effect into the model's framework. The model demonstrates that a positive union effect on 1) wages and 2) hours of employment is possible when it is assumed that the union voice effect reduces the variability in the flow of labor services for union workers as compared to nonunion workers.

The paper makes a contribution by providing a conceptual framework for explaining why the presence of a union in the work place may have a positive union voice effect on both wages and hours of employment. This paper makes an additional contribution by merging the literature on competitive firm behavior under uncertainty with the literature on labor union effects.

Proposition I demonstrates that the mere introduction of uncertainty over the flow of labor services will reduce firm output, as compared to firm output in a world of certainty about a fixed level of labor input.

Proposition II shows that for the risk neutral firm, the introduction of uncertainty over the flow of labor services reduces the marginal productivity of the nonunion labor unit relative to the union labor unit (or the certainty case). Consequently, given a fixed labor unit, the wage received by nonunion workers will be less than the wage received by union workers. At a market equilibrium, this implies a positive union wage differential and greater hours worked in the union sector.

Proposition III shows that the union wage differential and union hours worked will vary positively with the degree of firm risk aversion, suggesting that the more risk-averse firms become, the greater will be the union wage differential and the union effect on hours worked.

Proposition IV finds that as the uncertainty between union and nonunion labor quality declines, the union wage and hours worked differential will decline. Thus, with the elimination of uncertainty, the wage and hours worked will be identical for both union and nonunion labor services.

The results demonstrate that it is possible for union activity, by simply reducing the variance in labor service flows, to increase wages and employment without monopoly power. The paper provides a theoretical foundation for the beneficial effects of union activity. We are not dismissing the fact that unions do exert monopoly power. Instead, we assert that unions can have a positive effect on worker wages and hours of work without resorting to monopoly power.

A further extension of the theoretical issues addressed by this study will be pursued by

developing the long-run version of the model, as well as an empirical analysis of the testable hypotheses stated in propositions I through IV.

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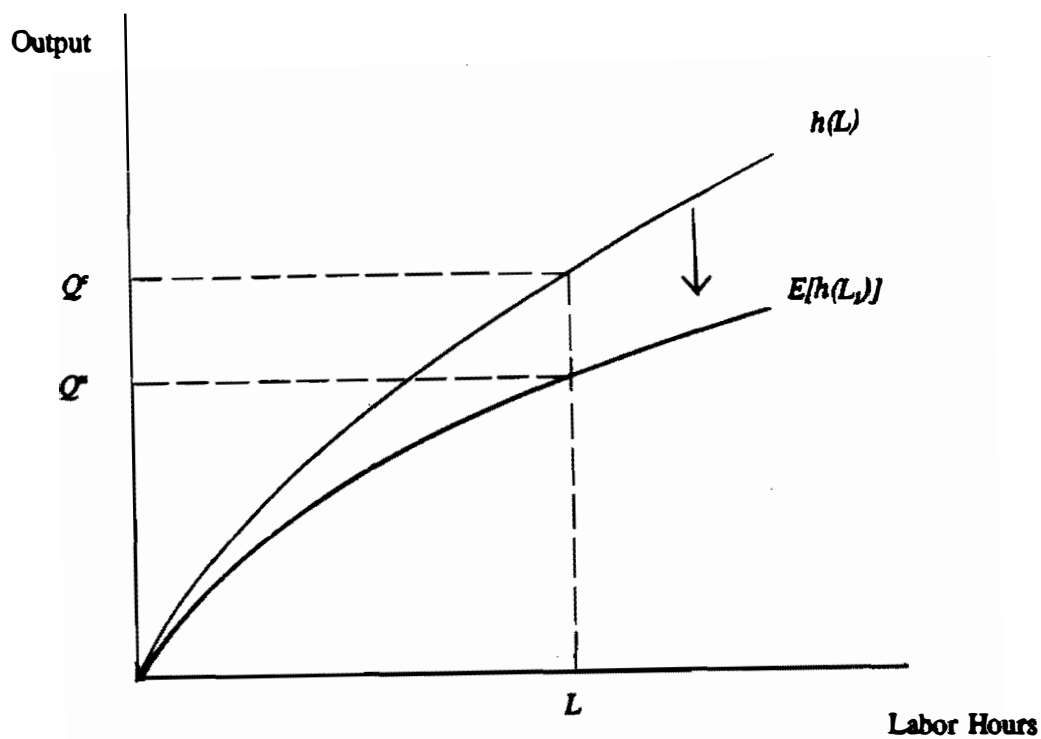
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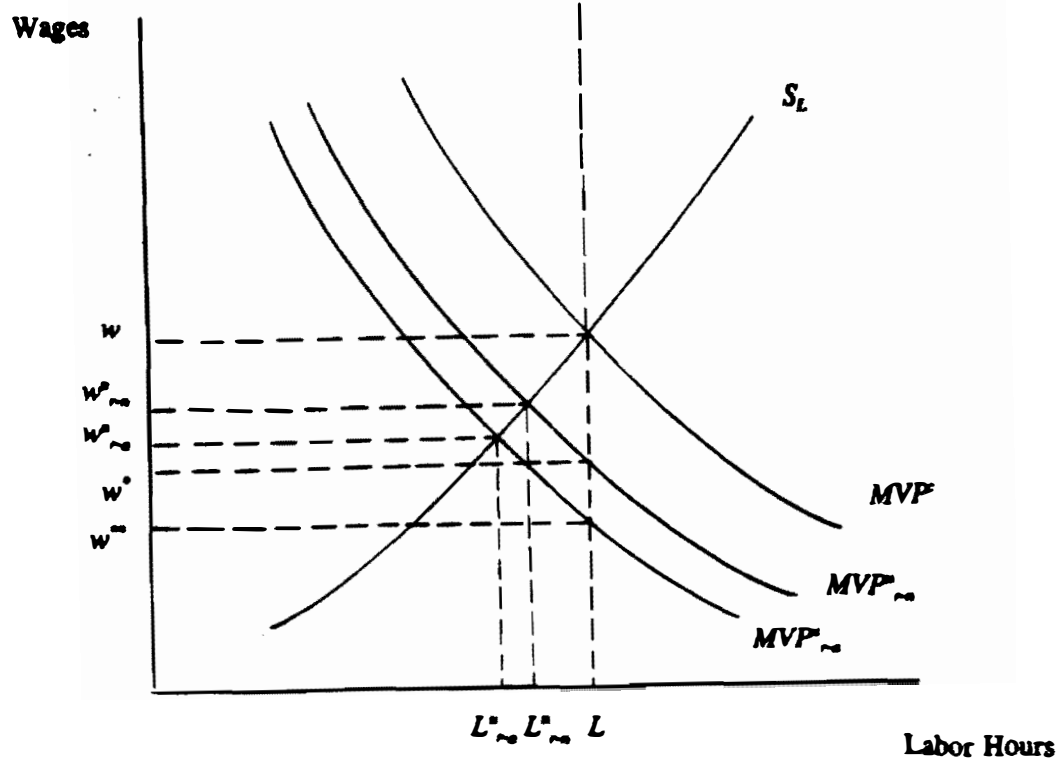
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Figure 1.

1a



1b



Wages	Labor Hours	Labor Hours	Output	1a	1b	MVP^c	MVP^u_{r-n}	MVP^u_{r-a}	w^{**}	w^*	w	w^u_{r-n}	w^u_{r-a}
Q^c	Q^u	L	L^u_{r-n}	L^u_{r-a}	$h(L)$	$E[h(L)]$							

The rapid decline in union sector employment during the 1980s while the union wage gap remained around 20% is *ad hoc* evidence of monopolistic union behavior and may reflect the semi-efficient bargaining and potential end game effects.²¹ Linneman *et al* (1990) argue that rising union wage differentials throughout the 1980s explained as much as 50 percent of the decline in union densities in certain industries.

Farber (1990) provides evidence that the rate of decline in union coverage was greatest in the heavily unionized industries (hence, shifts in the industrial structure are not the primary cause of the decline in the proportion of union employment). Farber's empirical results also indicate that increased firm resistance has largely accounted for the decline in the percentage of union coverage. One plausible explanation is that increasing international trade shares have increased product market competitiveness and resulted in more aggressive firm resistance.²² Farber also finds that demand for unions declined in the 1970s and 1980s primarily because of an increase in nonunion job satisfaction and a decline in workers' perceptions that unions can raise wages and improve employment conditions. Also, the passage of state and federal laws that restrict arbitrary employment dismissal may have reduced the demand for union representation. If the change in workers' preferences are related to fears of job loss, then the decline in union coverage is also related to union monopoly power.

Rather than competitive pressure, Dickens and Leonard (1985) show that much of the decline in union participation from the 1960s to the 1980s was primarily due to a shift in production from manufacturing to the services and high technology sectors which are considerably less unionized and to changes in labor-force demographics which resulted in a higher proportion of highly educated, white-collar, and female workers who tend to have lower demand for union representation. Voos (1984) shows that unions have not increased real expenditures on organizing elections nor have they attempted to aggressively organize the expanding sectors of the economy. Moreover, much of the decline in union coverage may be due to aggressive firm resistance related to drastic changes in the political environment of the 1980s (Freeman and Kleiner, 1990; Linneman *et al*, 1990).

The union sector continues to decline as percent of nonagricultural employment. This is true whether the union sector is measured in terms of union membership or union density (member and nonmember workers covered by union contracts as a percentage of nonagricultural employment). Union membership has declined from 18.0 percent to 14.1 percent from 1985 to 1997, and union density declined from 20.5 percent to 15.6 percent, respectfully. This trend has persisted throughout the 1990s in the presence of continued economic expansion and an unemployment rate that has fallen below 5 percent. Percentage union membership and union density have declined because the number of union members and number of workers covered by union contract continues to decline in the presence of strong employment growth. In fact, private nonagricultural employment in the union sector declined from about 11.3 million in 1990 (13.4% of total private employment) to 10.2 million in 1997 (10.8% of total private employment). Over the 1990s, union sector employment remains relatively stable only in the government sector (7.69 million workers or a 43.3% union density in 1990 versus 7.67 million workers or a 42.3% union density in 1997). The only time union membership and worker coverage actually increased was between 1993 and 1994, a time when economic expansion was

²¹Lawrence and Lawrence (1985) suggest that unions may use an end game strategy that trades off future jobs for higher current wages and employment in declining industries since they have limited opportunities to invest in new capital.

²²Firms cannot be perfectly competitive and share economic rents with unions; otherwise, the higher union wage levels would make these firms unprofitable and drive them out of business.

eliminating excess productive capacity.

Is the trend in union membership and union density *ad hoc* evidence of a long-run market response to unions behaving as labor cartels? Perhaps; and perhaps not. From 1980 to 1985, union membership declined by 25.7 percent (a decrease of 5.9 million members or an average of 1.2 million per year). Between 1985 and 1997, however, union membership fell only 5.2 percent (a decrease of 886,000 members or an average of 126,600 members per year), which is indicative of stabilizing union sector employment.²³ This suggests that there is a fairly stable core of union employment. Again, the union voice literature suggests that unions have both a "good" and "bad" face. The persistent decline in both union membership and union density may reflect the long-run consequences of a monopoly union effect. However, the flattening out of the decline in unionization may also reflect the "good" face of unions.

²³From Bureau of Labor Statistics, *Earnings and Other Statistics of Organized Workers*, Bulletin 2105, for 1980; From U.S. Department of Labor, *Employment and Earnings* (January 1986, 1991, and 1998), for 1985, 1990, and 1997, respectively.