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INTERNATIONAL COMPETITION AND
THE UNIONIZED SECTOR*

by

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ABSTRACT

In this paper I study the wage and employment behavior of a unionized sector that is confronted by an intensification of international competition. After developing a formal model of a monopoly union subject to majority rule, I study the response of a unionized sector operating under a seniority system for layoffs and rehires to a trend decrease in the international price of its output. Conditions are provided to validate the casual argument that majority voting in unions and the seniority system together provide an explanation for the lack of union wage adjustment. In order to highlight the role of seniority rules per se, I compare the wage response derived from the model to that which obtains when the layoff queue is determined by a random draw.

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I. INTRODUCTION

International competition which takes the form of a decline in the price of a substitute foreign good often effects an increase in the level of industry unemployment, while sectoral wages are "sticky downward". This observation has led trade theorists to extend to an open economy context a model first developed by Harris and Todaro (1970), which incorporates a sector-specific rigid wage and associated industry-specific unemployment. This model has been used extensively to investigate appropriate policy responses to international competition in this second-best setting.

A deficiency common to most of these analyses is that the level of the rigid wage is specified exogenously, and its cause is rarely discussed. For justification, appeal is sometimes made to the pressures of unions, but no attempt is made to model the union behavior that might give rise to the observed wage stickiness. At a more informal level, however, an explanation for this phenomenon has been suggested. It is casually argued that in the face of increased international competition union wages do not fall because union votes are swayed by senior workers for whom the probability of layoff is quite small.

The purpose of this paper is to investigate the wage and employment behavior of a unionized sector that is confronted by international competition. Two questions are addressed. First, how will a unionized sector operating under a seniority rule for layoffs and rehires respond to a trend decrease in the international price of its output? Second, what importance can be attached to
the seniority system in determining this response? In other words, would wages respond more flexibly if the layoff decision were based on criteria other than seniority, which might be less observable to workers?

To answer these questions, a model of the unionized sector I have developed in Grossman (1983) is adapted to an open economy setting. The salient features of this model, which is reviewed in Section II, are that (i) layoffs and rehires are based on seniority; (ii) the union wage demand emerges from a majority vote among union members; and (iii) the membership of the union is determined simultaneously with the wage demand by a steady-state equilibrium condition. In Section III, I apply this model to study how a fall in the international price of the sector's output will affect wages, union size and industry unemployment. Then in Section IV I compare the wage- responsiveness results for this model to those which emerge from an analysis based on the recent works of McDonald and Solow (1981) and Oswald (1982), in which the layoff queue is determined by a random draw.

II. THE MODEL

This section develops the basic model of the unionized sector which I shall use in the following sections to investigate the effects of international competition. The model presented here modifies that in Grossman (1983) to allow for the existence of an internationally-traded good which substitutes perfectly for the output of the unionized sector.

Consider, then, a small open economy that comprises two sectors. The outputs of both sectors are internationally traded,
and the world prices are taken to be exogenous. In the nonunion sector, which is intentionally made as simple as possible, the numeraire good, X, is produced by labor alone, according to a constant returns to scale technology. One unit of good X is assumed to require $1/\bar{w}$ units of labor, so that $\bar{w}$ is the prevailing wage in the nonunion sector by the zero-profit condition.

The union-sector good has international price $p^*$. Letting $v(p, w)$ be the indirect utility function of all workers, the utility of nonunion employment is given by $v(p^*, \bar{w})$. To further simplify the analysis of the wage demands of the union, I assume that the union good constitutes a negligible fraction of the consumption basket. Thus, the indirect effect of international competition (i.e. changes in $p^*$) on worker's utility as a function of his consumption behavior can be ignored, and we concentrate instead on its direct effects on the factor income of union members. With this assumption, the utility of nonunion workers is now written simply as $v(\bar{w}) \equiv \bar{v}$.

Output in the union sector requires labor and sector-specific capital. The production function for good $Y$ is

$$Y = \theta F(K, E)$$

(1)

where $K$ is the fixed stock of sector-specific capital, $E$ is the level of sectoral employment, and $\theta$ is a stochastic variable, assumed to be uniformly distributed on $[B-1, B]$. $\theta$ represents a random element in the production technology, and therefore the demand for labor, which is assumed to be unknown at the time
of labor negotiations. Uncertainty is resolved prior to the
time that employment and output decisions are made.

I assume that all workers have identical skills, and that
job sharing is ruled out with reference to a non-convexity in
the technology. Then $E$ represents the number of jobs, in addi-
tion to the labor input. Define $f(E) \equiv \partial F(K, E)/\partial E$, with de-
creasing returns to labor for fixed capital input implying that
$f'(E) < 0$. Then the marginal value product of labor is given
by $p^\star \partial f(E)$.

I make a number of simplifying assumptions concerning the
form of the labor contract and the nature of wage-setting pro-
cess. These assumptions have the virtue of according fairly well
with observed actions in many instances, but cannot be explained
by optimizing behavior derived strictly within the model. In
each case, I must appeal to transactions costs that are left
outside the analysis. First, I assume that the union in this
section has monopoly power vis-a-vis a large number of perfect-
ly competitive firms in the industry. However, the monopoly
power is assumed to extend only to the specification of wages,
and firms are left free in the labor contract to choose the le-
vel of employment once the state of nature is realized. McDonald
and Solow (1981) and Hall and Lillien (1979) have pointed out
and analyzed the inefficiency inherent in unilateral determi-
nation of employment by management.

Second, it is assumed that all workers are paid at the
same rate, irrespective of seniority. It is true that all union members in the model would prefer a wage schedule based on seniority, which, together with the layoff rule, would allow the union to operate as a discriminating monopolist. However, such schedules might be costly for the union to negotiate with the firms, since one of the supposed advantages of collective bargaining is that each wage need not be determined individually.

Third, I assume that the labor contract does not involve state-contingent wages. Admitting the possibility of state-contingent contracts into the union's internal discussions might make the deliberation process difficult and costly, as workers preferences over such schedules would differ in a complicated way. Furthermore, contingent contracts often entail substantial costs for monitoring and enforcement.

Finally, I rule out transfers within the union, such as, for example, internally-administered unemployment insurance schemes. Once again, the social choice process for the union would be exceedingly complex if such side-payments were allowed. With these four assumptions, the labor contract is fully described by a single, state-independent wage rate that is paid to all and only employed workers, which I refer to as the wage demand.

Next, in order to capture the costs associated with temporary layoffs, I draw a distinction between the ex ante and ex post costs of labor mobility. I assume that a worker who leaves
the union sector "between" contract periods can earn in the
next period the full nonunion-sector wage \( \bar{w} \). In contrast,
a worker who chooses to remain in the unionized sector,
and then is laid off involuntarily "during" the contract
period, attains a utility level for that period of \( v_o < \bar{v} \).
A positive difference, \( \bar{v} - v_o > 0 \), can arise, for example,
because a worker who chooses voluntarily to leave the union-
ized sector can await a particularly favorable offer outside
the sector, whereas one who is laid off from a union-sector job
may be forced to accept employment after a shorter period of
search. Alternatively, a decision to await recall to a union-
sector job may restrict the geographical region in which a wor-
ker can accept temporary employment outside the union sector,
and thus yield a wage lower than the best alternative uncon-
strained by location. Note that it is immaterial to what
follows whether or not the worker is actually unemployed for
the duration of the contract period, as is often assumed, for
example, in the implicit contracts literature.\(^6\) What is needed
is only that there is a sense in which a worker besides whether
to "stay in" or to "leave" the unionized sector, and that the
former choice entails some excess cost should a layoff occur.

The final assumption of the model concerns the proce-
dure governing the union's choice of its wage demand. Following
Atherton (1973) and especially Farber (1978), I suppose
that the union follows a process of majority voting. Union mem-
bers are indexed by \( i \in [0, L] \), where \( L \) is the size of the
union's membership. The index \( i \) represents seniority (i.e. place in the layoff queue), with \( i = 0 \) the most-senior member and \( i = L \) the least-senior member. All workers are aware of their (relative) seniority ranking. Each union member has wage preferences which depend systematically on his seniority, but all preferences are single-peaked. This implies the existence of a unique voting equilibrium, with the property that the union's wage demand maximizes the utility of the median (in terms of seniority) worker.  

It is now straightforward to describe the equilibrium in this economy. The probability of employment for a union member with seniority index \( i \), \( \pi_i \), given the union wage demand \( w \), is

\[
\pi_i = \Pr(p^*f(i) \geq w) \\
= \Pr(\theta \geq w/p^*f(i)) \\
= \min[B - w/p^*f(i), 1]
\]

(2)

The expected utility of a worker with index \( i \) is

\[
u_i = \pi_i v(w) + (1 - \pi_i)v_o
\]

(3)

The union maximizes the utility of the median worker, who has index \( L/2 \). The solution to this maximization is illustrated in Figure 1. The indifference curves deriving from (3),
for any given worker, are downward sloping and convex. Utility is maximized where the constraint relating the wage to probability of employment, as expressed in (2), is tangent to the indifference curve. More formally, the first order condition for the maximization of the utility of the median worker is

\[ (B_p f(L/2) - \omega) v'(\omega) = v(\omega) - v_0 \]  

(4)

The union's wage demand depends upon who is the median worker, and therefore on the size of the union. If the union contracts in size, the identity of the median worker changes to one with a higher seniority index. This "new" median worker is closer to the top of the job queue, and requires the realization of a less favorable state of nature than does the "old" median.
to guarantee his employment. Referring once again to Figure 1, we see that the median of a large union (with index $i_1$) faces a worse tradeoff between wage and probability of employment than does the median of a small union (with index $i_0 < i_1$), and hence prefers a lower wage. This relationship between the size of the union and the wage demand is termed the voting schedule, and depicted as the downward sloping curve, $W^d$, in Figure 2. The curve has slope

$$\frac{dW}{dL} \bigg|_{W^d} = \frac{B/2p^2f'(L/2)}{v(w) - \frac{v_0}{W^d'(w)}} R + 2 < 0$$

where $R$ is the coefficient of relative risk aversion, defined to be positive. When risk aversion is great, so that a marginal increase in the probability of unemployment has a large negative effect on utility, workers have approximately the same most-preferred wage, and the voting schedule is relatively flat.

A second relationship between the wage and the size of the union (measured at the start of a contract period), obtains in a long-run, steady-state equilibrium in which "closed-shops" are absent. The labor laws of the United States and some European countries forbid firms from making union membership a prerequisite for job offers. Under such conditions, entry into the union sector cannot be restricted
by the union, as nonunion members will have the opportunity to enter the sector whenever the demand for labor at the going union wage exceeds the union size. The union might, however, restrict entry into the union, so as to achieve a homogenous voting pool with similar wage objectives. But membership restriction among the sector's employees would entail the loss of membership dues from workers who would then be free riders on the costs of contract negotiation. It seems plausible, therefore, to assume that once a worker is offered employment in the union sector, he may, if he chooses (or, perhaps, will be required to) join the union.
As already mentioned, entry into the union sector, and hence into the union itself, will occur over time in favorable states of nature. The workers so hired will choose to stay in the union at the end of the contract period if their expected utility from remaining exceeds the utility, \( \bar{v} \), associated with employment outside the union sector. A steady state is reached when the least senior worker in the union is just indifferent between the expected utility associated with staying in the union sector and that available to him elsewhere. I term this indifference relationship the membership schedule, and write it algebraically as

\[
\pi_L v(w) + (1 - \pi_L) v_o = \bar{v}.
\]

or substituting equation (2),

\[
(v(w) - v_o)[B - w/p \cdot f(L)] = (\bar{v} - v_o).
\]  \( (5) \)

It is depicted as MM in Figure 2 and has slope

\[
\frac{dw}{dL} \bigg|_{MM} = \frac{-(v(w) - v_o)wf'(L)/f(L)}{[Bp \cdot f(L) - w]v'(w) - (v(w) - v_o)}.
\]

This is negative in the neighborhood of the VV curve, because an increase in wage lowers the utility of the least senior worker (who is most concerned with employment prospects) and causes the union to contract.
Equations (4) and (5) together determine the steady-state allocation of resources between the union and nonunion sectors, the wage in the union sector, and the employment (and hence unemployment) there in all states of nature. The steady-state equilibrium shown in Figure 2 is stable under plausible assumptions about dynamic adjustment, so long as the MM curve is steeper than the WW curve. I assume this to be the case throughout.

III. THE EFFECTS OF INTERNATIONAL COMPETITION

We are now prepared to answer the first question raised in the introduction, namely: what effect does a permanent increase in international competition have on the long-run equilibrium in an industry with unionized workers and a layoff and rehire rule based solely on seniority? To do so, we perturb the equilibrium described in Section II by changing the international price of the sector's output to a new (and lower) level, \( p_1^* = p_0^* + dp^* \).

The intensification of international competition affects both the voting and membership schedules. The fall in \( p^* \), \textit{ceteris paribus}, decreases the probability of employment of the original median worker at the initial equilibrium wage. Therefore, at the new price the original median worker prefers a lower wage to partially offset this worsening of his employment prospects (see Figure 3). The upshot is a downward shift of the WW schedule as shown in Figure 4, by an amount
Figure 3: International Competition Lowers the Most-Preferred Wage

\[
\frac{\partial W}{\partial p^*} \bigg|_{\nu \nu, \ dL=0} = \frac{Bp^*f(L/2)}{R[Bp^*f(L/2) - w] + 2w} > 0
\]

where a circumflex indicates a proportional derivative. Note that a sufficient condition for the fall in the most-preferred wage of a given worker to less than fully compensate for the price decline is \( R > 1 \). In this case the (product) real wage rises and the probability of employment falls (as drawn in Figure 3).

It will prove useful below to have the expression for the leftward shift of the \( \nu \nu \) curve (i.e. at constant wage). It
is given by

\[
\frac{\dot{L}}{p^*} = \eta(L/2)
\]

where \( \eta(i) \equiv -f(i)/if'(i) \), is the elasticity of the demand for labor schedule, evaluated at employment level \( i \). We can interpret this expression as the amount that the union would have to shrink such that the smaller union, with a more senior median worker, would vote for the same wage at the lower international price as the larger union did at the initial price.

The trend worsening of the industry's condition also causes the union to shrink (at a given wage). Given the wage, the decrease in employment probability of the original least-senior workers lowers their expected utility and causes them to leave the union sector. The result is a leftward shift of the MM schedule (see Figure 4) given by

\[
\frac{\dot{L}}{p^*} = \eta(L)
\]

where we recognize that \( \eta(L) \) is the elasticity of demand for labor at the point where the least-senior worker is just employed.

If the demand for labor is elastic (i.e. the marginal product schedule is inelastic), then as the price falls the decline in employment in any given state of nature will be large, the probability of employment for less-senior workers will decrease precipitously, and the MM curve will shift by a large amount.
Figure 4: Effects of International Competition on Unionized Sector Equilibrium

Evidently, international competition has two offsetting effects on the equilibrium wage rate in the unionized sector. On the one hand, a union of given size will vote for a lower wage, because at least some of the workers will find that the likelihood of their being laid off has increased. But at the same time, international competition tends, *ceteris paribus*, to cause the union to contract. This decline in union membership is not neutral with respect to the union's voting profile. Rather, the workers who exit are drawn exclusively from those who previously had the lowest most-preferred-wage rates (i.e. those who were least senior) and who therefore had exerted a moderating influence on the wage demand in the union's deliberation process. The contraction of the union causes there to be a new median worker who is closer to the top of the job ladder,
and who has a higher most-preferred wage than does the worker who was formerly at the median.

It is straightforward to show (by total differentiation of (4) and (5)), that

\[
\text{sgn}\left( \frac{\partial w}{\partial p^*} \right) = \text{sgn} \{ \eta(L/2) - \eta(L) \}.
\]

When \( \eta(L/2) > \eta(L) \), the leftward shift of the WW curve is greater than the leftward shift of the MM curve, and a lower union-sector wage obtains in the new equilibrium. In this case, the effect of the international competition on the employment prospect of the median worker exceeds the effect on that of the least-senior worker. It can be shown that \( R > 1 \) is sufficient for wages to fall proportionately less than does the international price, i.e. that the wage adjustment is less than complete. Since employment and hence output in any state of nature is a decreasing function of the real wage, this condition guarantees a normal output-price response.

When \( \eta(L/2) = \eta(L) \), as certainly holds, for example, if the labor demand schedule has constant elasticity everywhere, the long-run wage in the unionized sector is completely inelastic with respect to changes in the price of the good produced in the sector. In this case, all adjustment to international competition takes place through movements of workers into and out of the sector. Whereas the short-run wage within a contract period is rigid by assumption, the constant elasticity of labor demand case gives rise here to a long run wage in the sector that is endogenously sticky.
Finally, if $\eta(L) > \eta(L/2)$, the wage will actually rise when the price falls, forcing even greater adjustment in the size of the sector. In this case, the decline in each worker's individual most-preferred wage is more than offset by the effect of the change in the identity of the median worker in the union. A majority of the more senior union is sufficiently less concerned with layoffs that a higher wage demand emerges from the union vote.

The conditions on the elasticity of the demand for labor schedule can be related to the parameters of the underlying production function in the industry. Consider, for example, the case where that function has constant elasticity of substitution, $\sigma$, between capital and labor: partial wage adjustment occurs for $\sigma < 1$; wage movement in the opposite direction occurs for $\sigma > 1$; and endogenous wage stickiness corresponds to the Cobb-Douglas ($\sigma = 1$) case.

Turning now to the adjustment of union size in response to international competition, this is given by the solution, after totally differentiating (4) and (5), for $\hat{L}/\hat{p}^*$. As can be seen from the diagram (Fig. 4), an increase in union size is possible only if the leftward shift of the $VV$ curve is much greater than that of the $MM$ curve, and if the $VV$ curve is relatively steep. The algebra confirms this, and shows the $\eta(L) \geq \eta(L/2)$ or $R > 1$ is sufficient for the union to shrink. Only if the elasticity of substitution between capital and labor is very low and workers are very tolerant of risk can the union expand when competition intensifies.
A final variable of interest is the layoff rate in the industry. Layoffs occur because the wage is rigid within any contract period. Thus, the number of layoffs is a function most directly of the value taken by the random technology variable. However, changes in the extent of trend international competition have a long-run influence on the number of layoffs for any given realization of the random variable, via their effect on both the supply of and demand for labor in the sector.

Define the industry layoff rate in state of nature \( \theta \) as
\[
z(\theta) = \max \{0, [L - E(\theta)]/L\}.
\]
Then for periods in which the number of layoffs is positive we have
\[
\frac{dp^*}{dp} = \frac{E(\theta)}{L} \left[ \frac{\hat{p}^*}{\hat{p}^*} - \frac{L}{\hat{p}^*} + \eta(\hat{E}(\theta))(\frac{\hat{p}^*}{\hat{p}^*} - 1) \right]. \tag{5}
\]

Consider first the Cobb-Douglas case, for which the elasticity of the labor demand schedule is constant. Then a fall in the international price causes the union to contract by \( \eta dp^* \). But since in this case, as we have seen, the wage rate remains constant, labor demand in every state of nature also falls by \( \eta dp^* \). Thus, when the production function is Cobb-Douglas, international competition has no effect on the rate of industry unemployment in the unionized sector in any state of nature.

For more general production functions the analysis is rather complicated. After substitution in (5), it can be shown that
\[
\text{sgn}\left( \frac{\partial z(\theta)}{\partial p^*} \right) = \text{sgn}\left\{ \frac{w[v(w) - v_0]^2}{v'(w)} (R - 1) \left[ 1 - \frac{\eta(E)}{\eta(L)} \right] \\
\quad + w^2[v(w) - v_0] \left[ 1 - \frac{\dot{\eta}(E)}{\dot{\eta}(L)} \right] \\
\quad + Bp^*f(L/2) \left[ Bp^*f(L) - w \right] wv'(w) \left[ 1 - \frac{\eta(E)}{\eta(L/2)} \right]\right\}
\]

If \( R \) is large and \( \eta(E) \) is a decreasing (increasing) function (e.g. \( \sigma < 1 \) (\( \sigma > 1 \)) in the CES case) then the industry layoff rate is likely to increase (decrease) when \( p^* \) falls in all states of nature except those with nearly full industry employment. Unfortunately, not much more can be said about the number of layoffs, even in the CES case.

To summarize, we have seen that casual arguments to the effect that union voting behavior gives rise to wage stickiness in the face of international competition may indeed contain an element of truth for some production technologies. In fact, for unionized sectors with elasticities of substitution between labor and other fixed factors greater than one, the direction of union wage movement can be opposite to that of the price of the sector's output. In these cases, large adjustments in sectoral allocation of labor are necessitated, with the attendant political problems. For almost all reasonable parameter values, international competition does cause the union sector to contract, a plausible conclusion regarding resource reallocation. Finally, a permanent change in international competition may increase, decrease or leave unchanged the average long-run rate of industry unemployment.
IV. DOES THE SENIORITY RULE CONTRIBUTE TO WAGE STICKINESS?

Can the blame for wage sluggishness in unionized sectors following a fall in the international price be attributed entirely to the seniority system? In order to answer this question, we must investigate the behavior of a unionized sector which is in every way identical to that studied in the preceding sections except as regards the way in which the layoff decisions are made. To do so, I draw on the recent works of McDonald and Solow (1981) and Oswald (1982), who have studied union behavior under the assumption that every union member has an equal probability of obtaining one of the available union-sector jobs.

Suppose then, in contrast to the model of sections II and III, that the layoff ordering is determined by random draw. Then all workers are ex ante identical, and each has a probability of employment, \( \tilde{\pi} \), given by

\[
\tilde{\pi} = \frac{1}{L} \int_{B-1}^{B} E(w/\theta p^*) d\theta
\]  

(6)

The union voting process, which in this case will exhibit unanimity, gives rise to a wage which maximizes \( \tilde{\pi}v(w) + (1-\tilde{\pi}), v_o \); i.e., the union wage demand satisfies

\[
\left[ \int_{B-1}^{B} \frac{E'(w/\theta p^*)}{\theta p^*} d\theta \right] [v(w) - v_o] + \left[ \int_{B-1}^{B} E'(w/\theta p^*) d\theta \right] v'(w) = 0
\]  

(7)

It should be noted that the size of the union's membership does not enter into (7), and therefore has no effect on the union's wage demand.\footnote{The union size can then be determined...}
residually by, for example, an indifference condition analogous to equation (5) above.

The union wage response to international competition in an institutional setting where the seniority system is completely inoperative is found by differentiating (7) with respect to \( p^* \). The resulting elasticity expression, denoted \( (\hat{w}/\hat{p}^*)_{NS} \) (where NS stands for "no seniority") is

\[
\left( \frac{\hat{w}}{\hat{p}^*} \right)_{NS} = \frac{\alpha + \beta - \gamma}{2\alpha + \beta \gamma - \gamma}
\]

where

\[ \alpha = \frac{wv'(w)}{p^*} \left[ \int_{B-1}^{B} \frac{E'(w/\delta p^*)}{\delta} \, d\delta \right] > 0 ; \]

\[ \beta = v'(w) \left[ \int_{B-1}^{B} E(w/\delta p^*) \, d\delta \right] > 0 ; \]

\[ \gamma = \frac{w(v(w)-v_c)}{p^*} \left[ \int_{B-1}^{B} \frac{E''(w/\delta p^*)}{\delta^2} \, d\delta \right] \]

A sufficient (but not necessary) condition for \( (\hat{w}/\hat{p}^*)_{NS} > 0 \) is \( E''(w/\delta p^*) \leq 0 \). In the CES case, this is satisfied for \( \sigma < (2\kappa-1)/(1+\kappa) \), where \( \kappa \) is the elasticity of output with respect to labor, and must lie between zero and one. In general, not much more can be said about (8), so it is necessary to turn to some special cases for further insight.

Consider once again the example of a Cobb-Douglas industry production function. It is straightforward to show that for this
case, the price, $p^*$, can be cancelled from both sides of (7), so that the union wage is independent of the extent of international competition. Thus, the existence of a seniority rule for layoffs is not essential to the wage stickiness result for the Cobb-Douglas case. However, the explanation of the result is somewhat different in the alternative institutional scenarios.

Under a seniority rule for layoffs, if the size of the unionized sector were to remain constant, then an intensification of international competition would cause a decline in the union's wage demand. However, the induced change in the union's membership exerts a further influence on the union wage which, in the Cobb-Douglas example, fully offsets the direct effect. The wage stickiness should not, therefore, be attributed to the callousness of a given median worker who lacks concern for his junior co-workers, but rather to the change in the profile of the union's voting pool which inevitably results from the inter-sectoral reallocation of resources.

When, instead, layoffs are determined by random draw, a union of given size will, in the Cobb-Douglas case, choose not to change its wage demand after $p^*$ falls. It follows, therefore, that the attractiveness of being in the union sector must decrease, since the wage is constant and the probability of employment falls. Here too labor will shift out of the unionized sector. However, in this case the departing members are exactly like those who remain, and the change in the union's membership has no effect on the outcome of the union's voting process.
As a second example, suppose that the industry labor demand schedule is linear and is given by \( E(\omega/\theta) = a-b\omega/\theta \). If the seniority rule does not apply, then the elasticity of the wage with respect to the international price

\[
\frac{\hat{\omega}}{\hat{p}^*} = \frac{ap^*}{Rap^* + (2-R)bw \log[B/(B-1)]}
\]  

(9)

A plausible value for the coefficient of relative risk aversion is two,\(^{13}\) in which case \( \left(\frac{\hat{\omega}}{\hat{p}^*}\right)_{NS} = 1/2 \).

When the seniority rule is operative, then the change in the wage which emerges from majority vote among a union of given size is

\[
\left. \frac{\hat{\omega}}{\hat{p}^*} \right|_{VV,dL=0} = \frac{Bp^* (a-L/2)}{Rbp^* (a-L/2) + (2-R)wb}
\]  

(10)

Again setting \( R=2 \) for illustrative purposes, we find that \( \left(\frac{\hat{\omega}}{\hat{p}^*}\right)_{VV,dL=0} = 1/2 \). That is, when labor demand is linear and \( R = 2 \), a union of given size will choose via majority voting to respond to output price changes in exactly the same way (in percentage terms), regardless of whether layoffs are determined by seniority or by random draw. But now when we allow for the induced change in the size of the union's membership, we find that wage is less price responsive when the union operates subject to the seniority rule. For, under the seniority system, the movement of labor out of the unionized sector causes an
increase the wage, so that $\left(\hat{\omega}/\hat{p}^*\right)_S < 1/2$. The fall in union membership has no effect in the no-seniority case.

To summarize, it seems that the role of the seniority system in the determination of the wage response to intensification of international competition is a complex and ambiguous one. It would not be correct to say that the existence of a seniority structure is "the explanation" for the failure of wages to adjust in response to adverse demand shocks. Indeed, the wage elasticity under a system of random determination of layoff queue might be less than, equal to, or greater than that which obtains when seniority hierarchies are important.

Under seniority rule, an essential factor in the determination of how any exogenous shock alters the union's wage demand is the effect that the shock has at a given wage on the the probability of employment of the median worker. Under random draw for layoffs, it is the average probability of employment that is critical. The relationship between these two probabilities depends upon the curvature of the employment function, which in turn is related to the third derivative of the underlying production function.\(^{14}\)

One somewhat general principle does emerge from the analysis. We have noted that an intensification of international competition can influence the union wage via two channels, namely: (i) a union of given size may alter its wage demand when confronted with new labor demand conditions; and (ii) resources may shift out of the declining sector, and the attendant change in union membership
may further influence the outcome of the union's internal political process. It is difficult to compare the first of these effects under the alternative institutional assumptions. But the second generally favors an (algebraically) smaller wage responsive in the case of a seniority system. The workers who leave first from the union sector under seniority rule are those who have the lowest wage demands. Their departure systematically alters the balance of power in the union's political deliberations, and introduces a tendency for wages to rise. When, instead, the union jobs are awarded randomly, all workers are identical, and those who exit are a representative sample of the initial membership. Thus, the profile of workers in the union is not affected by changes in the size of its membership, and the wage is influenced little or not at all by such changes.

V. CONCLUSIONS

In this paper, I have investigated the casual argument that majority voting in unions and the seniority system together provide an explanation for the failure of union wages to adjust in response to intensification of international competition. In the context of a formal model of a small union sector embedded in a two-sector economy, I have shown that the elasticity of the union sector wage with respect to changes in the international price of the sector's output depends critically on the production technology in that sector. In the Cobb-Douglas case the long-run equilibrium wage in the union sector is "endogenously sticky". A perhaps surprising result is that when the elasticity of the
marginal product of labor schedule is a decreasing function of the level of employment, a decline in the international price of the union-sector good causes the wage rate in that sector to rise.

The seniority system, in and of itself, is not the sole explanation for the failure of union-sector wages to adjust to international price changes. Indeed, endogenous wage stickiness can also emerge from analysis of a model in which all workers are identical, and jobs are allocated by random draw. In general, it is hard to judge on theoretical grounds whether the existence of a seniority system reduces wage responsiveness. The question must be left for empirical scrutiny.

Welfare statements do not follow immediately from the present analysis. Here I have been concerned solely with positive questions of the effect of international competition on union wages, union size and sectoral unemployment. But the potential scope for trade policy is evident, if the market distortions described here accurately reflect aspects of the real world. An advantage that the present formulation offers for studying trade policy is its ability to incorporate the effects of anticipated government intervention on the wage demands set by unions. The normative questions are left for future research.
FOOTNOTES

1. See, for example, Bhagwati and Srinivasan (1974), Srinivasan and Bhagwati (1975), Corden and Findlay (1975) and Khan (1980).

2. An exception is Calvo (1978). However, Calvo does not attempt to explain industry wage stickiness, focusing instead on general equilibrium resource allocation issues under the assumption that unions seek to maximize the urban-rural wage differential.

3. The prototypical example of this occurrence might be the United Auto Workers settlement of 1979 when, amidst increased competition from Japanese cars, the union negotiated a wage pact calling for an increase of approximately 35% in expected nominal wages, which translated to a small expected increase in real wages. At the time, the industry unemployment rate was in excess of fifteen percent.

4. It would be possible to model the bargaining process, as for example do McDonald and Solow (1981), but that would add further complication, and does not seem essential to the issues addressed here.

5. Recall that all labor is assumed to be homogeneous, so skill differentials do not provide a rationale for a wage gradient in the model.

6. Two examples of papers that make this assumption are Azariadis (1975) and Grossman and Hart (1983).
7. See Blair and Crawford (1981) for more discussion of the existence of a unique equilibrium in the context of the union voting problem.

8. In Grossman (1983), I discuss some simple dynamics that yield convergence, for a range of parameter values, to the steady state described here. Essentially, the indifference condition for the least-senior worker will be a good approximation if entry into and exit from the union is relatively unimpeded, at least in the long run. If closed shops exist, or if union membership is restricted to certain workers among those in the industry, then even the marginal worker may enjoy a rent. In such cases, the size of the union is determined in some other way, and presumably becomes subject to the union's political decision-making process. From a technical point of view, this raises a modelling problem, because a voting equilibrium may fail to exist when two policy variables are simultaneously under consideration.

9. This result would need to be modified if the unionized sector were "large", so that the allocation of workers into or out of this sector would affect labor's marginal product in the rest of the economy.

10. In writing equation (6), I implicitly assume that the union finds it optimal to choose a wage such that there is some union unemployment in all states of nature. Some of the implications of the alternative assumption will be explored in footnotes below.
11. If the union members are fully employed in the union sector in some states of nature, then changes in the size of the union do affect the optimal wage. In such cases, a larger union will choose a smaller wage, just as in a union operating under seniority rule.

12. This is essentially an extension of a result proved in McDonald and Solow (1981), to situations of uncertainty in the productivity of labor. When the union wage is such that layoffs of union members do not occur in all states of nature, the wage response to output price changes continues to be nil, once the endogenous effect on the union size is taken into account.

13. In a careful empirical study, Friend and Blume (1975) found that the coefficient of relative risk aversion is approximately constant across income groups, and is nearly equal to or slightly in excess of two.

14. For further discussion, see Grossman (1983). There I discuss the role that the seniority system plays in the determination of the equilibrium wage in the unionized sector.
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