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IMPORTS, TRADE POLICY, AND UNION WAGE DYNAMICS

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Abstract

From the late sixties until the early eighties the union wage premium expanded while imports' share of domestic sales increased. A dynamic model of union wage and employment determination is used to examine the effects of import penetration on unionized labor markets. Higher current wages put domestic firms at a competitive disadvantage and encourage future imports. Barriers to trade were reduced in the late sixties and again in the mid-seventies. The long run effect is to decrease the union wage gap and increase the level of imports. In the short run the union may choose to increase wages while opportunities exist, lowering them over time as the labor demand curve shifts inwards in response to the growth of imports.

From the late sixties throughout the seventies and early eighties, imports made significant inroads into markets that were previously dominated by domestic producers. For example, imports accounted for 13.7 percent of domestic steel sales in 1969 but by 1982 had risen to almost 22 percent of the market. Even more striking is the decline in market share of domestic automobile manufacturers from 88.5 percent in 1969 to 72.1 percent in 1982. This phenomenon of rising imports was not uniformly distributed across industries. Rather, markets that are characterized by high concentration ratios appear be the ones most affected by this import penetration. (Domowitz, Hubbard, and Petersen (1986)). Because unions are most concentrated in industries having high price-cost margins, it would appear that unionized labor markets have been disproprtionately affected by the increase in foreign competition.

How have unions adjusted to this growth in imports? Paradoxically, unions have responded to the erosion of employment opportunities in a seemingly self-destructive manner. Rather than moderating wage demands to temper the effects of import penetration, unions instead responded by *increasing* the relative wage of their members. According to Rissman (1987), the union/nonunion wage differential expanded by between 14 and 27 percent from 1969 to 1982. Johnson (1982b) estimated the union wage premium rose roughly 14 percent between 1969 and 1979 while Lewis (1986) found the wage gap to have risen about 7 perent over the same period.[1]

In models of union wage and employment dynamics such as analyzed in Dunlop (1944) and Cartter (1959), the firm unilaterally sets the level of employment so as to maximize profit each period given the union wage rate. The union in turn is assumed to know the parameters of the firm's problem and selects the point on the derived labor demand schedule that maximizes some objective function having employment and wages as its arguments. Imports erode the employment possibilities in existing unionized labor markets. If wages and employment are both "normal" goods from the union's perspective, then, theoretically, the effect of rising imports would be to *lower* both the optimal union wage rate and level of employment. By demanding additional wage increases, the decline in employment resulting from the increase in imports was reinforced as employment decreased along the negatively sloped labor demand schedule.[2]

Why unions should choose to raise wages when confronted with significant and apparently permanent import penetration is not immediately obvious. One possibility is that unions are not able to adapt quickly to a changing economic environment because of long term contracting. According to this hypothesis, the higher union wages over this time period are attributable to built-in inertia. Although such an explanation may have some merit in describing the short run behavior of the union/nonunion wage differential over the business cycle where disturbances are generally of short duration, it is unsatisfactory in explaining the long term nature of the process. Since union wages are typically negotiated in three year intervals, it is doubtful that a period of expansion in the wage premium lasting over ten years can be explained by such adjustment lags.

Lawrence and Lawrence (1985) sought to explain the rise in the union wage premium by considering how capital stocks adjust to permanent declines in product demand. They argued that imports reduce the wage elasticity of demand for labor in the short run as substitution possibilities between labor and existing capital stocks are reduced. In terms of the labor demand curve equilibrium model, imports do not simply shift the labor demand curve laterally, but also make it steeper in the short run. Over time, however, capital stocks adjust so that the labor demand curve eventually becomes more elastic. The theory explains the rise of relative union wages over the seventies and fall in the union wage premium in the early eighties.[3] However, the model offers no explanation as to why unionized industries are characterized by slow adjustment of capital stocks when faced with permanent declines in product demand.

Edwards and Swaim (1986) suggested an alternative Darwinian survival-of-the-fittest explanation for the increase in the union wage premium over the seventies. According to their hypothesis, competitive pressures in traditionally unionized product markets caused many weaker unions to disappear, leaving only those that were most capable of sustaining large wage increases. The average level of the union wage rose as the composition of unionism changed. Although this explains the rise in the union wage premium in the 1970's, the hypothesis offers no insight into why the union wage differential fell during the eighties. Nor does it explain why the union wage gap in manufacturing rose over this period even though union membership declined.[4]

Models of union wage dynamics typically assume that demand disturbances are exogenous. The exogeneity of demand fluctuations is a reasonable assumption in analyzing union wage and employment behavior over the business cycle. However, such an assumption may be inappropriate in studying the union wage response to import penetration. Import penetration is most likely to occur in industries that are at a competitive disadvantage. Because unions raise wages above perfectly competitive levels, domestic firms are not able to compete with lower cost foreign producers. Presumably, the greater is the degree of wage distortion introduced by unions, the larger is the cost disadvantage of domestic firms in the market. Therefore, imports will be attracted precisely to those industries having high unionization rates and, thus, high wages.

The union is faced with a problem similar to that encountered in the limit pricing literature of industrial organization.[5] If the union demands the full monopoly wage, then it puts domestic firms at a cost disadvantage, and encourages future imports that erode the union's employment opportunities. If this continues indefinitely, the union essentially prices itself out of the market. Alternatively, the union can deter all entry by charging a sufficiently low wage. This "limit" wage is the wage rate that would make foreign producers indifferent to expanding into domestic markets. However, in following this strategy the union sacrifices higher short term wages for long term employment opportunities. The union is likely to follow a strategy somewhere in between the two extremes. It is this trade-off between short run gains and long term losses that determines the optimal union wage path.

Barriers to entry, either artificially in the form of trade protectionism or naturally via economies of scale and transportation costs, are important determinants of the competitive position of domestic producers. In the late sixties and again in the mid-seventies tariffs were reduced on many traded goods. This easing of trade restrictions effectively reduced the limit wage, causing both wages and imports to adjust. The long run effect of lower tariffs is to decrease the union/nonunion wage differential and increase the amount of imports. However, in the short run the optimizing union may actually choose to *raise* wages. The result depends upon the wage and import elasticities of labor demand, the discount rate, and the speed with which foreign producers respond to cost differentials.[6]

The remainder of this paper consists of four sections. In Section I the basic model is presented in which imports are determined exogenously and affect the firm's profit maximization only through their effect upon product price. The model is expanded in Section II to analyze the case where imports are endogenous. Imports are assumed to grow at a rate proportional to the difference between union wages and the wage rate that would make foreign producers indifferent to entering the product market. In Section III, a simple example is presented for the case of linear labor demand curves and risk neutral workers in which closed form solutions are obtained. The parameter space is analyzed in detail. Conclusions are contained in Section IV.

Section I: The Basic Model

In this section a simple model of union wage and employment determination is analyzed. The model is a variant of the labor demand curve equilibrium models of Dunlop (1944) and Cartter (1959) in which the union unilaterally sets the wage rate while the firm chooses the level of employment so as to maximize profits given the wage. The firm is assumed to operate in a competitive product market.[7] The union knows the parameters of the firm's problem and, therefore, effectively selects a point on the firm's labor demand schedule. Imports are assumed to be exogenously determined and affect only the product price directly. An increase in imports, ceteris paribus, decreases the price of the good produced in the unionized labor market and, therefore, translates into an inward shift in the labor demand curve.

The Firm:

The firm acts as both a price- and wage- taker, choosing the level of employment so as to maximize profits given the level of imports. The profits of the firm are given by:

$$\pi = p(m)f(L) - wL \qquad [1.1]$$

where π is profits, $f(L)$ is the production function of the firm, L is the level of employment, w is the wage rate, and $p(m)$ is the product price, which depends upon the level of imports, m. It is assumed that $f'(L) > 0$, $f''(L) < 0$, $p'(m) < 0$, and $p''(m) < 0$. Thus, rising imports, ceteris paribus, cause prices to fall at a decreasing rate.

The firm chooses L so as to solve:

$$\max_{L} \; p(m)f(L) - wL \; . \qquad [1.2]$$

The first order condition for a maximum says that the level of employment is chosen so as to equate the wage rate with the value of the marginal product of labor, i.e.

$$p(m)f'(L) = w \; . \qquad [1.3]$$

The second order condition, $p(m)f''(L) < 0$, holds for all L due to the assumption of a diminishing marginal product of labor.

Equation [1.3] implicitly defines a labor demand schedule $L = L(w,m)$, which depends upon the wage rate and level of imports. The comparative statics are easily found by differentiating the expression in [1.3] so that:

$$L_w(w,m) = \frac{1}{p(m)f''(L^*)} \qquad [1.4.a]$$

$$L_m(w,m) = -\frac{p'(m)f'(L^*)}{p(m)f''(L^*)} \; , \qquad [1.4.b]$$

where the superscript '*' indicates the expression is evaluated at the optimum. Thus, the labor demand curve is negatively sloped, and increases in imports cause the labor demand curve to shift inwards. Assuming $f'''(L) < 0$, it can be shown that $L_{ww}(w,m) < 0$ and $L_{wm}(w,m) < 0$. Furthermore, since $p''(m) < 0$, it follows that $L_{mm}(w,m) < 0$.

The Union:

There are M union members, L of whom are employed in unionized jobs and receiving a wage of w with associated utility $u(w)$. The remaining $M - L$ union members receive an alternative wage w_a which can be thought of as the nonunion wage rate or the monetary equivalent of the opportunity cost of a union job. Thus, w_a reflects the level and availability of unemployment benefits. The alternative wage is assumed to be independent of the union wage rate, w. The utility that union members receive from alternative opportunities is $u(w_a)$. It is assumed that $u'(\ ) > 0$, and $u''(\ ) < 0$. Employment is determined by lottery so that each member has an equal chance of union employment.

The union's utility function is the expected utility of the representative member. Hence,

$$U(w,L) = \frac{L}{M}u(w) + \frac{(M-L)}{M}u(w_a)\ . \tag{1.5}$$

The union's problem is to choose w so as to maximize the expression in [1.5] subject to the constraint that $L = L(w,m)$, i.e. that the wage and employment outcome are on the firm's demand curve for labor. This problem is equivalent to solving:

$$\max_{w}\ [u(w) - u(w_a)]L(w,m) \tag{1.6}$$

where the constraint has been substituted directly.

The first order condition for the union's problem is found by differentiating [1.6] with respect to w and setting the expression equal to zero. Thus, at the optimum w^*:

$$u'(w^*)L(w^*,m) + [u(w^*) - u(w_a)]L_w(w^*,m) = 0\ . \tag{1.7}$$

Rearranging terms, the first order condition can be written as:

$$\frac{u'(w^*)w^*}{[u(w^*) - u(w_a)]} = -\frac{L_w(w^*,m)w^*}{L(w^*,m)} = \epsilon_{Lw}(w^*,m)\ . \tag{1.8}$$

Equation [1.8] shows that at the optimum, the wage elasticity of demand, ϵ_{Lw}, equals the elasticity of the benefit to union employment in utility terms with respect to the wage. The second order condition for a maximum is that $u''(w)L(w,m) + 2u'(w)L_w(w,m) + [u(w) - u(w_a)]L_{ww}(w,m) < 0$ which holds for all $w \geq w_a$.

The effect of imports and the alternative wage on the optimal union wage rate can be analyzed by solving the comparative statics. Total differentiation of equation [1.7] yields:

$$\frac{dw^*}{dm} = -\frac{[u'(w)L_m + (u(w) - u(w_a))L_{wm}]}{[u''(w)L + 2u'(w)L_w + (u(w) - u(w_a))L_{ww}]} \qquad [1.9.a]$$

$$\frac{dw^*}{dw_a} = \frac{u'(w_a)L_w}{[u''(w)L + 2u'(w)L_w + (u(w) - u(w_a))L_{ww}]} \qquad [1.9.b]$$

where the arguments of the labor demand function have been suppressed for notational convenience. The sign of dw^*/dw_a is unambiguously positive so that as the alternative wage rises, the optimal union wage increases. The effect of rising imports on the union wage rate depends upon the sign of the bracketed term in the numerator of equation [1.9.a]. The first term is unambiguously negative while the second term is also negative provided that $f'''(L) < 0$. Thus, as imports rise, the union wage declines.

The effect of imports on employment is found by differentiating $L(w(m),m)$ with respect to m, where $w(m)$ is the implicit function defined by the union's first order condition in equation [1.7]. Hence,

$$\frac{dL^*}{dm} = L_w(w^*,m)\frac{dw^*}{dm} + L_m(w^*,m) \ . \qquad [1.10]$$

Rising imports affect employment both directly, by shifting the labor demand schedule inwards, and indirectly, by causing wages to fall. The first effect reduces employment while the second effect tends to increase employment. A sufficient condition for an increase in imports to decrease employment is that $L_{ww}L_m - L_{wm}L_w > 0$. This condition is analogous to having a positive income effect in the classical theory of the consumer.

In summary, as imports increase, the labor demand schedule shifts inwards. Given the functional form assumed for the union's preferences, an increase in imports unambiguously causes the optimal union wage rate to decline so long as $L_{wm}(w,m)$ is less than zero. This condition implies that, for a given wage rate, rising imports increase the wage elasticity of demand for labor.[8]

Section II: Endogenous Imports

This section examines the optimal wage strategy of a union facing potential entry by foreign producers into the product market in which the union is employed. It is a widely held belief that one of the reasons for the expansion of foreign firms into domestic markets is that domestic costs of doing business, particularly labor costs, are relatively high. Unions are thought to raise wages above the level that would occur in competitive equilibrium. The distortion introduced places domestic unionized firms at a competitive disadvantage since production costs are increased and, presumably, passed on to the consumer in the form of higher prices. Foreign producers, who face lower labor costs, ceteris paribus, will be drawn to the domestic product market as opportunities for additional profits exist.

The union is faced with a dilemma: If it keeps wages too high, imports are attracted and long run opportunities disappear accordingly. On the other hand, if the union sets the wage rate too low so as to keep foreign competitors out of the market, the union foregoes short term wage opportunities for its members. This balancing of short run and long run considerations determines the optimal wage path and has implications for the behavior of employment and imports over time. The dependence of future employment possibilities on the current wage rate suggests that the union's problem is more appropriately cast within the framework of dynamic optimization.[9]

The Union:

Assuming union membership to be exogenously determined, the union's problem is to maximize the discounted utility flow of the representative union member over an infinite time horizon:

$$V(w) = \int_0^\infty [u(w(t)) - u(w_a)]L(w(t),m(t))e^{-rt}dt \qquad [2.1]$$

where $V(w)$ is the union's discounted utility, $w(t)$ is the wage rate at time t, and r is the discount rate. As before, w_a is the exogenous alternative wage rate, $L(w(t),m(t))$ is labor demand at time t which depends upon the current wage rate and level of imports. Labor demand is derived from the profit maximization problem of the price-taking firm. As in the previous model, $L_w < 0$, $L_m < 0$, $L_{ww} < 0$, $L_{mm} < 0$, and $L_{wm} < 0$.

The rate of entry of foreign producers into the domestic product market, $\dot{m}$, depends upon their expected rate of return. In the simplest formulation, imports are assumed to grow at a rate proportional to the difference between the current wage rate and the exogenous limit wage so that:

$$\dot{m} = k(w - \overline{w}) \ . \qquad [2.2]$$

The limit wage, $\overline{w}$, is the wage rate at which foreign producers would have no incentive to either enter or leave the product market. When w exceeds $\overline{w}$, entry by foreign competitors is positive. When w is less than the limit wage, rivals leave the market. The parameter k reflects the speed of response of foreign producers to cost differentials.

It is also assumed that $\overline{w} \geq w_a$. Since w_a can be thought of as the opportunity cost of a union job, this assumption implies that there is some nonnegative long term advantage to union employment. A strictly positive long run union wage advantage is likely to occur due to transaction costs and other artificial and natural barriers to entry. In order to make the problem non-trivial, it is further assumed that $[u(w) - u(w_a)]L_w(w,m) + u'(w)L(w,m) < 0$ for all w less than $\overline{w}$. If this does not hold, then the union simply pushes foreign producers out of the market by acting as a static monopolist.

The union's problem is to choose a wage path $w(t)$ so as to maximize [2.1] subject to [2.2], given the initial level of imports at time 0 is m_0. The current value Hamiltonian for this problem is given by:

$$\mathscr{H} = [u(w(t)) - u_a]L(w(t),m(t)) + \mu(t)k(w(t) - \overline{w}) \ , \qquad [2.3]$$

where $u_a \equiv u(w_a)$. The costate variable, $\mu(t)$, is the shadow price of an additional unit of import penetration at time t and is equal to $\partial V/\partial m(t)$. The first term in the Hamiltonian is the instantaneous utility flow from current wages and employment. The second term reflects the effect of current wages on future utility.

The necessary conditions for an optimal wage path can be found by applying the Pontryagin maximum principle. Thus, there exists a $\mu(t)$ such that:

$$\dot{\mu}^*(t) = r\mu^* - [u(w^*) - u_a]L_m(w^*, m^*) \qquad [2.4.a]$$

$$\lim t \to \infty \left[\mu^*(t)e^{-rt}\right] = 0$$

$$u'(w^*(t))L(w^*(t), m^*(t)) + [u(w^*(t)) - u_a]L_w(w^*(t),m^*(t)) + \mu^*(t)k = 0 \qquad [2.4.b]$$

$$\dot{m}^*(t) = k(w^*(t) - \overline{w}) \qquad [2.4.c]$$

where the superscript '*' denotes the optimal trajectory. The continuity and concavity of $[u(w) - u(w_a)]L(w,m)$ in w assures the existence of at least one optimal path provided that the wage rate and imports are contained in compact sets.[10]

Solving for μ^* in equation [2.4.b] yields:

$$\mu^*(t) = -\frac{[u'(w^*)L(w^*, m^*) + (u(w^*) - u_a)L_w(w^*, m^*)]}{k} \ . \qquad [2.5]$$

Since the costate variable is the shadow price of import penetration, it is necessarily negative, implying that the bracketed term in the above expression in strictly positive. Recalling from equation [1.7] of the previous section, in a static problem where current wages do not affect future employment opportunities, the optimizing union sets the bracketed expression equal to zero. Due to the concavity of the functional in w, it follows that the union sets the wage rate higher in the myopic case than in the case where it fully considers the effect of current actions on future opportunities.

Taking the time derivative of equation [2.5] and substituting the appropriate expressions from equations [2.4.a] and [2.4.c] gives a two equation system of first order differential equations:

$$\dot{w} = \frac{[-r(u'L + (u - u_a)L_w) + kL_m[u'(w - \overline{w}) - (u - u_a)] + (u - u_a)(w - \overline{w})kL_{wm}]}{-[u''L + 2u'L_w + (u - u_a)L_{ww}]} \qquad [2.6.a]$$

$$\dot{m} = k(w - \overline{w}) \ . \qquad [2.6.b]$$

The two equations generate a family of trajectories in the $m - w$ plane. The transversality condition and initial condition can be used to determine which of the various paths are optimal.

In steady state equilibrium both $\dot{w}$ and $\dot{m}$ equal zero. From equation [2.6.b] this implies that $w_s = \overline{w}$ where the subscript 's' indicates the steady state value. Substituting the steady state value of the wage into the expression for the $\dot{w} = 0$ locus gives:

$$0 = r[u'(\overline{w})L(\overline{w}, m_s) + (u(\overline{w}) - u_a)L_w(\overline{w}, m_s)] + kL_m(\overline{w}, m_s)(u(\overline{w}) - u_a) \qquad [2.7]$$

where m_s is the steady state equilibrium level of imports.

The expression in equation [2.7] implicitly defines the steady state level of imports but provides no explanation as to how the steady state is attained. By taking a first order Taylor Series approximation of the system of differential equations in [2.6] about the point $(\overline{w}, m_s)$, the behavior of the system about the steady state may be examined. The linearized equations of motion are:

$$\begin{bmatrix} \dot{w} \\ \dot{m} \end{bmatrix} = \begin{bmatrix} r & b \\ k & 0 \end{bmatrix} \begin{bmatrix} w - \overline{w} \\ m - m_s \end{bmatrix} \qquad [2.8]$$

where

$$b \equiv \left\{ \frac{r[u'L_m + (u - u_a)L_{wm}] + kL_{mm}(u - u_a)}{u''L + 2u'L_w + (u - u_a)L_{ww}} \right\} \Bigg|_{\substack{w = \overline{w} \\ m = m_s}} > 0 \ .$$

The characteristic equation for the above system is:

$$\lambda^2 - r\lambda - kb = 0 \qquad [2.9]$$

with solutions:

$$\lambda_1, \lambda_2 = \frac{r}{2} \pm \frac{(r^2 + kb)^{1/2}}{2} \ . \qquad [2.10]$$

Since both b and k are positive, it follows that one of the eigenvalues is strictly positive and greater than the discount rate, say λ_1, and the other strictly negative, λ_2. Thus, the equilibrium is a saddlepoint.

A phase diagram is useful in analyzing the movement of the system about the steady state. (See Figure 1.) From equations [2.8], the $\dot{m} = 0$ locus is horizontal at $w = \overline{w}$ and the $\dot{w} = 0$ locus is negatively sloped. If the system is initially on the $\dot{m} = 0$ locus and the wage rate rises, then imports must also rise. Similarly, if initially the system is on the $\dot{w} = 0$ locus and imports rise, then wages must increase. The two loci effectively divide the $m - w$ plane into four distinct regions. Regions I and III are characterized by divergent paths. Any trajectory entering or starting in Region I (III) has both the wage rate and level of imports increasing (decreasing) without bound. These trajectories cannot be optimal since they both imply ever increasing disutility after some point.

The optimal path, if it exists, must therefore lie within regions II and IV and is shown in Figure 1. This path necessarily satisfies the transversality condition. From equation [2.5], the transversality condition requires that:

$$\lim t \to \infty \left[- \frac{[u'(w^*)L(w^*, m^*) + (u(w^*) - u_a)L_w(w^*, m^*)]}{k} e^{-rt} \right] = 0 \ . \qquad [2.11]$$

Since the path converges to the steady state w and m which are bounded, the condition holds because the expression is dominated by the negative exponential as $t \to \infty$.

The optimal strategy for the union to follow depends upon the initial level of imports. For $m_0 < m_s$, the union gradually lowers the wage rate over time to the limit wage $\overline{w}$. The result of this behavior is to increase the level of imports over time. Conversely, for $m_0 > m_s$ the union sets the wage rate below the limit wage so as to drive out imports. Over time the wage rate gradually rises to $\overline{w}$.

Comparative Statics:

By examining equation [2.7], which implicitly defines the steady state level of imports, we may analyze the effect of changes in the model's parameters, namely k, w_a, r, $\overline{w}$, and m_0, on the long run level of imports. Furthermore, since steady state employment is given by $L_s = L(w,m_s)$, we are also able to examine the effect of changes in these parameters on the long run level of union employment.

The comparative statics on imports and employment are found by differentiating the expression in equation [2.7] with respect to the various model parameters. Therefore:

$$\frac{dm_s}{dk} = \frac{-L_m(\overline{w}, m_s)[u(\overline{w}) - u_a]}{r[u'(\overline{w})L_m(\overline{w}, m_s) + (u(\overline{w}) - u_a)L_{wm}(\overline{w}, m_s)] + kL_{mm}(\overline{w}, m_s)[u(\overline{w}) - u_a]} \leq 0 \;[2.12.a]$$

$$\frac{dL_s}{dk} = L_m(\overline{w}, m_s)\frac{dm_s}{dk} \geq 0$$

$$\frac{dm_s}{dr} = \frac{-[u'(\overline{w})L(\overline{w}, m_s) + (u(\overline{w}) - u_a)L_w(\overline{w}, m_s)]}{r[u'(\overline{w})L_m(\overline{w}, m_s) + (u(\overline{w}) - u_a)L_{wm}(\overline{w}, m_s)] + kL_{mm}(\overline{w}, m_s)[u(\overline{w}) - u_a]} > 0 \;[2.12.b]$$

$$\frac{dL_s}{dr} = L_m(\overline{w}, m_s)\frac{dm_s}{dr} < 0$$

$$\frac{dm_s}{dw_a} = \frac{[rL_w(\overline{w}, m_s) + kL_m(\overline{w}, m_s)]u'(w_a)}{r[u'(\overline{w})L_m(\overline{w}, m_s) + (u(\overline{w}) - u_a)L_{wm}(\overline{w}, m_s)] + kL_{mm}(\overline{w}, m_s)[u(\overline{w}) - u_a]} > 0 \;[2.12.c]$$

$$\frac{dL_s}{dw_a} = L_m(\overline{w}, m_s)\frac{dm_s}{dw_a} < 0$$

$$\frac{dm_s}{d\overline{w}} = \qquad [2.12.d]$$

$$\frac{\{-r[u''L + 2u'L_w + (u-u_a)L_{ww}] - kL_{wm}(\overline{w}, m_s)[u-u_a] - kL_m(\overline{w}, m_s)u'\}}{r[u'L_m(\overline{w}, m_s) + (u-u_a)L_{wm}(\overline{w}, m_s)] + kL_{mm}(\overline{w}, m_s)[u-u_a]} < 0$$

$$\frac{dL_s}{d\overline{w}} = L_w(\overline{w}, m_s) + L_m(\overline{w}, m_s)\frac{dm_s}{d\overline{w}} \gtrless 0$$

$$\frac{dm_s}{dm_0} = \frac{dL_s}{dm_0} = 0 \ . \qquad [2.12.e]$$

From [2.12.a], the more rapidly foreign producers respond to labor cost differentials, the lower is the steady state level of imports and the higher is the equilibrium level of employment. In terms of the phase plane, the effect of an increase in k is to shift the $\dot{w} = 0$ locus to the left.

The higher is r, the more heavily the union discounts the future. Condition [2.12.b] indicates that as the discount rate rises, the long run level of imports increases and the equilibrium level of employment falls. Diagramatically, an increase in the discount rate shifts the $\dot{w} = 0$ locus outwards.

An increase in the limit wage, $\overline{w}$, causes both loci to shift in the phase plane with the $\dot{w} = 0$ locus shifting inwards and the $\dot{m} = 0$ locus reinforcing the effect on imports by shifting upwards. Therefore, increases in the limit wage unambiguously decrease the long run level of imports as the advantage of the union rises. The effect of the limit wage on the level of employment is ambiguous, however, due to two offsetting forces. First, the higher limit wage reduces imports and, therefore, increases employment directly. However, as the limit wage rises, the equilibrium union wage rises and causes employment to fall. By making the appropriate substitutions, sufficient conditions for an increase in the limit wage to increase equilibrium employment are that $L_w L_{mm} - L_m L_{mw} < 0$

and $L_{ww}L_{mm} - L_{wm}^2 > 0$ where the expressions are evaluated at $(\overline{w}, m_s)$. These two conditions combined imply that $L_wL_{wm} - L_mL_{ww} < 0$, which in the static case discussed in the previous section was a sufficient condition for increases in imports to decrease employment.

Conditions [2.12.*c*] and [2.12.*d*] together indicate that as the long run advantage of union sector employment rises, $(\overline{w} - w_a)$, the steady state level of imports declines. If the union has no long run advantage over alternative employment so that $\overline{w} = w_a$, then the union effectively prices itself out of the market with eventually all production in the industry taken over by foreign firms. If increases in the limit wage increase equilibrium employment, then a rise in the long run union wage premium should be associated with an increase in the steady state level of employment.

Finally, it should be noted that a change in the initial level of imports does not have any effect upon the equilibrium level of imports, employment, or wages but only affects the path to equilibrium.

Comparative Dynamics:

The above comparative statics results analyze long run behavior but do not explain how the long run adjustment occurs. Comparative dynamics are in general more difficult to analyze. However, examination of the slope of the trajectory in the $m - w$ phase plane offers some insight. The slope of any path is given by:

$$\frac{dw}{dm} = \frac{\dot{w}}{\dot{m}} = \qquad [2.13]$$

$$\frac{\{-r(u'L + (u - u_a)L_w) + kL_m[u'(w - \overline{w}) - (u - u_a)] + (u - u_a)(w - \overline{w})kL_{wm}\}}{-k(w - \overline{w})[u''L + 2u'L_w + (u - u_a)L_{ww}]}.$$

By differentiating the above expression with respect to the various parameters of the model, we can find how the slope of the trajectory changes with the different parameters and attempt to draw conclusions about the comparative dynamics by arguing from the phase plane.

Differentiating the above expression with respect to the parameter k gives:

$$\frac{d}{dk}\left(\frac{dw}{dm}\right) = -\frac{r[u'L + (u - u_a)L_w]}{k^2(w - \overline{w})[u''L + 2u'L_w + (u - u_a)L_{ww}]} \ . \qquad [2.14]$$

Since the costate variable is necessarily negative, the numerator of the above expression is negative and the sign of the derivative is given by the sign of $w - \overline{w}$.

Suppose that w is greater than the limit wage. From equation [2.14], it follows that the old and new trajectories cannot intersect. If they did intersect, then the new path must move above the old as the slope decreases. No such path could converge to the new equilibrium point since it would by necessity imply that the trajectory moved into region I. Therefore, the new trajectory must initially lie below the old. As a result, an increase in the responsiveness of foreign producers to the current labor cost differential causes the optimal wage path to be lowered in the short run. There is no long run effect on wages.

Comparative dynamics results for the other parameters of the model can be found by differentiating equation [2.13] with respect to r, w_a, and $\overline{w}$:

$$\frac{d}{dr}\left(\frac{dw}{dm}\right) = \frac{[u'L + (u - u_a)L_w]}{k(w - \overline{w})[u''L + 2u'L_w + (u - u_a)L_{ww}]} \qquad [2.15.a]$$

$$\frac{d}{dw_a}\left(\frac{dw}{dm}\right) = \qquad [2.15.b]$$

$$-\frac{\{[u''L + 2u'L_w](rL_w + kL_m) - ru'LL_{ww} - k(w - \overline{w})[(u''L + 2u'L_w)L_{wm} - u'L_mL_{ww}]\}u'(w_a)}{k(w - \overline{w})[u''L + 2u'L_w + (u - u_a)L_{ww}]^2}$$

$$\frac{d}{d\overline{w}}\left(\frac{dw}{dm}\right) = \frac{r[u'L + (u - u_a)L_w] + kL_m(u - u_a)}{k(w - \overline{w})^2[u''L + 2u'L_w + (u - u_a)L_{ww}]} \qquad [2.15.c]$$

From the expression in [2.15.a], the effect of an increase in the discount rate is to increase the wage rate in the short run. Again, there is no long run effect on the union wage. The sign of the expression in equation [2.15.b] is ambiguous. However, if the curvature of the labor demand schedule is not too great and if $L_{wm}\simeq 0$, then the short term effect of an increase in the alternative wage is to raise the optimal wage rate.

Without making some additional simplifying assumptions, it is difficult to determine the immediate impact of an increase in the limit wage on the optimal wage trajectory. The following section analyzes the case where workers are assumed to be risk neutral and the labor demand schedule is linear in wages and imports. A fall in the limit wage causes the optimal union wage rate to increase initially for certain areas of the parameter space.

Section III:

Linear Labor Demand and Risk Neutral Workers

Let $L(w,m) = a - bw - gm$ be the labor demand curve facing the union. Assuming union members to be risk neutral, the union's optimal control problem can be easily solved for the equations of motion for wages and imports:

$$\begin{bmatrix} \dot{w} \\ \dot{m} \end{bmatrix} = \begin{bmatrix} r & \frac{rg}{2b} \\ k & 0 \end{bmatrix} \begin{bmatrix} w \\ m \end{bmatrix} + \begin{bmatrix} \frac{-r(a + bw_a) + k(\overline{w} - w_a)}{2b} \\ -k\overline{w} \end{bmatrix}. \qquad [3.1]$$

The solution to the above system of differential equations can be expressed as the sum of the general solution to the associated homogeneous system and any particular solution of the nonhomogeneous system.

The general solution to the homogeneous system is:

$$w(t) = c_1 e^{\lambda_1 t} + c_2 e^{\lambda_2 t} \qquad [3.2]$$

$$m(t) = c_1(\lambda_1 - r)\frac{2b}{rg}e^{\lambda_1 t} + c_2(\lambda_2 - r)\frac{2b}{rg}e^{\lambda_2 t} \ ,$$

where λ_1 and λ_2 solve $\lambda^2 - r\lambda - \dfrac{krg}{2b} = 0$. Thus, $\lambda_1,\ \lambda_2 = \dfrac{1}{2}\left[r \pm \left(r^2 + \dfrac{2krg}{b}\right)^{1/2}\right]$. Let λ_1 and λ_2 be the positive and negative roots respectively.

A particular solution to the nonhomogeneous system is easily calculated by setting $\underline{\dot{y}} \equiv (\dot{w}, \dot{m})' = \underline{0}$ so that:

$$w_s = \overline{w} \qquad [3.3]$$

$$m_s = \frac{\left[r(a + bw_a - 2b\overline{w}) - k(\overline{w} - w_a)\right]}{rg} \equiv \theta \ .$$

The solution (w_s, m_s) corresponds to the steady state wage and import combination.

The general solution to [3.1] is therefore:

$$w(t) = c_1 e^{\lambda_1 t} + c_2 e^{\lambda_2 t} + \overline{w} \qquad [3.4]$$

$$m(t) = c_1(\lambda_1 - r)\frac{2b}{rg}e^{\lambda_1 t} + c_2(\lambda_2 - r)\frac{2b}{rg}e^{\lambda_2 t} + \theta \ .$$

Since $\lambda_1 > r > 0$, the transversality condition implies that $c_1 = 0$ giving:

$$w(t) = c_2 e^{\lambda_2 t} + \overline{w} \qquad [3.5]$$

$$m(t) = c_2(\lambda_2 - r)\frac{2b}{rg}e^{\lambda_2 t} + \theta \ .$$

The constant c_2 is found by applying the initial condition $m(0) = m_0$ to equation [3.5] so that:

$$c_2 = (m_0 - \theta)\frac{rg}{2b(\lambda_2 - r)} \quad . \qquad [3.6]$$

The solution to this problem can be easily simulated for various values of the parameters. The most interesting comparative dynamics exercise involves changes in the limit wage. In Figure 2 the optimal wage trajectories are plotted for two sets of parameter values: $a = 100$, $b = 1$, $k = 1$, $g = 1$, $r = 0.1$, $w_a = 10$, and $m_0 = 0$. The dotted line shows the wage trajectory for $\overline{w} = 17$. For these particular values of the parameters, the wage rate declines smoothly over time asymptoting to the limit wage. The effect of decreasing the limit wage to 15 at time 0 while keeping all other parameters constant is given by the solid line. Comparing the two wage trajectories, a decrease in the limit wage in this case shifts upwards and steepens the optimal wage path.

Analytically, the effect of an increase in the limit wage on the optimal wage trajectory can be found by differentiating equation [3.5] with respect to $\overline{w}$. Specifically,

$$\frac{\partial w(t)}{\partial \overline{w}} = 1 + \frac{(2br + k)}{2b(\lambda_2 - r)}e^{\lambda_2 t} \quad . \qquad [3.7]$$

Changes in the limit wage have two opposing effects upon the optimal wage path. First, as $\overline{w}$ rises, the asymptote also increases shifting the trajectory upwards. However, offsetting this effect somewhat, an increase in the limit wage decreases the steady state level of imports. Since λ_2 is negative, the effect of this is to lower the wage path in the short run with the magnitude decreasing over time.[11] As $t \to \infty$ and the steady state is approached, the wage rate rises by an amount equal to the increase in the limit wage.

Under what circumstances will an increase in the limit wage initially *decrease* the optimal union wage rate? Figure 3 depicts the solution to $\partial w(0)/\partial \overline{w} < 0$ in $k/b - g$ space. For a given discount rate, r, those values of the parameters lying in the region below the dotted line solve the inequality. Thus, for a given response of labor demand to changes in imports, g, an increase in the limit wage is more likely to cause a short term fall in the union wage rate the greater is the responsiveness of foreign producers to cost differentials relative to the slope of the labor demand curve (k/b). Ceteris paribus, the union wage rate is less likely to decrease in the short run as the limit wage rises the larger is the discount rate. In the extreme where the discount rate approaches ∞, as long as g is less than unity, the initial response of the union wage rate is to fall as $\overline{w}$ rises.

Section IV: Conclusions

The limit wage is defined as the wage rate that would induce no foreign entry into or exit from the domestic product market. If barriers to entry are reduced, the limit wage declines. Given the alternative wage, the effect of a reduction in quotas and tariffs is to increase the steady state level of imports and decrease the steady state wage rate. However, as shown in the above example, in the short run a *loosening* of trade restrictions is likely to *increase* the optimal union wage rate. The union chooses to obtain as much rent from the firm as possible while the opportunities exist, realizing that by doing so future opportunities will be limited.

The rise in the union/nonunion wage differential over the late sixties and seventies and the decline found in the wage gap in the early eighties may be explained in part by reductions in trade restrictions over this period. In the late sixties, the Kennedy Round of the trade negotiations took effect in which tariffs were reduced by approximately 35 percent on average and some 50 percent in industries that were not exempt. Again in the mid-seventies, the Tokyo Round (1973-1979) further reduced trade restrictions by focusing on the reduction of nontariff barriers to trade. The theory suggests that the long term effect of the reduction in barriers to trade is to decrease the union/nounion wage differential. However, in the short run the opposite may occur.

These hypotheses concerning union wage differential dynamics are broadly consistent with the stylized facts. The union wage premium increased over the late sixties continuing throughout the seventies--a period during which trade barriers were reduced. Although possibly premature, recent estimates of the union wage gap suggest that the differential has fallen somewhat since its high in 1982. Because changes in tariffs and quotas have been implemented at different times for various items, a satisfactory test of the theory requires the use of panel data.

The analysis has emphasized the endogeneity of import penetration. It has been explicitly assumed that the union cannot affect the responsiveness of foreigners to cost differentials or barriers to entry. These simplifications make the model tractable and provide some interesting comparative statics and dynamics results. However, a richer theory must consider how the union may be able to influence both $\overline{w}$ and k. For example, since the limit wage depends critically upon trade restrictions, unions may be able to affect it through the political process. Judging from the recent attempts in Congress to pass more restictive trade legislation, such as the failed Gephardt Ammendment, unions have had limited influence upon the limit wage.

Imports have been assumed to shift the labor demand curve inwards so that the employment opportunities facing domestic unionized workers are reduced. Unions are unable to unionize foreign workers because of geographical and political boundaries. However, one possible option available to the union is to encourage joint ventures between domestic and foreign producers, such as has occurred in the automobile industry. In this way unions may be able to maintain employment and membership without substantial cuts in wages.

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Endnotes

1. Additional evidence of an increasing union wage gap is found in Ashenfelter (1979), Moore and Raisian (1983), Freeman (1986), and Linneman and Wachter (1986). Pencavel and Hartsog found the opposite to have occurred.

2. Union membership as a percentage of private nonagricultural employment peaked in 1956 at 34.6 percent, falling to 22.3 percent by 1980. See Neumann and Rissman (1984).

3. Between 1982 and 1984, the union wage gap declined by about 3 percent. See Rissman (1987) for details.

4. Rissman (1987) estimated that the union/nonunion wage differential increased by between 3 and 12.6 percent between 1969 and 1982. Similarly, Edwards and Swaim (1986) found that the union wage premium in Transportation, Communication, and Public Utilities rose by over 9 percent between 1979 and 1984.

5. See Gaskins (1971).

6. A similar effect occurs with respect to prices and the competitive fringe in the industrial organization literature. According to Gaskins (1971), the short term effect of an increase in entry barriers is to decrease the dominant firm's price. In the long run, product price actually rises.

7. See Neumann (1988) for an analysis of the bargaining problem when product markets are oligopolistic.

8. This is in direct contrast to the argument made in Lawrence and Lawrence (1985) that imports reduce the elasticity of demand for labor.

9. The formulation of the problem parallels closely that used in Gaskins (1972).

10. The proof is attributed to Lamberto Cesari (1966).

11. This points to an apparent error in Gaskins (1971) where he claims that in the case of linear product demand curves, the effect of an increase in the limit price is to unambiguously lower the optimal price path of the dominant firm under threat of entry. A more accurate statement is that $\partial(p(t) - \bar{p})/\partial\bar{p} < 0$, i.e. that the difference between the optimal price trajectory and the steady state price decreases with the limit price.

Figure 1
Phase plane

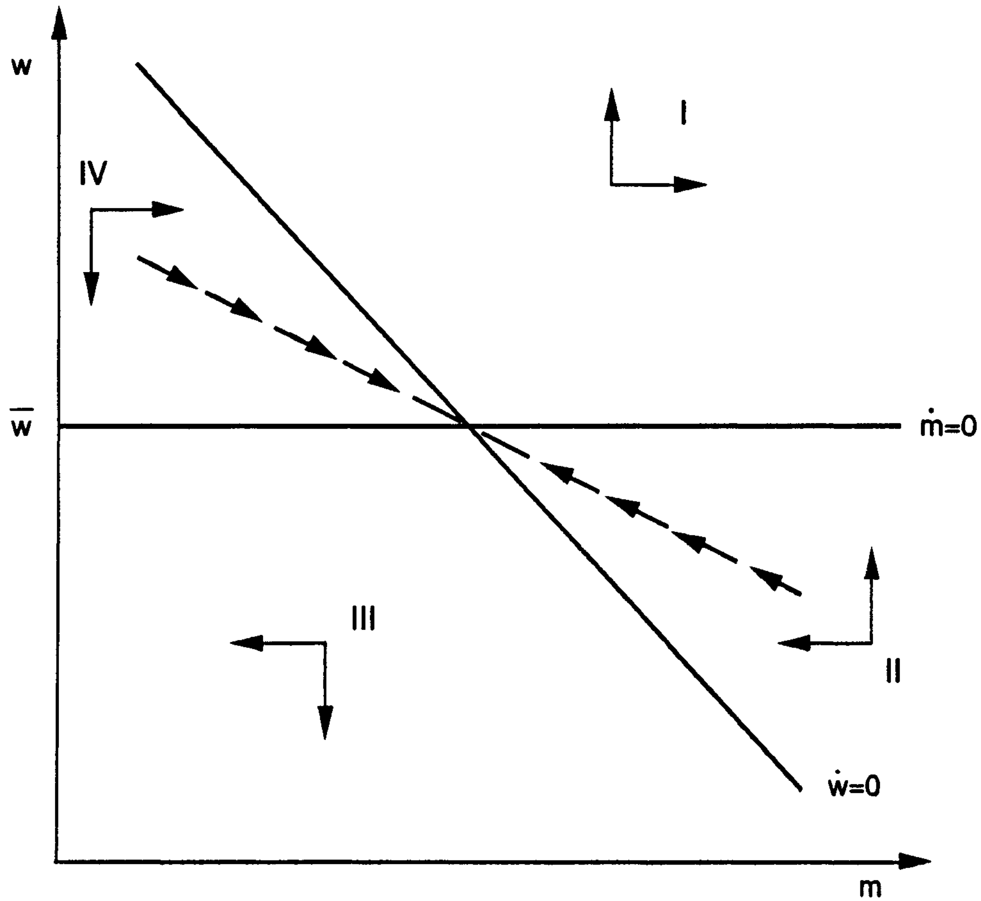
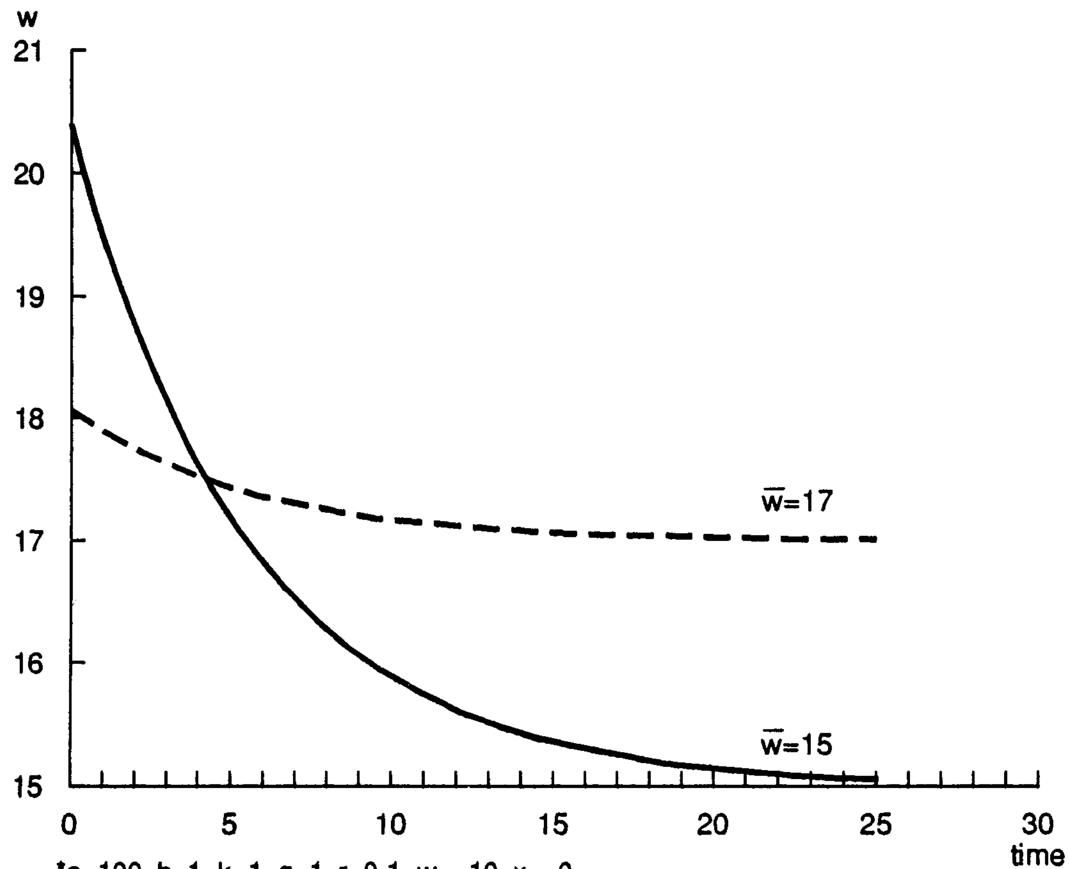


Figure 2
Optimal wage trajectories*



*a=100, b=1, k=1, g=1, r=0.1, w_a=10, x_0=0.

Figure 3
Analysis of parameter space