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ORGANIZED LABOR AND THE SCOPE OF INTERNATIONAL SPECIALIZATION

Robert W. Staiger

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ABSTRACT

This paper examines the interaction between union wages and the international pattern of production and trade. If union goods are heterogeneous in labor intensity, the introduction of an active union in the domestic country causes only the least labor-intensive range of union goods to be produced there, with goods of greatest labor intensity produced abroad due to the relatively high cost of domestic union labor. A narrowing of the scope of domestic union production will eliminate relatively labor-intensive goods, leading a rent-maximizing union to raise its union premium. The implications of this union behavior for comparative statics results are considered.

Robert W. Staiger
Department of Economics
Stanford University
Stanford, CA 94305

I. Introduction

General equilibrium analysis of labor unions has taken place primarily within the context of closed- or small-open-economy versions of the two-sector neoclassical model. The early contributions to this literature introduce an exogenous union wage premium in one sector and consider the implications for various properties of the general equilibrium.[1/] Several recent papers have made endogenous the actions of the labor union in an effort to understand both the way unions respond to changing international conditions and the implications of union behavior for broader comparative statics results.[2/] What has not been considered formally is the effect of union activity on the international location of production and the pattern of international trade: that is, the simultaneous determination of the union wage and the set of products produced by union workers.

By modeling the union as operating in an import-competing sector that produces a variety of heterogeneous goods, this paper explores the union's impact on the pattern of trade and, at the same time, the effect on union wages of shifting international patterns of production. In particular, if goods within the union sector differ in the intensity with which they require union labor, and if the (domestic) union wage premium is an important source of international cost differences, then only the least labor-intensive range of union-sector goods will be produced domestically, with goods of greatest labor intensity being produced abroad as a result of the relatively high cost of domestic union labor. With goods arranged in order of increasing labor

intensity, the identity of the "marginal" good--the good of highest labor intensity that is produced in the domestic union sector--will be determined by the size of the domestic union wage premium: it defines the scope of domestic production in the union sector, and hence the range of domestic export goods, as a function of union behavior. However, the scope of domestic union-sector production will itself affect the sectoral labor intensity of production, on which the wage premium of a rent-maximizing union depends.[3/] As such, when a union supplies labor for the production of heterogeneous goods, the union wage premium and the pattern of international trade will be determined simultaneously.

The key ingredients of the formal model developed below to explore the link between trade patterns and union behavior are that countries differ only with respect to their degree of union activity, that goods produced with union labor are heterogeneous in the intensity with which their production requires union labor, and that there is a single labor union setting a uniform wage across goods of the "union sector." The first assumption is extreme, but represents a modeling technique that has proved useful in highlighting the contributions of such determinants as endowments and technology to the pattern of international trade.[4/] The second assumption approximates an industry-wide union, such as the United Auto Workers or the United Steel Workers, whose members produce a variety of products. Finally, the assumption of a single union is made to keep the model simple. Extending the model to include many unions operating within the union sector is discussed in a footnote.

The particular framework upon which the analysis rests is a variant of the two-country continuum-of-goods Ricardian model of Dornbusch, Fischer, and Samuelson (1977), and is similar in some respects to the model developed in Dixit and Grossman (1982). There are two final-goods sectors and a non-traded intermediate good sector. In the union sector, firms combine unionized labor and the intermediate good in different proportions to produce the various goods of the sector. For concreteness, this sector might be thought of as the automobile industry, the union as the UAW, and the various goods within the sector as the array of different models produced. The goods in the non-union sector are produced with combinations of non-union labor and the intermediate good and can, without loss of generality, be aggregated into one non-union good. The intermediate good is non-traded and is produced in the intermediate good sector with non-union labor alone. To neutralize any Ricardian basis for international trade, technological differences between countries that would lead to comparative advantage are assumed to be absent: only the operation of a labor union in the domestic country distinguishes it from the foreign country. Finally, the domestic labor union is assumed to organize workers in the domestic union sector and to choose a single rent-maximizing wage at which its members will be hired to produce the heterogeneous goods of the sector.

The relationship between the union wage premium and the pattern of production and trade that emerges from this model has important implications for the model's comparative statics results. Since the aggregate labor intensity of the domestic union sector is increasing in

the scope of domestic production, the wage premium of a rent-maximizing doemstic labor union will rise in response to increased "intensity" of foreign competition. Consequently, the scope of domestic production takes on a significance of its own, and the effects of labor migration, demand shifts, and technological change will be altered according to their respective impacts on domestic production. In this way, union activity can alter in a systematic way the standard comparative statics results familiar from competitive Ricardian trade theory.

The remainder of the paper proceeds as follows. After developing the model in section II, section III illustrates the effect of an active union on comparative statics results of the Ricardian model by considering the union response to a decline in demand for union products, to a policy of directing R&D efforts into the union sector, and to international labor migration. Section IV concludes.

II. The Model

The continuum-of-goods Ricardian model of Dornbusch, Fischer, and Samuelson (1977) yields strong comparative statics results concerning the effects of changes in technology, tastes, and national labor endowments on the terms of trade, relative and real wages, and the scope of production in each of the two countries of the model. A convenient graphical representation of the model is developed by the authors to provide a simple and intuitive method for determining the equilibrium and generating comparative statics results. The purpose of this section is to develop a pair of diagrams which together characterize the

world trade equilibrium in the presence of a rent-maximizing labor union in the domestic country. This is accomplished in two steps. First, the model is solved given an exogenous union wage premium. Then union behavior is explicitly considered, and the general equilibrium of the model is obtained.

Union Wage Premium Exogenous

Located in each of the two countries of the model are two final goods sectors and an intermediate good sector. The intermediate good, which will be called "capital" and which is nontraded by assumption, is used as an input into the production of final goods, and is produced with non-union labor alone according to a linear homogenous technology common to both countries. Define units of the capital good so that one unit of labor produces one unit of capital in either country. Let r and w, respectively, be the price of the capital good and the wage of non-union labor at home, and define r^* and w^* similarly abroad, all measured in any common unit. Then perfect competition will ensure that

$$r = w; \; r^* = w^* \tag{1}$$

as long as the capital good is produced in both countries.

The two traded-goods sectors employ labor and capital to produce final goods for consumption. Consider first the domestic economy. Goods of the non-union sector are produced with combinations of non-union labor and capital according to linear homogenous technologies. Since the relative price of factors used in this sector is fixed by (1), competition keeps the relative prices of goods produced in the non-union

sector fixed as well. Under the assumption that subutility over the non-union goods is homothetic, a composite non-union good can be defined whose production requires inputs of capital and non-union labor in fixed proportions. This composite non-union good will be called good 2.

The union sector contains a continuum of goods indexed by $z\varepsilon[0,1]$ and produced under constant returns to scale by combining capital and union labor in fixed proportions. The assumption of Leontief technologies in the union sector is primarily for graphical convenience, though its implications for the endogenous determination of the union wage premium will be discussed below.[5/] Goods in the union sector are indexed according to increasing labor intensity, and the ratio of labor to capital, while uniquely fixed for any good, is assumed to vary continuously between zero and infinity as z goes from zero to one. Finally, domestic preferences over the entire set of consumption goods $z\varepsilon\{[0,1], 2\}$ are assumed to be Cobb-Douglas.

Now consider the foreign country. As noted above, technology for producing the capital good is identical at home and abroad. Further, assume that the Cobb-Douglas preferences over the final goods are shared by both countries. Finally, to neutralize any Ricardian basis for trade, it is assumed that, in the production of final goods, an economy-wide efficiency differential exists between the domestic and foreign countries which may give rise to an absolute but not to a comparative advantage. That is, defining $\ell(z)$ and $k(z)$ as labor and capital requirements, respectively, for unit production of good z in the

domestic country, and defining $\ell^*(z)$ and $k^*(z)$ analogously for the foreign country, it is assumed that

$$\begin{matrix} \ell^*(z) = e\ell(z) \\ k^*(z) = ek(z) \end{matrix} \quad ; \quad z\varepsilon\{[0,1], 2\} \tag{2}$$

where e measures the efficiency differential between domestic and foreign production of final goods. A rise in e corresponds to an increase in the relative efficiency of domestic producers.

In the absence of a domestic union wage premium, condition (2) implies that there will exist no basis for trade between the two countries. A single equilibrium wage w will be earned by all domestic labor, while w^* will be earned by labor abroad. Given (1) and (2), and assuming the absence of transportation costs, relative wages at home and abroad must in equilibrium satisfy

$$e = \frac{w}{w^*} , \tag{3}$$

since otherwise one country would have a cost advantage in the production of all traded goods. Under equilibrium condition (3), neither country has a cost advantage in the production of any good and, as a result, the international pattern of production is completely arbitrary.

The introduction of a domestic union wage premium provides the basis for trade between the two countries. A two-quadrant version of the Lerner-Pearce diagram familiar from Heckscher-Ohlin trade theory can

be used to illustrate the no-trade equilibrium and how the existence of a domestic union wage premium gives rise to international trade. With labor measured on the horizontal axis and capital measured on the vertical axis, the right and left quadrants of Figure 1 depict the unit isocost lines and unit value isoquants that obtain in the union sector and the non-union sector, respectively, in the absence of a union wage premium. For graphical convenience, e is set to unity implying that technologies are identical in the two countries.

In the absence of a domestic union wage premium, and with e set to one, (3) implies that, in equilibrium, domestic and foreign wages will be identical. Normalizing this common wage to unity and using (1), the unit isocost line pictured in each quadrant of Figure 1 is shared by both countries and intersects each axis of the two-quadrant Lerner-Pearce diagram at one, reflecting the reciprocal of the unitary wage paid to labor in each sector and the reciprocal of the unitary price of capital. Cobb-Douglas preferences imply that each good will be demanded and thus produced somewhere in the free trade equilibrium, so that final goods prices will adjust to ensure that every unit value isoquant just touches the unit isocost line in its sector. Since the unit value isoquants and unit isocost lines are shared by the two countries, zero-profit production of any good can occur in either country, and as such, the international location for the production of any final good will be completely arbitrary.

Finally, recall that, in the union sector, each good z is assumed to be produced with a unique ratio of labor to capital; this too is

reflected in Figure 1. In particular, the ratio $\frac{\ell}{k}(z')$ for any $z' \in [0,1]$ can be read from the right-hand quadrant of Figure 1 as the inverse of the slope of the ray from the origin through the point on the curve labeled ZZ that lies vertically above z'. Under the assumption that the labor-capital ratio is continuous and monotonically increasing in z over the interval $z \in [0,1]$ with $\frac{\ell}{k}(0) = 0$ and $\frac{\ell}{k}(1) = \infty$, the ZZ curve, which associates with each $z \in [0,1]$ a labor-capital ratio in the way described above, will intersect the horizontal axis at one, be continuous over $z \in [0,1]$, and have negative but finite slope.

Now consider the introduction of an exogenous union wage premium, $\rho = \frac{\omega - w}{\omega}$, which raises above one the wage paid to labor employed in the domestic union sector, ω. Since the domestic union wage is now higher than the unitary wage abroad, the domestic price of capital must fall below one if the union sector is to continue to operate at all in the domestic country. This implies, using (1), that the domestic non-union wage must fall. In fact, for any given union premium, the level of the domestic non-union wage will determine completely the scope of domestic production and the pattern of international trade. This is depicted in Figure 2.

With the foreign wage still normalized to unity, the foreign unit isocost lines continue to intersect each axis of the Lerner-Pearce diagram at one. The domestic unit isocost line in the non-union sector will now be given by a line such as $\overline{ed}$ in the left quadrant of Figure 2, with vertical intercept $\frac{1}{r}$ where $\frac{1}{r} > \frac{1}{r^*} = 1$, and horizontal

intercept $\frac{1}{w}$ where $\frac{1}{w} = \frac{1}{r}$ by (1). The domestic unit isocost line in the union sector will be given by the line $\overline{dd}$ in Figure 2, with vertical intercept $\frac{1}{r}$, horizontal intercept $\frac{1}{\omega}$ where $\frac{1}{\omega} < \frac{1}{w^*} = 1$, and slope $-[\frac{1}{1-\rho}]$. The exact position of $\overline{ed}$ and $\overline{dd}$ for any union premium will depend on the level of the domestic non-union wage w, which can be determined once the demand side of the model is completed.

Finally, goods prices will eliminate profits in equilibrium. In the left quadrant of Figure 2, the unit value isoquant will move out along a radial path from the origin until its vertex lies on the outermost unit isocost line, that of the domestic country. Accordingly, the non-union good will be produced domestically. Similarly, each unit value isoquant in the right quadrant will move along a radial path from the origin until its vertex lies on the convex hull of the two unit isocost lines. The good labeled $\bar{z}$ in Figure 2 is the "marginal" good whose production can occur in either country in equilibrium, all goods $z \in [0,\bar{z})$ produced at home and all goods $z \in (\bar{z},1]$ produced abroad. Consequently, in the presence of a domestic labor union, the domestic country specializes in the production of the non-union good, and in the capital intensive goods of the union sector.

The real wage effects of the domestic labor union can also be read from Figure 2. The foreign nominal wage w^* is unchanged at its normalized value of unity. Prices of goods $z \in [\bar{z},1]$ are also unchanged relative to w^*. However, prices of goods $z \in \{[0,\bar{z}),2\}$ have fallen relative to w^* as a result of the domestic union wage premium,

as reflected in the outward radial shift of the unit value isoquants for these goods. Therefore, foreign labor gains in real terms from the unionization of the domestic labor force. This occurs because the domestic union wage premium has provided the basis for trade between the two countries, and foreign labor enjoys the benefits of this trade. The real wage of those employed in the domestic union sector rises by an even greater amount, since ω increases relative to the foreign wage w^*. However, the domestic labor union causes the wage of laborers employed in the domestic non-union sector to fall in real terms with respect to every good except $z\varepsilon\{0,2\}$ which by assumption use only non-union labor in their production, and whose prices therefore move in tandem with the domestic non-union wage w. Hence, for any union wage premium and domestic non-union wage, the Lerner-Pearce diagram of Figure 2 can be used to determine the pattern of production and trade, and the real returns to factors in the two countries.

The next step is to determine the domestic non-union wage w as a function of the exogenous union wage premium. To begin, the marginal good Z can be defined implicitly by setting the production cost of Z equal in the two countries. With the foreign wage normalized to one, and using the fact that $r = w$ by (1), Z will be an implicit function of w and e and of the domestic union wage premium ρ as given by

$$w\left[\frac{1}{1-\rho}\,\ell(Z) + k(Z)\right] = e[\ell(Z) + k(Z)] \qquad (4)$$

Expression (4) can be manipulated to yield

$$\frac{\ell}{k}(z) = \frac{(1-\rho)(1-\frac{w}{e})}{\frac{w}{e} - (1-\rho)} \tag{5}$$

Define $f(\cdot) \equiv \frac{\ell}{k}^{-1}(\cdot)$. Then (5) can be solved for z as

$$z = f\left(\frac{(1-\rho)(1-\frac{w}{e})}{\frac{w}{e} - (1-\rho)}\right) \tag{6}$$

Since the labor-capital ratio is by assumption continuous and monotonically increasing in z over the interval $z \in [0,1]$ with $\frac{\ell}{k}(0) = 0$ and $\frac{\ell}{k}(1) = \infty$, $f(\cdot)$ will be continuous and monotonically increasing in its argument with $f(0) = 0$ and $f(\infty) = 1$. As such, expression (6) implies that, for any $0 < \rho < 1$, w must satisfy $e(1 - \rho) < w \leq e$. If $w = e$, $z = 0$ by (6) and the domestic country produces only the non-union good: on the other hand, w must be strictly less than $e(1 - \rho)$ since if $w = e(1 - \rho)$, then by (6), $z = 1$ and the domestic country would produce everything. Finally, inspection of (6) reveals that z is a continuous and decreasing function of w and of ρ, and an increasing function of e, or

$$z = z\overset{(-)}{(}w, \overset{(-)}{\rho}, \overset{(+)}{e}) \tag{7}$$

Next, define $\Gamma(z(w,\rho,e),b(2))$ as the fraction of income spent (anywhere) on those goods in which the home country has a comparative advantage, or

$$\Gamma(\bar{z}(w,\rho,e),b(2)) = b(2) + \int_0^{\bar{z}(w,\rho,e)} b(z)dz \qquad (8)$$

where $b(2)$ is the budget share alloted to consumption of good 2, and $b(z)dz$ is the budget share alloted to consumption of union sector goods $z \in [z, z + dz]$. Then $1 - \Gamma(\cdot)$ is the fraction of income spent (anywhere) on goods produced abroad. The properties of $\bar{z}(w,\rho,e)$ noted in (7) and the non-negativity of $b(z)$ imply that $\Gamma(\bar{z}(w,\rho,e),b(2))$ is non-increasing in both w and ρ, and nondecreasing in e and $b(2)$.

Finally, using the fact that preferences are Cobb-Douglas, the fraction of world income captured by the domestic labor union in the form of union rents is given by $R(\bar{z}(w,\rho,e),\rho)$ defined as

$$R(\bar{z}(w,\rho,e),\rho) = \rho \cdot \int_0^{\bar{z}(w,\rho,e)} b(z) \left[\frac{\ell(z)}{\ell(z) + (1-\rho)k(z)}\right]dz \qquad (9)$$

$\Gamma(\bar{z}(w,\rho,e),b(2)) - R(\bar{z}(w,\rho,e),\rho)$ is then the fraction of world income received by the domestic labor force, net of union rents.

With L and L^* defined as the domestic and foreign labor force, respectively, and with w^* normalized to one, domestic income Y will be given by

$$Y = \frac{wL + R(\bar{z}(w,\rho,e),\rho)L^*}{1 - R(\bar{z}(w,\rho,e),\rho)} \qquad (10)$$

The equilibrium value of the domestic non-union wage, $\bar{w}$, is then determined by the balanced trade condition

$$[1 - \Gamma(\mathcal{Z}(\varpi,\rho,e),b(2))]\ Y = \Gamma(\mathcal{Z}(\varpi,\rho,e),b(2))L^*$$

or

$$\varpi = \frac{\Gamma(\mathcal{Z}(\varpi,\rho,e),b(2)) - R(\mathcal{Z}(\varpi,\rho,e),\rho)}{1 - \Gamma(\mathcal{Z}(\varpi,\rho,e),b(2))}\left(\frac{L^*}{L}\right) = B\left(\mathcal{Z}(\varpi,\rho,e),\rho,b(2),\frac{L^*}{L}\right) \quad (11)$$

For any exogenous value of the union wage premium, ρ, the equilibrium domestic non-union wage can be found as the solution to (11).

Lemma: A unique ϖ exists for any $0 < \rho < 1$, provided that $e > \frac{b(2)}{1-b(2)}\frac{L^*}{L}$.

Proof: From their respective definitions, it follows immediately that for $0 < \rho < 1$,

$$\begin{aligned} &\Gamma(\mathcal{Z}(\varpi=e,\rho,e),b(2)) = b(2) \\ &R(\mathcal{Z}(\varpi=e,\rho,e),\rho) = 0 \\ &\Gamma(\mathcal{Z}(\varpi=e(1-\rho),\rho,e),b(2)) = 1 \\ &R(\mathcal{Z}(\varpi=e(1-\rho),\rho,e),\rho) < 1 \end{aligned} \quad (12)$$

Consequently,

$$\begin{aligned} &B\left(\mathcal{Z}(\varpi=e,\rho,e),\rho,b(2),\frac{L^*}{L}\right) = \frac{b(2)}{1-b(2)}\frac{L^*}{L} < e \\ &B\left(\mathcal{Z}(\varpi=e(1-\rho),\rho,e),\rho,b(2),\frac{L^*}{L}\right) = \infty \end{aligned} \quad (13)$$

In addition, $[\Gamma(\cdot) - R(\cdot)]$ can be rewritten as

$$[\Gamma(\cdot) - R(\cdot)] = b(2) + (1-\rho) \int_0^{\mathcal{Z}(w,\rho,e)} b(z) \cdot \left[\frac{\ell(z) + k(z)}{\ell(z) + (1-\rho)k(z)}\right] dz \qquad (14)$$

Since $\mathcal{Z}(w,\rho,e)$ is decreasing and continuous in w, $[\Gamma(\cdot) - R(\cdot)]$ is a nonincreasing and continuous function of w, while $[1 - \Gamma(\cdot)]$ is a nondecreasing and continuous function of w, so that $B(\cdot)$ is a continuous function of w and

$$\frac{\partial B(\mathcal{Z}(w,\rho,e),\rho,b(2),\frac{L^*}{L})}{\partial w} \leq 0 \; . \qquad (15)$$

Conditions (13) and (15) and the continuity of $B(\cdot)$ ensure the existence of a unique $\bar{w}$ that solves (11). Q.E.D.

Using equilibrium condition (11), the equilibrium domestic non-union wage can be determined as a function of ρ for fixed values of e and $\frac{L}{L^*}$. In particular, for $\rho = 0$, we know from (3) that $\bar{w} = e$. Further, from their definitions in (8) and (14), $\Gamma(\cdot)$ and $[\Gamma(\cdot) - R(\cdot)]$ are nonincreasing in ρ so that

$$\frac{\partial B(\mathcal{Z}(w,\rho,e),\rho,b(2),\frac{L^*}{L})}{\partial \rho} \leq 0 \qquad (16)$$

With (15) and (16), it follows from (11) that $\frac{d\bar{w}}{d\rho} < 0$. Finally, for $\rho = 1$, expression (6) implies that $\mathcal{Z} = 0$ which, according to (8) and (9), means that $\Gamma(\mathcal{Z}(w,\rho=1,e),b(2)) = b(2)$ and $R(\mathcal{Z}(w,\rho=1,e),\rho=1) = 0$. Consequently, (11) implies that when $\rho = 1$, $\bar{w} = \frac{b(2)}{1-b(2)} \frac{L^*}{L} = \bar{w}_{min}$.

Is is assumed that $\bar{w}_{min} < e$. The relationship describing $\bar{w}$ as a function of ρ implicit in condition (11) is summarized by the downward sloping curve in Figure 3. For any exogenous union premium, this curve gives the equilibrium value of the domestic non-union wage.

Modeling Union Behavior

The potential importance of making endogenous the pattern of production and trade from the standpoint of determining the effects of foreign competition on union wage-setting behavior is brought out by noting that trade will have two opposing effects on the optimal union wage premium in this model. On the one hand, the union wage will be constrained by international trade through a higher elasticity of derived demand for union labor: this results from the international relocation of production that would occur at the margin in response to further increases in the union wage. On the other hand, the goods whose production does remain at home will be those that use relatively unintensively the services of union labor, and the average labor intensity of production in the union sector will decline: this effect tends to reduce the elasticity of derived demand for union labor, and consequently leads to a higher union wage. If the former effect is invariant with respect to the scope of domestic production, then through the latter effect, "intensification" of foreign competition which manifests itself in a narrower scope of domestic production will bring about a higher union wage premium, since the increased competition from abroad weeds out precisely those firms whose relatively intensive use of

union labor held down the domestic union wage premium. These results are derived formally as follows.

Domestic union membership is taken as exogenously determined. Union members who do not get jobs in the union sector are assumed to find employment in the non-union sector at the prevailing non-union wage. The union is assumed to choose ω to maximize the rents earned by its members, taking the domestic non-union wage and level of world income $(Y + L^*)$ as fixed.[6/] Domestic union rents can be written as

$$\Pi(\omega) = [\omega - w] \int_0^{Z(w,p(\omega),e)} \ell(z)d(z;P(z;\omega))dz \qquad (17)$$
$$= [\omega - w]D(\omega)$$

where $d(z;P(z;\omega))dz$ is world demand for union sector goods $z \in [z,z+dz]$ and $P(z;\omega) \equiv \omega\ell(z)+wk(z)$ is the price of good z. World income has been suppressed as an argument of demand since it is by assumption taken as given by the domestic union. The first order condition for the union's problem is

$$\frac{\partial \Pi(\omega)}{\partial \omega} = D(\omega) + (\omega - w)\frac{\partial D(\omega)}{\partial \omega} = 0 \qquad (18)$$

Manipulation yields an expression for the optimal union premium

$$\bar{p} = \frac{1}{\eta} \qquad (19)$$

where $\eta \equiv \frac{-\partial D(\omega)}{\partial \omega}\frac{\omega}{D(\omega)}$ is the elasticity of derived demand for domestic union labor with respect to ω with the sign reversed.

The derived demand elasticity η can be broken into two components, one associated with changes in derived demand for each union good holding the scope of domestic production constant, and the other associated with changes in the scope of domestic production itself. Explicit calculation of η yields

$$\eta = \int_0^{Z(w,\rho,e)} \lambda(z;Z(w,\rho,e),\rho)\theta(z;\rho)dz + \sigma \qquad (20)$$

where

$$\theta(z;\rho) \equiv \frac{\omega \ell(z)}{P(z;\omega)} = \frac{\ell(z)}{\ell(z) + (1-\rho)k(z)}$$

is the domestic union labor's share of production costs for good z,

$$\lambda(z;Z(w,\rho,e),\rho) \equiv \frac{b(z)\ \theta(z;\rho)}{\int_0^{Z(w,\rho,e)} b(z)\theta(z;\rho)dz}$$

is the share of derived demand for domestic union labor associated with good z, and

$$\sigma \equiv -\ \omega \frac{\partial Z}{\partial \omega}\ \lambda(Z(w,\rho,e);Z(w,\rho,e),\rho)$$

is the elasticity of derived demand for domestic union labor associated with the international relocation of the production of marginal goods. According to (20), η can be written as the elasticity of demand for domestic union labor associated with changes in the scope of domestic

production, σ, plus a weighted average of derived union labor demand elasticities across goods produced in the domestic union sector which, due to the Cobb-Douglas demand and Leontief technology assumptions, are given by the union cost share variable $\theta(z;\rho)$. [7] The optimal union premium according to (19) is simply the inverse of this sum.

Given e, (19) defines the equilibrium $\bar{\rho}$ as a function of w. A sufficient condition for $\bar{\rho} \in [0,1)$ to exist for a given w is that σ exceed one. Since (6) implies that $\frac{\partial \bar{z}}{\partial \omega} = -f'(\cdot)\frac{e-w}{(\omega-e)^2}$, σ will be greater than one over the relevant range of w's provided that $f'(\cdot)$ is sufficiently large, i.e., provided that variation in labor-capital ratios across z in the relevant range is not too large. The second order condition will also be met provided that $f'(\cdot)$, and thus σ, is sufficiently large at the optimum. This is assumed to be the case. Finally, it is assumed that the distribution of budget densities and $f''(\cdot)$ are such that σ is invariant with respect to changes in the scope of domestic production in the relevant range. It is then easily shown from (19) that, provided second order conditions are met,

$$\frac{d\bar{\rho}}{dw} > 0. \tag{21}$$

The relationship describing $\bar{\rho}$ as a function of w is illustrated by the upward sloping curve in Figure 3. For given values of w, this curve gives the value of ρ satisfying the rent-maximizing conditions of the union. The solution to the two equilibrium conditions of the

model, equations (11) and (19), is illustrated in Figure (3) as $(\bar{w},\bar{\rho})$. Finally, having determined general equilibrium values for the union wage premium and the domestic non-union wage in Figure 3, Figure 2 can be used to determine the real wages paid to those employed in the union and non-union sectors at home, and to labor abroad, and the equilibrium pattern of production and trade. The next section explores how the endogeneity of the union affects several comparative statics results of the model.

III. Comparative Statics

The model developed in the previous section can be used to illustrate the effects of changes in the international environment on union behavior. This section explores the union response to three events: a shift in consumer preferences toward non-union goods, the imposition of a domestic targeting program aimed at union-sector goods, and the international migration of non-union labor.

Demand Shifts

Lawrence and Lawrence (1985) provide an explanation for the rising union wage premium in the U.S. over the period 1970-1984 which is based on a prediction of rising union wage differentials in response to long run declines in demand growth: the decline in demand growth in the union sector reduces the substitution possibilities between capital and labor, leading to a less elastic derived demand for union labor and a greater wage premium. The model of section II yields a similar relationship between declining union sector demand and rising wage

differentials, but for a very different reason.

Consider an increase in $b(2)$, the proportion of income spent on the non-union good, accompanied by a proportional decrease in the budget shares of all union sector goods $z\varepsilon[0,1]$, so that $\lambda(z;\cdot)$ is unchanged for $z \varepsilon [0,1]$ and the budget shares over all final goods still sum to one. The decline in union sector demand will have no affect on the equilibrium relationship between $\bar{p}$ and w given by condition (19), since $b(2)$ does not enter (19) directly (see the definition of η given in (20)). Combinations of $\bar{p}$ and w that satisfy (19) are depicted by the upward sloping curve in Figure 4. However, $b(2)$ does enter into equilibrium condition (11). For any $\rho>0$, the increase in $b(2)$ will lead to a domestic trade surplus which, according to (11), requires a rise in $\bar{w}$ to restore equilibrium. If $\rho = 1$, then (11) implies that $\bar{w} = \frac{b(2)}{1-b(2)} \frac{L^*}{L} = \bar{w}_{min}$ so that $\bar{w}_{min}$ must rise with an increase in $b(2)$. If $\rho=0$, then $w=e$ and the location of production is arbitrary, so that changes in budget shares have no affect on relative wages. This is summarized by the upward shift in the negatively sloped curve shown in Figure 4, which depicts the relationship between $\bar{w}$ and ρ given in (11).

At the original $\bar{\rho}_o$, the domestic non-union wage is bid up relative to the wage of foreign labor due to the shift in preferences away from goods of the union sector and toward good 2: this makes domestic union sector production less competitive relative to production abroad, and the production of a marginal range of domestic union goods is lost to foreigners. Since the domestic plants that close are the

most labor intensive of the domestic union sector, the sectoral labor intensity of the domestic union sector declines, inducing the rent-maximizing union premium to rise. The new equilibrium is illustrated in Figure 4 by $(\bar{w}_1, \bar{\rho}_1)$, where the union premium has risen as a result of the declining demand for union sector goods.

Fundamentally, it is not the decline in union sector demand per se but rather the loss of marginal goods associated with it that leads to a rise in the domestic union wage premium. The loss of marginal goods is brought about by an increase in the domestic non-union wage resulting from the greater demand for domestic non-union workers. As such, the model associates rising union wage premiums with falling union sector demand only when, as in the proportional case considered here, the shift in demand away from the goods of the union sector results in greater demand for the services of domestic non-union labor.

Targeting

As Krugman (1987) has noted, the case for industrial targeting stands or falls with the ability to identify sectors that "ought" to be targeted, where targeting is understood to imply a policy of affecting the sectoral pattern of investment rather than its aggregate level. Since the choice of the targeted sector will have implications for the scope of domestic union production in the model of section II, it will also affect the union wage premium. This in turn can provide a reason to alter the sectoral mix of investment through a policy of industrial targeting.

As an illustration of this point, consider the choice between

allocating a given amount of R&D expenditures to either the union or the non-union sector of the domestic country, where the direct (cost-saving) effect of the R&D results in an increase in e in the targeted sector. Assume that the change in e alone would lead to cost reductions for the domestically produced goods of the sector which imply an equivalent increase in utility regardless of the sector chosen for targeting. Thus, from the standpoint of the direct effect of R&D, there is no basis upon which to favor one sector over the other.

If the non-union sector were targeted, all benefits would be captured in this direct effect: the increase in the domestic efficiency of the non-union sector and the resulting drop in $P(2)$ would be the only benefit of the program, since endogenous variables of the model would be unaffected. This is easily seen by noting that e enters both equilibrium conditions (11) and (19) only through $\mathbf{Z}(w,\rho,e)$, and hence, only in so far as it captures the international technology differences in production of union sector goods. As such, the domestic utility benefits of R&D applied to the non-union sector are captured completely by the resulting price reduction for good 2.

Not so for a policy of targeting the domestic union sector which, in altering the efficiency of production of the marginal union good, affects the equilibrium values of w and ρ. Specifically, consider first the impact of an increase in e on equilibrium condition (11). The efficiency parameter e enters (11) only through its affect on $\mathbf{Z}(w,\rho,e)$ as given in expression (6). Thus, for any $0 < \rho < 1$, (6) implies that an increase in e would require an equivalent percentage

increase in w to leave $Z(w,\rho,e)$, and hence $B(\cdot)$, unchanged. But this would leave w greater than $B(\cdot)$, and hence for (11) to be satisfied, ϖ must rise by less than the percentage increase in e. For $\rho = 1$, ϖ is unaffected by the change in e since $\varpi = \varpi_{min} = \frac{b(2)}{1-b(2)} \frac{L^*}{L}$, while for $\rho = 0$, (3) implies that $\varpi = e$ and thus ϖ rises by the full increase in e. This information is reflected in the upward shift (by less than the percentage increase in e) of the negatively sloped curve in Figure 5a. Next consider the effect of increasing e on equilibrium condition (19). Holding $\bar{p}$ constant, (6) implies that w must rise by the same percentage as e to leave Z, and hence $1/n$, unchanged. Thus, the upward sloping curve in Figure 5a shifts up by the same percentage as the change in e.

The resulting equilibrium $(\bar{w}_1, \bar{\rho}_1)$ is given in Figure 5a. At the original $\bar{\rho}_0$, the scope of domestic union sector production would increase as a result of the targeting program, since according to (11) the domestic non-union wage does not rise to fully offset the cost savings resulting from the technological advance. Since the additional plants added to domestic union sector production are more labor intensive than existing domestic production, the sectoral labor intensity of the domestic union sector rises, causing the rent-maximizing union premium to fall. The final equilibrium is given by $(\bar{w}_1, \bar{\rho}_1)$, where the domestic non-union wage has increased and the domestic union premium has fallen as a result of the union sector targeting.

The welfare implications of the change in $\bar{w}$ and $\bar{\rho}$ induced by

union-sector targeting are illustrated in Figure 5b.[8/] The unit isocost lines of the foreign country are given by the solid lines. Assuming that technologies are originally identical, i.e., that $e_o=1$, the original unit isocost lines of the domestic country are given by the dashed lines. With R&D targeted to the domestic union sector, e will rise above one in that sector. Holding ρ fixed, Figure 5a shows that w (and thus r) rises, but by less than e, to w'. The dotted lines in the two quadrants of Figure 5b reflect this new equilibrium value of w, where ρ has been held fixed. The rise in w and r shifts inward the domestic unit isocost line in the non-union sector, as depicted in the left hand quadrant. In the right hand quadrant, the foreign country's unit value isoquant will be the domestic country's "e" value isoquant, since the two countries no longer share technologies for production of the union goods. As such, the domestic union sector's "e" isocost line is depicted by the dotted line in the right hand quadrant. At the original $\bar{\rho}_o$, it has shifted out, since w (and thus r) has fallen relative to e.

Even before allowing ρ to respond, it is apparent from Figure 5b that a terms-of-trade argument can be made for targeting the union sector in this model, since domestic wages (union and nonunion) increase not only with respect to the prices of domestically produced union sector goods (the direct effect), but also with respect to the prices of all goods produced abroad (the terms of trade effect). In contrast, targeting the non-union sector leads only to a direct real wage effect with respect to the non-union good, since it leaves the (double

factoral) terms of trade unaltered. This result, however, has nothing to do with the operation of the union per se: it occurs simply because the union sector happens to include the marginal good, on whose relative production efficiency the relationship between domestic and foreign wages depends. 9/

The real case for targeting the union sector comes from the additional effect of the targeting policy once the union is allowed to react. As shown in Figure 5a, ρ falls, inducing w to rise further from w', until the new equilibrium $\bar{\rho}_1$ and $\bar{w}_1$ are reached. The dash-dot lines in Figure 5b reflect this final equilibrium. The additional welfare gains to domestic non-union workers that arise from the union response come in the form of lower priced union sector goods produced domestically and lower priced imports from abroad. As a result of the fall in ρ and the accompanying increase in w, the domestic non-union wage rises with respect to the prices of all goods $z \in (0,1]$: the relative wage increase makes foreign produced goods more affordable at home, while the drop in ρ lowers the price of domestically produced union sector goods relative to the domestic non-union wage. Finally, the domestic union members must benefit in real terms as well from the union's response to the targeting program, even though the union is assumed to ignore its effect on w when choosing ρ. This is because the drop in the union premium serves to increase the domestic non union wage, and hence the (ignored) double factoral terms of trade effect of the union response is in this case beneficial to domestic union workers.

Therefore, the reduction in ρ and accompanying increase in w brought about by union sector targeting is welfare enhancing for the domestic economy, and suggests a rationale for caring especially about the "competitiveness" of the union sector.[10/]

Labor Migration

International labor migration can be represented in the model as a change in $\frac{L^*}{L}$. In the competitive model explored in Dornbusch, Fischer, and Samuelson (1977), labor migration from the low wage to the high wage country would reallocate the world stock of labor toward the country whose marginal-good technology is most efficient. This serves to expand the world production possibilities frontier, and makes labor in the low wage country better off, though the (original) inhabitants of the high wage country suffer a welfare decline. Of course, the expansion of world production possibilities ensures that the gainers could compensate the losers. Findlay (1982) has argued in the context of a Ricardian model that, with regard to several well-known notions of distributive justice, free trade cum migration is "just" in that it at once expands the world production possibilities and brings about a more equal international distribution of income.

In the model of section II, the consequences of labor migration in response to international wage differentials can be quite different. First, the union can cause the less efficient country to have the high non-union wage, so that (non-union) labor migration in the direction of higher wages contracts the world production possibilities frontier. Moreover, in response to this migration abroad, the scope of domestic

production contracts, and the union wage premium therefore rises, offseting the real gains that would otherwise accrue to domestic non-union workers and reducing the amount by which migration closes the international non-union wage discrepancy.

This is illustrated in Figures 6a and 6b. Figure 6a illustrates the initial determination of $\bar{\rho}_o$ and $\bar{w}_o$ where, as drawn, $e > 1 > \bar{w}_o$, i.e., the home country is more efficient in the production of all final goods than the foreign country, but the domestic union wage premium has reduced the domestic non-union wage below the unitary wage of labor abroad. The solid lines in Figure 6b reflect foreign unit isocost lines, while the dashed lines represent the home country's initial "e" isocost lines.

With the initial domestic non-union wage lower than the wage abroad, migration will occur in the direction of the foreign country. As such, (L^*/L) increases, and labor migrates towards the technologically inferior country. This will have no effect on the upward sloping curve in Figure 6a, as can be seen by noting that $(\frac{L^*}{L})$ does not enter directly into equilibrium condition (19). However, equilibrium condition (11) implies that the downward sloping curve in Figure 6a will shift upward: for $\rho = 1$, the percentage increase in the domestic wage will equal the percentage increase in $(\frac{L^*}{L})$, while for $\rho = 0$, $\bar{w}$ equals e and is unaffected by relative changes in the size of the domestic labor force.

At the initial $\bar{\rho}_o$, the increase in the domestic non-union wage that results from the exodus of non-union labor will contract the scope

of union sector production in the home country. Since the most labor-intensive activities are the first to go, the sectoral labor intensity of production in the domestic union sector declines, inducing a rise in ρ. The final equilibrium is given by $(\bar{\rho}_1, \bar{w}_1)$ in Figure 6a, where both the union wage premium and the domestic non-union wage have increased as a result of the migration.

The real wage effects of this migration are contained in Figure 6b. The dotted lines represent the final "e" isocost lines for the home country, and reflect the fact that both w and ρ have increased. The implications of the union response to migration for the utility of foreign workers is ambiguous: for a given domestic non-union wage the higher ρ makes domestic goods more expensive abroad, while the drop in the domestic non-union wage induced by the increase in ρ makes them cheaper. Overall, however, foreign residents must be hurt by the influx of labor, since both w and ρ rise. The effect of the union response to migration on the utility of domestic non-union workers is unambiguously negative, since the rise in ρ diminishes the purchasing power of the domestic non-union wage with respect to domestically produced union sector goods, and the induced fall in w makes goods abroad more expensive as well. The overall effect of the migration on domestic non-union residents is ambiguous, however, due to the rise in both w and ρ. If domestically produced union goods enter with sufficient weight in utility, the (remaining) domestic non-union labor force will be made worse off by the exodus of domestic labor.

IV. Conclusion

Competitive trade theory suggests that freely working market forces in a world economy will determine optimally the international location of production, and that a country engaged in trade need have no additional concerns over the identity of sectors operating within its borders. While recent literature has questioned this result, and points toward the potential national benefits of the domestic location of sectors with certain attributes, the focus has been primarily on product markets.[11/] Moreover, there is nothing inherently perverse about the free trade allocation of production across countries in this literature: there simply exist certain sectors that all countries would rather have operating within their borders.

This paper has focused on the existence of an optimizing labor union, and has explored the interaction between union wage demands and the international pattern of production and trade. In the model considered, the scope of domestic production takes on a special welfare significance of its own, since it determines in a systematic way the characteristics of the set of firms served by the trade union. A broader scope of production at home is associated with a lower domestic union wage premium, while an "intensification" of foreign competition leads to a higher domestic union premium.

As illustrated in section III, this relationship implies several conclusions concerning the effects of changes in the international environment which lead to shifts in the international pattern of production. First, a shift in preferences away from union sector goods

and into the non-union goods of the domestic country will, in driving up the domestic non-union wage relative to the wage abroad, diminish the scope of domestic union sector production and hence reduce the sectoral labor intensity of production: this leads to a rise in the rent-maximizing domestic union wage premium. As such, the model predicts a rising union premium in the face of declining demand for union products. Second, directing domestic R&D efforts toward the union sector will expand the scope of union production and reduce the union premium, while R&D in the non-union sector leaves the scope of union sector production, and hence union behavior, unchanged: this raises the possibility of welfare gains from a program of union sector targeting. Finally, international labor migration can have very different effects when a labor union is present. In paticular, the presence of a union in the technologically more advanced country can cause migration of non-union labor to occur in the direction of the less advanced country. Moreover, as this migration takes place, the union wage premium is driven up, offsetting the welfare gains of migration to the remaining non-union population in the domestic country.

The inverse relationship between scope of production and the union premium which emerges from this model depends critically on the notion that international differences in union activity are an important determinant of international cost differences. An extreme view has been adopted here, in that the presence or absence of a union is all that distinguishes countries in the model. The interaction of labor union activity with other determinants of trade patterns, as well as with the

actions of other unions at home and abroad, is clearly a direction for further research.

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Footnotes

*This paper has benefited substantially from the detailed and insightful comments of Alan Deardorff and Robert Stern, from helpful discussion with John Pencavel, Guido Tabellini, and members of the International Trade Seminars at Stanford and Princeton, and from the very helpful comments of an anonymous referee. Any remaining errors are my own.

1/ See, for example, Johnson and Mieszkowski (1970), Jones (1971), Magee (1971), and Diewert (1974).

2/ See, for example, Oswald (1982) and Hill (1984). Grossman (1982) has focused on modeling the response of union wage demands to an increase in international competition when the union follows a seniority layoff and rehiring rule. His results suggest that such hiring rules could be responsible for the empirical observation that sectoral wages often fail to fall in response to a reduction in the price of competing import goods. The results of this paper provide an alternative explanation for such wage behavior.

3/ The effect of capital intensity on the derived demand elasticity for labor is often cited as one explanation of greater union activity in more capital intensive sectors. For empirical evidence on this relationship, see, for example, Hirsch and Berger (1984).

4/ For example, Ricardian trade theory singles out technological differences as the determinant of trade patterns, while Heckscher-Ohlin theory focusses on differences in relative factor endowments.

5/ What is important is not that the elasticity of factor substitution is zero for goods in the union sector, but that it is the same across goods. Footnote 7 contains a discussion of varying factor substitution elasticities. Note also that, at the sectoral level, factor substitution will occur in response to changing relative factor prices, but it will be accomplished by altering the mix of goods produced within the sector, rather than by altering the mix of factors in the production of any good.

6/ As noted in Hill (1984), rent-maximizing behavior is a special case of the union objective function employed by McDonald and Solow (1981), in which union members are risk neutral. That the union ignores its effect on the domestic non-union wage and level of world income when setting its wage is an assumption which can be motivated by thinking of this union as one of many unions, no one of which is large enough to affect aggregate variables, but which together have a significant impact. For a paper focussing on many small unions in a continuum-of-goods general equilibrium model, see Staiger (1985).

7/ More generally, the elasticities of factor substitution and product demand will also enter into the determination of the derived demand elasticity for union workers. However, empirical evidence of uniformly low substitution elasticities between union and non-union inputs can be found in Freeman and Medoff (1981, 1982), and it seems natural to focus on variations in cost shares as the main element of heterogeneity among goods served by the union. Limited

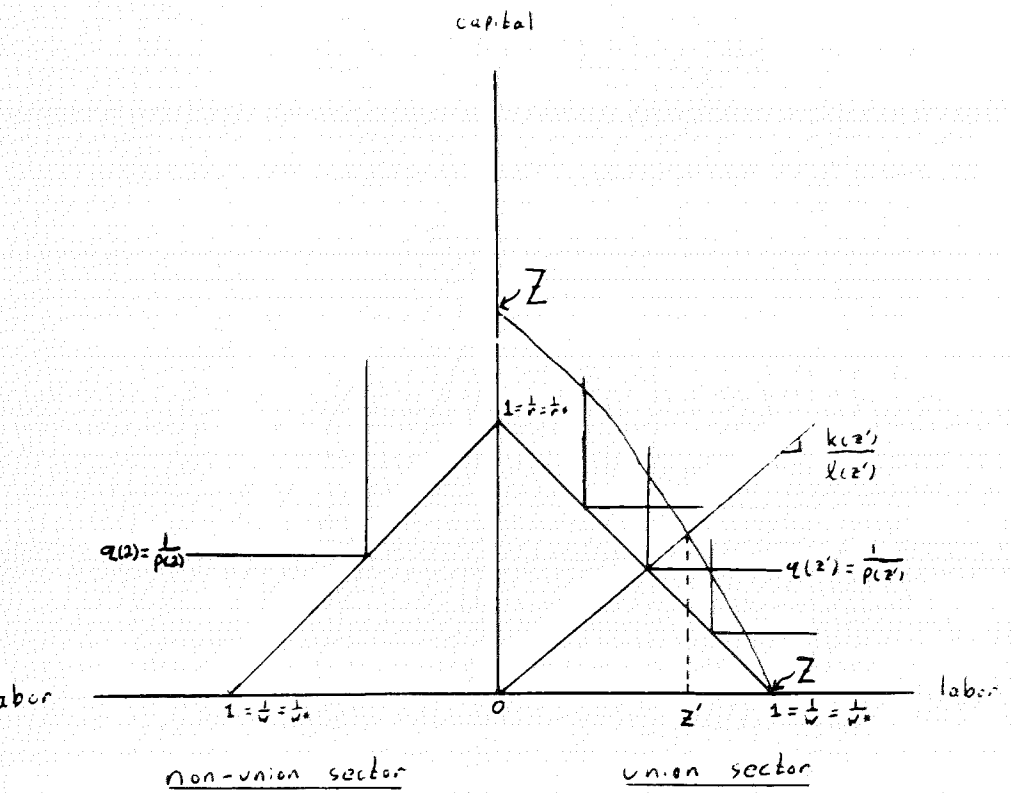
variation in factor substitution and/or demand elasticities across goods would complicate but not alter the conclusions of this paper.

8/ The ZZ curve is suppressed from figures 5b and 6b since it remains unchanged throughout.

9/ An argument for targeting "marginal" goods due to this terms of trade effect has been made recently by Itoh and Kiyono (1987).

10/ The policy of targeting analyzed here assumes that the union takes as given the government R&D decision when it sets its wage demands.

11/ See Krugman (1986) for a recent review.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$q(z')=\frac{1}{p(z')}$
Z
labor
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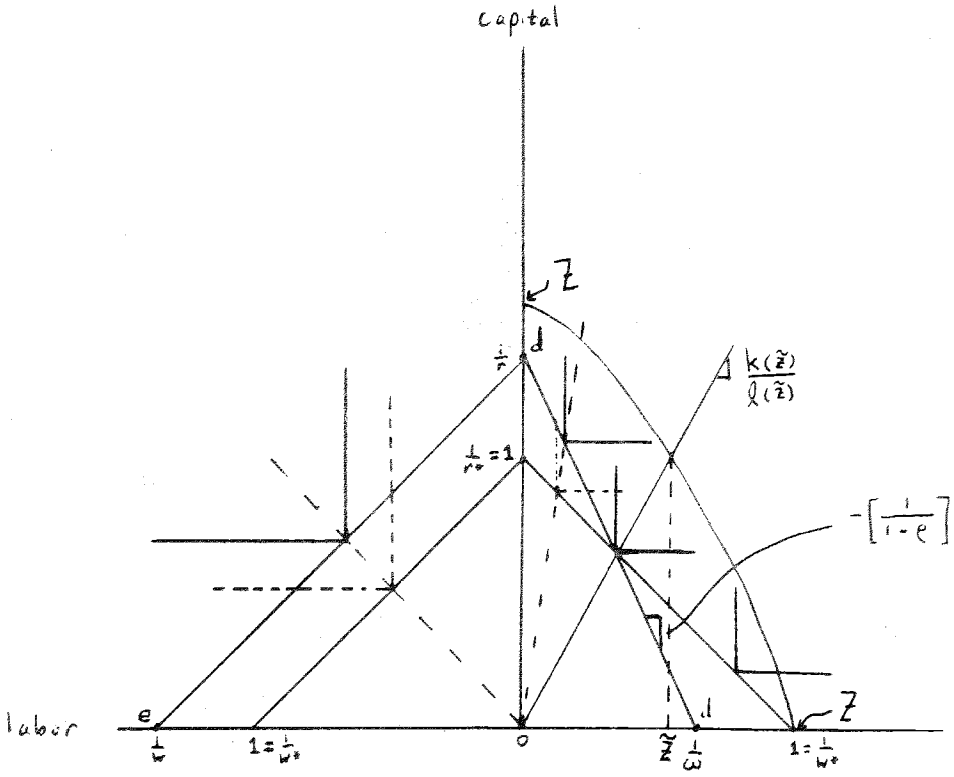
0
z'
$1=\frac{1}{w}=\frac{1}{w_0}$
labor
non-union sector
union sector

Figure 1


capital
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$1=\frac{1}{w^*}$
non-union sector
union sector

Figure 2

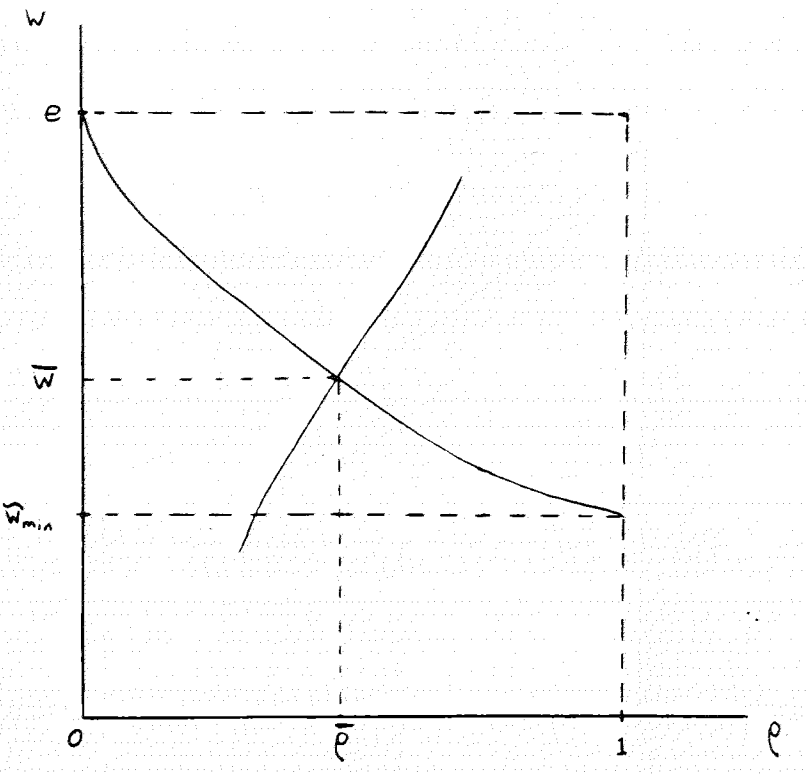

Figure 3

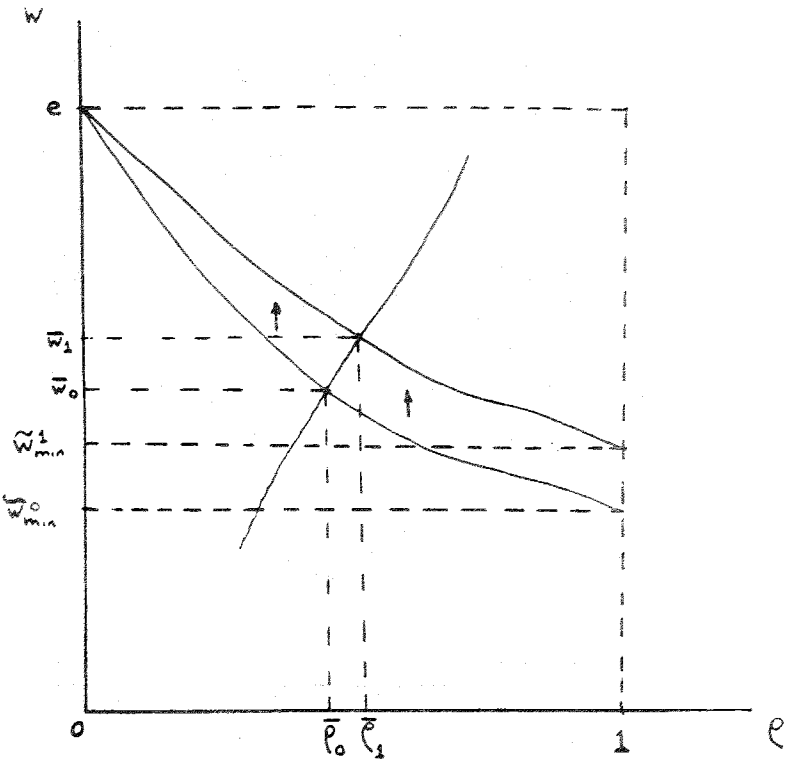

Figure 4

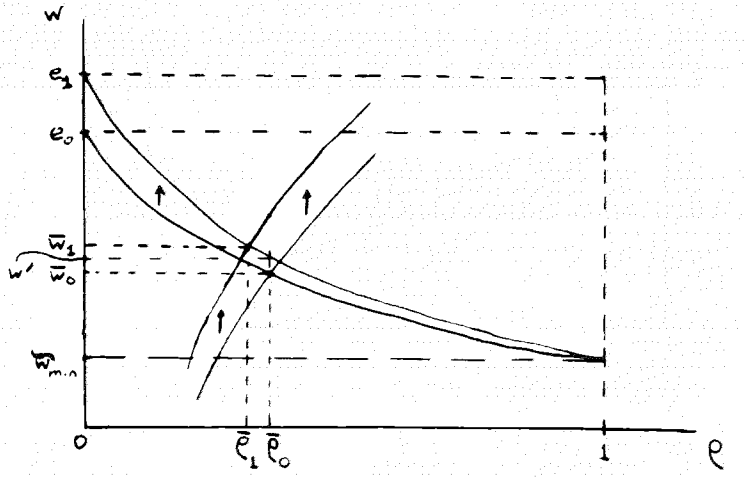

Figure 5a

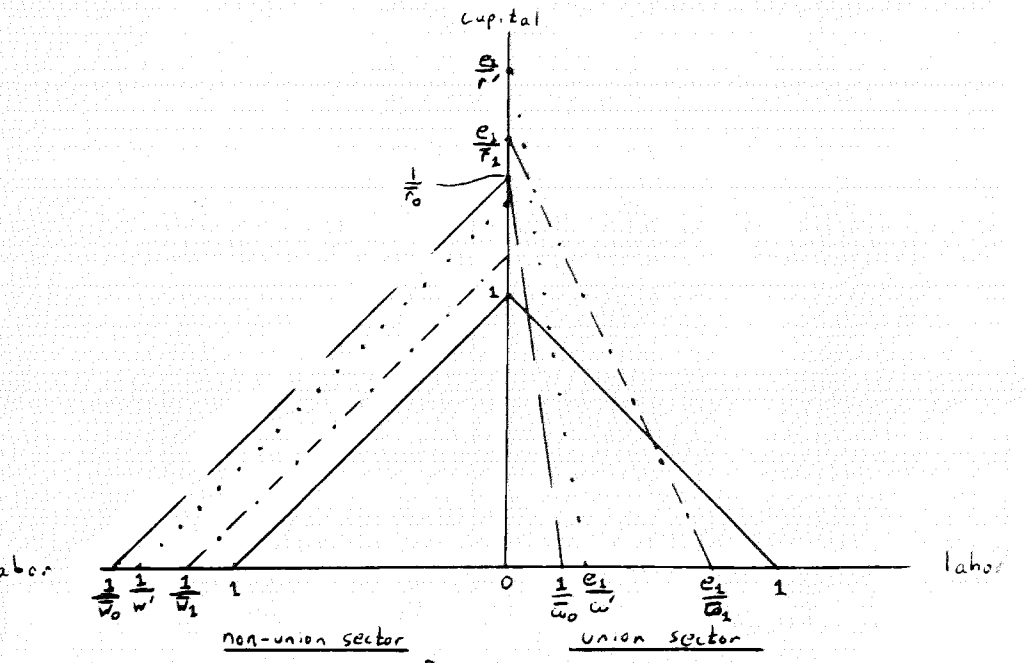

Figure 5b

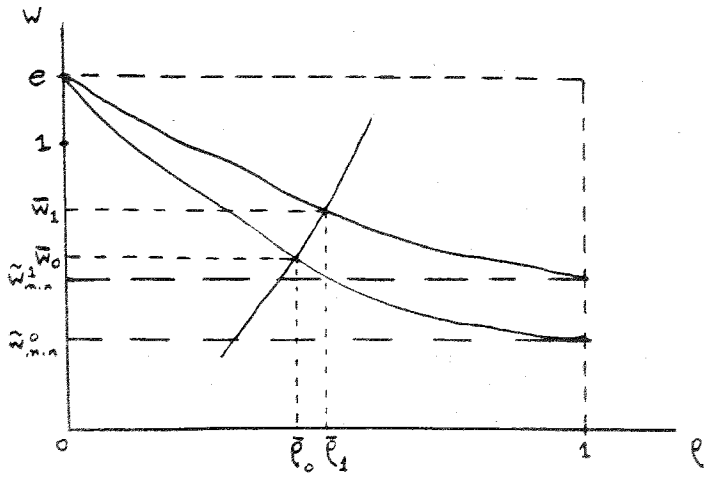

Figure 6a

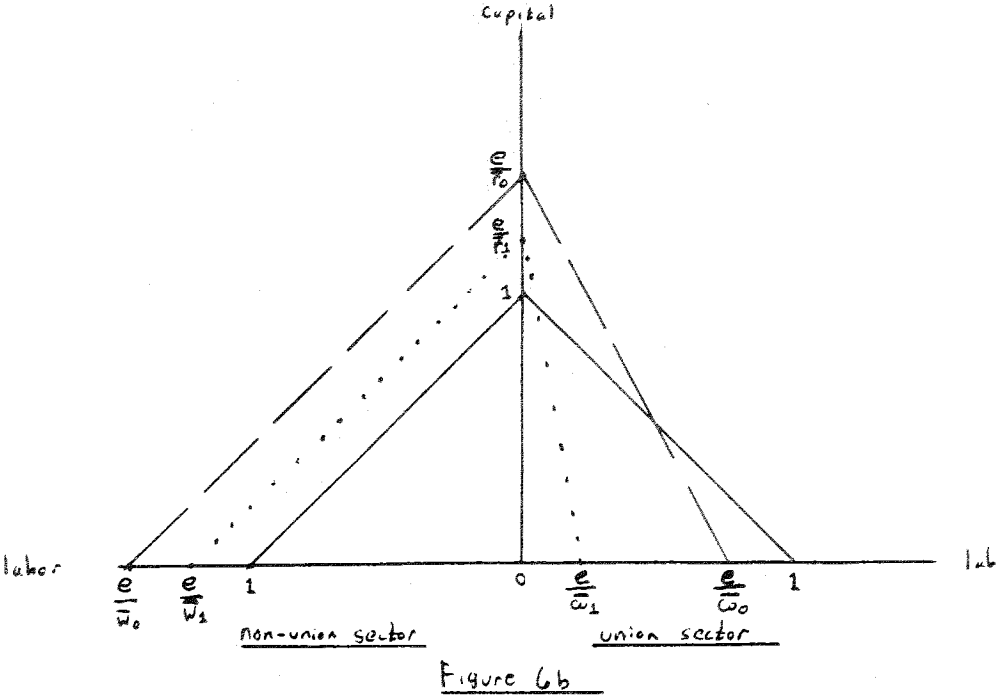

Figure 6b