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CHOICE BETWEEN INTERNATIONAL CAPITAL AND LABOR MOBILITY

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Reflecting recent deepening of economic interdependence among countries, international capital and labor movements have increasingly become as active as international commodity trade is. In such a world with various ways of connecting economically the countries which compose it, each country will be required to choose the best regime to operate its economy efficiently, and the choice made by one country may be different from those by the others because different countries usually have different production technologies and factor endowments. This paper considers a situation where, expecting the partners to make the same choice as its own, each country can unilaterally make a choice between the regime which allows free international commodity trade with capital mobility and the one which allows free international commodity trade with labor mobility and it examines which regime is more advantageous to a country with a particular technology and factor endowment and whether there is a conflict of interest between the countries. With this question answered, it would, in addition, be possible to estimate the economic appropriateness of the existing policies of many countries to restrict or prohibit in-and-out flows of capital and labor.

If the production technologies of each good are identical across countries as in the Mundell(1957) model, three types of international economic regimes, such as free international commodity trade, perfect international capital mobility, and perfect international labor mobility, are completely substitutable for each other provided that every country is incompletely specialized. Thus it is quite indifferent which regime is chosen out of the three, and hence there are no conflicts of interests between any countries. However, it is not necessarily the case if the technologies

are internationally different. Introducing a particular type of technological superiority in one country but not the others is the situation this paper intends to consider in a standard 2 x 2 x 2 trade model.

It has been pointed out that at least one of the countries is likely to specialize completely in the production of its export when international commoditiy trade and factor mobility are simultaneously allowed in the standard trade model [Jones (1967)]. In fact, Chipman(1971) has shown that if for given technologies and factor endowments there is a case of global diversification in which two countries have positive outputs of each good it occurs at a unique price ratio between the two goods. The alternative conditions for such a case to exist are, according to Uekawa(1972), that each industry has a particular type of inter-country difference in technology or each country has a particular type of inter-industry difference in technology. Since the latter Uekawa condition is sufficiently restrictive to yield a worldwide ranking of industries by the factor intensity, I built the model based on it to shed light on the problem of choice between the two international economic regimes from the welfare point of view of the countries with diversified production structures. It can also be shown that the model based on the other Uekawa condition together with an alternative assumption of the factor-intensity ranking leads to the results which are essentially the same but superficially different from the ones derived here.[1]

There is little literature on the choice between international capital and labor mobility. Wong(1983) deals with the choice problem in the standard trade model from the welfare viewpoint of a small country which has the same factor endowment ratio as the partner's but a type of inter-country difference in technology such that it forces the small country into complete specialization under regimes allowing both free international trade and factor mobility. These special characteristics of his model narrow

the applicability of his results to the real world and make it impossible for him to reveal relations between the choice of a regime and the factor endowment and to show the possibility of international conflicts of interests. Ramaswami(1968), Bhagwati-Srinivasan(1983), Calvo-Wellisz(1983), and Jones-Coelho-Easton(1986) argue the problem of which is an optimal policy for a capital-abundant country with monopoly and monopsony powers in world factor markets between the policies restricting capital outflows and labor inflows to respective optimal levels in two-factor, one-sector models with internationally identical technologies. They are different from the present paper in that they look at the choice problem only from one country's point of view and they neglect the involvement of commodity trade and international differences in technology.

I. Inter-Industry Differences in Technology

There are two countries, home and foreign countries, each of which produces two commodities, commodities 1 and 2, with two factors, capital and labor. The production function of each good is continuously differentiable, homogeneous of degree one and different between the two countries. Denote by X_j the output of good j and by K_j and L_j the inputs of capital and labor in industry j respectively and let an asterisk stand for a corresponding foreign variable, the home and foreign production functions of industry j are represented respectively by $X_j = F_j(K_j, L_j)$ and $X_j^* = G_j(K_j^*, L_j^*)$ for $j = 1,2$. Furthermore, let x_j be the per capita output of good j, l_j the share of L_j in total employment and k_j the capital-labor ratio of good j, each production function can be rewritten in per capita terms as

$$(1) \quad x_j = l_j f_j(k_j) \qquad x_j^* = l_j^* g_j(k_j^*) \qquad j = 1,2$$

where $f_j(k_j) \equiv F_j(1, k_j)$ and $g_j(k_j^*) \equiv G_j(1, k_j^*)$, which represent the labor productivity of industry j in the home and foreign country respectively. As the characteristics common to all production functions I assume for $j = 1$ and 2, $f_j(k_j) > 0$, $f_j'(k_j) > 0$, and $f_j''(k_j) < 0$ for $k_j > 0$, $g_j(k_j^*) > 0$, $g_j'(k_j^*) > 0$, and $g_j''(k_j^*) < 0$ for $k_j^* > 0$, $f_j(0) = g_j(0) = 0$, $f_j'(0) = g_j'(0) = \infty$, and $f_j'(\infty) = g_j'(\infty) = 0$.[2]

Expecting the partner to make the same choice as its own, each country can unilaterally choose one of two types of international economic regimes, free international trade in goods accompanied by free international capital and no labor mobility and free international trade in goods accompanied by free international labor and no capital mobility. I hereafter denote them by K-T regime and L-T regime respectively. Take commodity 1 as a numeraire and assume no trasportation costs in

international trade in goods and factors. Then, in both countries the relative price of commodity 2 is the same under both regimes, and real wages are the same under the L-T regime and real rental is the same under the K-T regime. The possibility of both capital and labor to be internationally mobile at once is eliminated because otherwise a country with less efficient technology, as will be assumed below, could not continue to be incompletely specialized.

Denote by p the relative price of commodity 2. In order for all countries to have diversified production structures for some value of p under the K-T and L-T regimes, it is assumed that there are inter-industry differences in labor productivity in each country in the following way: there exist positive $\bar{p}$, $\tilde{k}$ and $\tilde{k}^*$ such that

$$
\begin{aligned}
& f_1(k) < \bar{p} f_2(k) \quad \text{for} \quad 0 < k < \tilde{k} \\
& f_1(k) > \bar{p} f_2(k) \quad \text{for} \quad \tilde{k} < k < \infty \\
& f_1(\tilde{k}) = \bar{p} f_2(\tilde{k}) \\
& g_1(k^*) > \bar{p} g_2(k^*) \quad \text{for} \quad 0 < k^* < \tilde{k}^* \\
& g_1(k^*) < \bar{p} g_2(k^*) \quad \text{for} \quad \tilde{k}^* < k^* < \infty \\
& g_1(\tilde{k}^*) = p g_2(\tilde{k}^*).
\end{aligned} \tag{2}
$$

This assumption is the simplified form of one of the alternative sufficient conditions derived by Uekawa (1972) for the existence of global diversification under the K-T regime[3] and implies that at a country-specific value of capital-intensity there is a switch from one industry to another of the absolute superiority in labor productivity measured at $\bar{p}$ in terms of commodity 1 and that the direction of the switch in one country is opposite to that in another. The production functions satisfying (2) are

depicted in Figure 1-a for the home country and in Figure 1-b for the foreign country. In the diagrams, $\tilde{w}_j \equiv f_j(\tilde{k}) - \tilde{k}f_j'(\tilde{k})$, $\tilde{r}_j \equiv f_j'(\tilde{k})$, and $\tilde{w}_j^*$ and $\tilde{r}_j^*$ denote the foreign country's counterparts of $\tilde{w}_j$ and $\tilde{r}_j$ respectively. Clearly, they satisfy the relationships, $\tilde{w}_1 < \bar{p}\tilde{w}_2$, $\tilde{r}_1 > \bar{p}\tilde{r}_2$, $\tilde{w}_1^* > \bar{p}\tilde{w}_2^*$, and $\tilde{r}_1^* < \bar{p}\tilde{r}_2^*$.

Perfect competition prevails and inter-industry factor mobility is completely free within each country. Denote by r_j and w_j the rental for capital and wage for labor in terms of commodity j respectively. Then the profit-maximizing conditions in the competitive economies are

$$(3) \quad r_j = f_j'(k_j) \qquad r_j^* = g_j'(k_j^*)$$

$$(4) \quad w_j = f_j(k_j) - k_j f_j'(k_j) \qquad w_j^* = g_j(k_j^*) - k_j^* g_j'(k_j^*).$$

Free factor mobility within an economy will ensure

$$(5) \quad r_1 = pr_2 \qquad r_1^* = p^* r_2^*$$

$$(6) \quad w_1 = pw_2 \qquad w_1^* = p^* w_2^* .$$

Let ω_j be the ratio of wage to rental in terms of commodity j, then (5) and (6) imply

$$(7) \quad \omega \equiv \omega_1 = \omega_2 \qquad \omega^* \equiv \omega_1^* = \omega_2^*.$$

Let σ_j be the substitution elasticity of k_j for ω_j and θ_{Kj} and θ_{Lj} the distributive shares of capital and labor in industry j (j =1,2). Then for a given value of real wage in terms of commodity 1 the proportional changes of endogenous variables in the equations from (3) to (7) can be represented in each country by

$$(8) \quad \hat{k}_j = \sigma_j \hat{w}_j / \theta_{Kj} \qquad \hat{k}_j^* = \sigma_j^* \hat{w}_j^* / \theta_{Kj}^*$$

$$(9) \quad \hat{r}_j = -\theta_{Lj} \hat{w}_j / \theta_{Kj} \qquad \hat{r}_j^* = -\theta_{Lj}^* \hat{w}_j^* / \theta_{Kj}^*$$

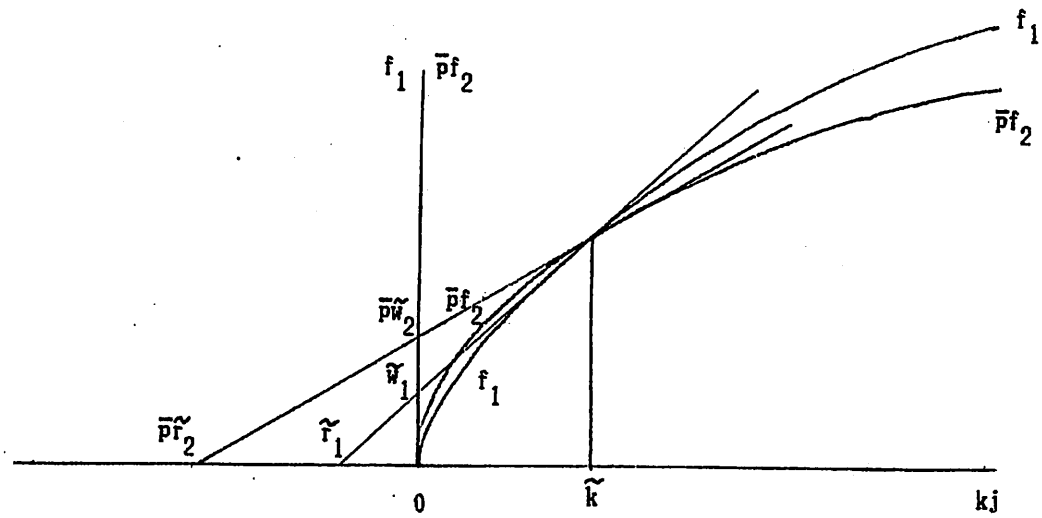

Figure 1-a

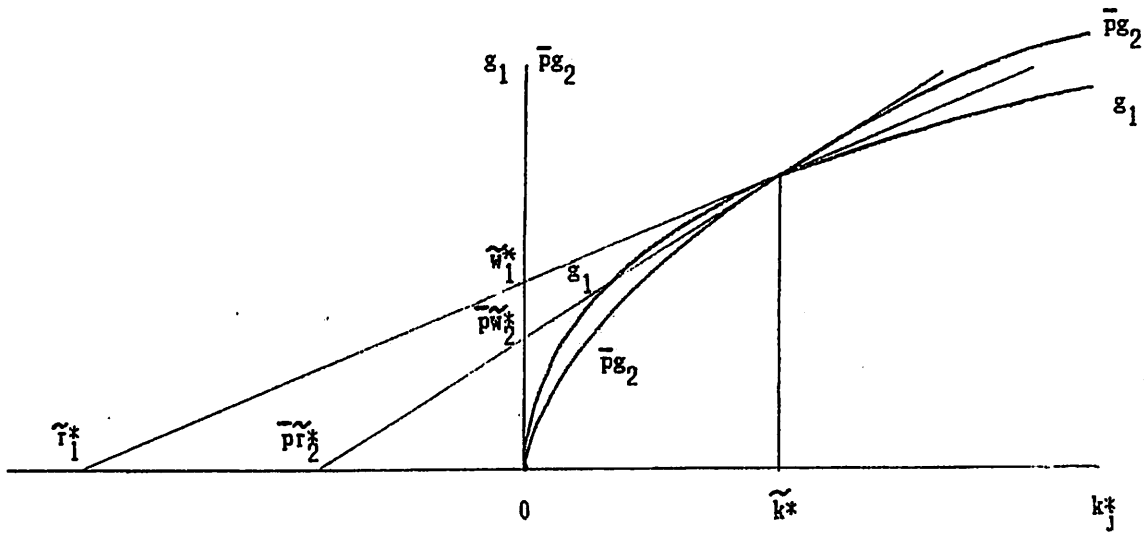

Figure 1-b

(10) $\hat{\omega}_j = \hat{w}_j / \theta_{Kj}$ $\qquad$ $\hat{\omega}^*_j = \hat{w}^*_j / \theta^*_{Kj}$

(11) $\hat{w}_2 = \theta_{K2}\hat{w}_1 / \theta_{K1}$ $\qquad$ $\hat{w}^*_2 = \theta^*_{K2}\hat{w}^*_1 / \theta^*_{K1}$

(12) $\hat{p} = (\theta_{K1} - \theta_{K2}) \hat{w}_1 / \theta_{K1}$ $\qquad$ $\hat{p}^* = (\theta^*_{K1} - \theta^*_{K2}) \hat{w}^*_1 / \theta^*_{K1}$.

It is possible to show that $p(w_1)$ - and $p^*(w^*_1)$ - curves based on (12) have a unique intersection by applying the analysis by Uekawa(1972) to the case under the L-T regime. Sketching out the course of argument, it consists of showing (i) in (k_1, w_1) - or $(k_2, \bar{p}w_2)$ - plane $k_1(w_1)$ - and $k_2(w_2)$ - curves represented by (8) are positively-sloped and within the range of w_1, $[\tilde{w}_1, \bar{\tilde{p}}\tilde{w}_2]$,[4] the former lies to the right of the latter while in (k^*_1, w^*_1) - or $(k^*_2, \bar{p}w^*_2)$ - plane $k^*_1(w^*_1)$ - and $k^*_2(w^*_2)$ - curves are also positively-sloped and within the range of w^*_1, $[\bar{\tilde{p}}\tilde{w}^*_2, \tilde{w}^*_1]$, the former lies to the left of the latter; (ii) in (ω_1, w_1) - or $(\omega_2, \bar{p}w_2)$ - plane $\omega_j(w_j)$ - curves represented by (10) are monotonically increasing, convex towards the vertical axis and intersect once with each other within the range of $(\tilde{w}_1, \bar{\tilde{p}}\tilde{w}_2)$, while in (ω^*_1, w^*_1) - or $(\omega^*_2, \bar{p}w^*_2)$ - plane $\omega^*_j(w^*_j)$ - curves are monotonically increasing, convex towards the vertical axis and intersect once with each other within the range of $(\bar{\tilde{p}}\tilde{w}^*_2, \tilde{w}^*_1)$; (iii) from the relative positions between the ω_1 - and ω_2 - curves and between the ω^*_1 - and ω^*_2 - curves, $w_2(w_1) > w_1 / \bar{p} > w^*_2(w_1)$ for $0 < w_1 < W$, and $w^*_2(w_1) > w_1/\bar{p} > w_2(w_1)$ for $W^* < w_1 < \infty$, where $w_2(w_1)$ denotes the value of w_2 which satisfies $\omega_1(w_1) = \omega_2(w_2)$, W and W^* the values of w_1 and w^*_1 at the intersecting points between the ω_1 - and ω_2- curves and between the ω^*_1 - and ω^*_2 - curves, respectively, and W is assumed to be less than W^* without a loss of generality; and (iv) from (6) and the results shown in (iii) above, $p(w_1)$ - and $p^*(w_1)$ - curves have a unique intersection for a value of w_1 between W and W^*.

In order to specify the condition of inter-country difference in labor productivity in industry 1, I assume

(13) $f_1(k) = \alpha g_1(k)$ for all $k > 0$

where α is a constant which is not smaller than unity. This assumption means that the home country has Hicks-neutral technological superiority in industry 1 to the foreign country's and implies that for a given value of w_1 which is common to each country, $k_1 \leqq k_1^*$, $r_1 \geqq r_1^*$, and $\omega_1 \leqq \omega_1^*$, where the equalities are held only when $\alpha = 1$. Suppose that in an initial situation, with which this section is concerned, the technologies in industry 1 are identical in both countries.

Under this assumption the $p(w_1)$ - and $p^*(w_1)$ - curves are depicted in the first quadrant of Figure 2, where the intersection is denoted by (w_1^0, p^0). The $p(w_1)$ - curve is monotonically increasing and the $p^*(w_1)$ - curve monotonically decreasing because, according to the analysis sketched out above, good 1 is capital-intensive in the home country and so is good 2 in the foreign country for the values of w_1 within and in the neighborhood of [W, W*]. Both curves show the relative costs of commodity 2 at a given value of w_1 in the home and foreign countries with the diversified production structures respectively. Under the L-T regime, $w_1 = w_1^*$ and at the same time $p = p^*$. Therefore, the two countries are at the point (w_1^0, p^0).[5] By the assumption of internationally identical technologies in industry 1, real rental rates are also internationally equalized in the presence of a factor-intensity reversal, as shown by Uekawa (1972).

By (9) and (12) , p - and p* - curves can also be derived as the functions of r_1. Clearly, the $p(r_1)$ - curve is monotonically decreasing, the $p^*(r_1)$ - curve monotonically increasing, and at p^0they have a unique intersection, (r_1^0, p^0), where the home and foreign countries can be under the K-T regime. They are depicted in the second quadrant of Figure 2.[6] Note that the absolute value of the slope of the $p(r_1)$ - curve equals that of the $p(w_1)$ - curve multiplied by k_1, and the slope of

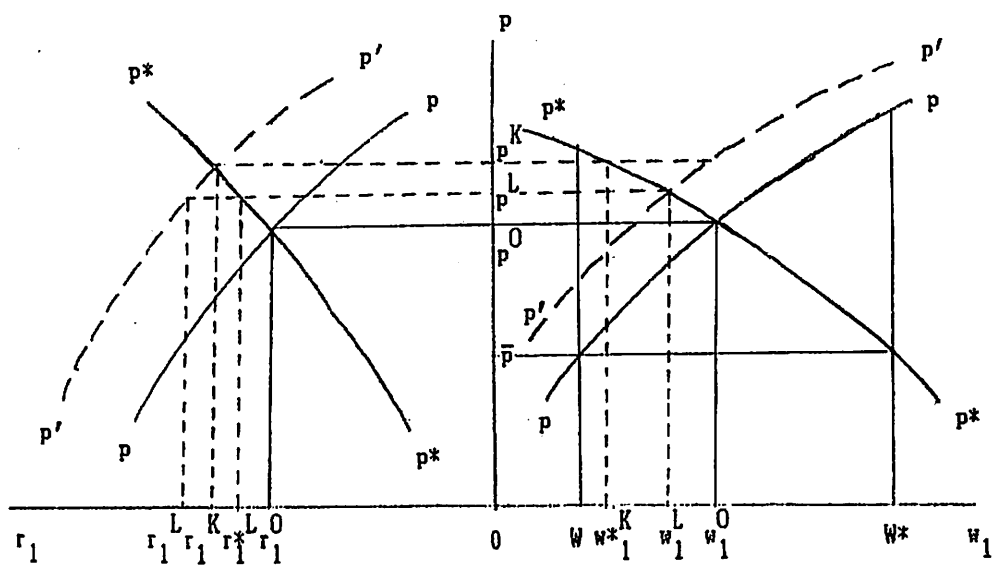

Figure 2

the $p^*(r_1^*)$ - curve equals the absolute value of that of the $p^*(w_1^*)$ - curve multiplied by k_1^*. If both countries allow free international capital mobility but not any international commodity trade, $p^* > p$ for a real rental rate higher than r_1^0 and $p^* < p$ for a real rental rate lower than r_1^0, thus, there is a reversal in the pattern of comparative advantage between the two countries, as pointed out by Ferguson(1978).

II. Inter-Country Difference in Technology

In this section I explore the effects on the relative price of commodity 2 of technological improvement in the home country's industry 1, its capital-intensive industry, to show that the new equilibrium price which is consistent with global diversification is higher than the initial level by a greater extent under the K-T regime than under the L-T regime. Suppose that in the situation of inter-country difference in technology in industry 1 postulated in (13) with α being initially equal to unity, the home country's technology in that industry is improved to such a small extent that the conditions (2) still hold and hence the two countries have the diversified production structures after the technological innovation. Since $w_1 = \alpha\{g_1(k_1) - k_1 g_1'(k_1)\}$ and $r_1 = \alpha g_1'(k_1)$, the shift in the $p(w_1)$ - curve due to the innovation is obtained using (8), (10), (11) and (12),

$$(14) \quad \hat{w}_1 / d\alpha_1 = (-\theta_{K2} + \theta_{K1} \hat{p} / d\alpha) / (\theta_{K1} - \theta_{K2}).$$

The shift in the $p(r_1)$ - curve due to the innovation is derived by those equations and (14),

$$(15) \quad \hat{r}_1 / d\alpha = (1 - \theta_{L1}\hat{w}_1 / d\alpha) / \theta_{K1}.$$

This shows that the magnitude of the shift in the $p(r_1)$ - curve is larger by 1 /

θ_{K1} than that in the $p(w_1)$ - curve multiplied by $\theta_{L1} / \theta_{K1}$ although the directions of the shifts in both curves are opposite. Since $\theta_{K1} > \theta_{K2}$, $\hat{w}_1 / d\alpha < 0$ and $\hat{r}_1 / d\alpha > 0$ when $\hat{p} / d\alpha = 0$. They are exactly the redistribution effects of Hicks-neutral technical progress in a capital-intensive industry studied by Findlay-Grubert (1959) and true for any value of p which ensures incomplete specialization in the home country under the given conditions of technology. Thus, the $p(w_1)$ - and $p(r_1)$ - curves shift leftwards in the first and second quadrants of Figure 2, where the new curves are depicted as dotted lines, $p'(w_1)$- and $p'(r_1)$ - curves, respectively. Let p^L and p^K denote the equilibrium relative prices of commodity 2 realized under the L-T and K-T regimes respectively, then it turns out from the diagrams that $p^L > p^0$ and $p^K > p^0$.

The relative position between these equilibrium prices can be easily worked out in the following way. Under the L-T regime the technical progress in the home country's industry 1 shifts the $p(w_1)$ - curve along the $p^*(w_1)$ - curve, maintaining the equilibrium conditions for world labor market, $w_j = w_j^*$ for j = 1 and 2. The elasticity of the relative price of commodity 2 with respect to w_1 on this curve is $-\hat{p}^* / \hat{w}_1 = (\theta_{K2}^* - \theta_{K1}^*) / \theta_{K1}^*$, the reproduction of (12). Denote by $(\hat{p} / d\alpha)^L$ and $(\hat{p} / d\alpha)^K$ the changes in the equilibrium relative price of commodity 2 due to technical progress under the L-T and K-T regimes respectively. Then (14) can be used to get the former,

$$(16) \qquad (\hat{p} / d\alpha)^L = [(\theta_{K2}^* - \theta_{K1}^*) / \theta_{K1}^*] \, (-\hat{w}_1 / d\alpha).$$

Under the K-T regime the technical progress shifts the $p(r_1)$ - curve along the $p^*(r_1)$ - curve, preserving the equilibrium conditions for the world capital market, $r_j = r_j^*$ for j = 1 and 2. The elasticities of p* with respect to r_1 on this curve are obtained by (9) and (12) as $\hat{p}^* / \hat{r}_1 = (\theta_{K2}^* - \theta_{K1}^*) / \theta_{L1}^*$ which equals $\theta_{K1}^* / \theta_{L1}^*$

times elasticity of p^* with respect to w_1. (15) and (16) yield the change in p under the K-T regime,

$$(17) \quad (\hat{p} / d\ \alpha)^K = (\theta^*_{K2} - \theta^*_{K1}) / (\theta_{K1} \theta_{L1}) + (\hat{p} / d\ \alpha)^L .$$

Obviously, $(\hat{p} / d\alpha)^K > (\hat{p} / d\alpha)^L$ because $\theta^*_{K2} > \theta^*_{K1} = \theta_{K1}$ at the initial equilibrium with internationally identical technologies in industry 1.

If we assume that, instead of (13), $g_1(k) = \alpha^* f_1(k)$ for all $k > 0$, where $\alpha^* > 1$, the foreign country has Hicks-neutral technological superiority in industry 1, its labor-intensive industry, to the home country's then it can be easily shown that in this case the foreign $p^*(w_1)$ - and $p^*(r_1)$ - curves are shifted rightward in the first and second quadrants of Figure 2 to raise p^L to a greater extent than p^K as long as global diversification is maintained after the technical progress.[7] Therefore, we can conclude:

THEOREM 1: <u>In case of global diversification based on (12), Hicks-neutral technological progress in industry 1 of one of the countries raises the relative price of commodity 2 both under the L-T and K-T regime.</u>

The economic mechanism to cause the results in theorem 1 is a combination of the redistribution effects of Hicks-neutral technological innovation and the Rybczynski effects of the induced international factor movement. Under the L-T regime the innovation causes labor movement from the home to the foreign country at the initial relative price p^0 because w_1 falls if it occurs at home while w^*_1 rises if it occurs abroad. This international movement of labor decreases the output of commodity 2 both in the home and foreign country. In addition, the innovation generally increases the demand for commodity 2 in the innovating country by increasing real income there.[8] Thus, the relative price of commodity 2 must rise in order to clear the internationl

commodity markets. Under the K-T regime the innovation causes capital movement from the foreign to the home country at p^0 because r_1 rises if it occurs at home while r_1^* falls if it occurs abroad. Since the aggregate output of commodity 2 is decreased by the Rybczynski effects of this international capital movement, the relative price must rise through the same mechanism as worked under the L-T regime.

As to the relative level between p^L and p^K, it can be derived from (17) that $p^K > p^L > p^0$ when the home country has Hicks-neutral technological superiority in industry 1 to the foreign country's. On the other hand, $p^L > p^K > p^0$ when the foreign country has the technological superiority of the same type in the same industry. Therefore, we can have

THEOREM 2: <u>If the home country has slight Hicks-neutral technological superiority in industry 1 to the foreign country's such that the production functions of all industries in both countries satisfy conditions (2), then the relative price of commodity 2 realized under the K-T regime is higher than that under the L-T regime.</u>

The result of theorem 2 essentially depends upon the factor-intensity condition of an industry with Hicks-neutral technical innovation. If such an industry is capital-intensive in the innovating home ocuntry, as assumed in the theorem, the leftward shift in the $p(r_1)$ - curve, measured by the rate of increase in r_1, due to the innovation is sufficiently larger than that in the $p(w_1)$ - curve, measured by the rate of decrease in w_1 , at any relevant value of p in Figure 2 so that this dominates the result of raising p^K greater than p^L, regardless of the elasticities of p in response to the percentage changes in r_1 and w_1 along the $p^*(r_1)$ - and $p^*(w_1)$ - curves respectively. If such an industry is labor-intensive in the innovating foreign country on the ceteris paribus assumption, the rightward shift in the $p^*(r_1)$ - curve due to the innovation is now much smaller than that in the

$p^*(w_1)$ - curve in Figure 2 (not drawn), so that this dominates the result of raising p^K less than p^L, regardless of the elasticities of p in response to the percentage change in r_1^* and w_1^* along the $p(r_1)$ - and $p(w_1)$ - curves.

A comparison can be made between the distributional sides of the two international economic regimes as an implication of theorem 2. Let r_1^K, r_1^L and r_1^{*L} be the real rental rate realized under the K-T regime and those realized under the L-T regime in the home and foreign country respectively. Then, according to theorem 2,

$$(18) \qquad r_1^L > r_1^K > r_1^{*L}$$

because of the Stolper-Samuelson relations in both countries. Thus, for home capital the L-T regime is more favorable than the K-T regime while for foreign capital the reverse is true. Similarly, let w_1^L, w_1^K and w_1^{*K} denote the real wage rate realized under the L-T regime and those realized under the K-T regime in the home and foreign country respectively, then, according to theorem 2,

$$(19) \qquad w_1^K > w_1^L > w_1^{*K} .$$

Thus, for home labor the K-T regime is more favorable than the L-T regime while the reverse is true for foreign labor.[9]

If, instead of (13), the home country has technological superiority of the Harrod-neutral type in industry 1, or if the production function of home industry 1 is represented by $f_1(k_1) = \alpha g_1(k_1 / \alpha)$ where $\alpha \gtrless 1$ for all positive k_1, the result of theorem 2 still holds although whether theorem 1 holds mutatis mutandis depends upon the value of the substitution elasticity of home industry 1. In this case, $r_1 = g_1'(k_1 / \alpha)$ and $w_1 = \alpha g_1(k_1 / \alpha) - k_1 r_1$. Thus, by the same procedure as above I can see the effects of Harrod-neutral technical progress in home industry 1 on the $p(w_1)$ - and $p(r_1)$ - curves in Figure 2. The shift in the latter is represented by

(20) $\hat{r}_1 / d\alpha = (\theta_{L1}\theta_{L2}/\sigma_1 - \theta_{L1}\hat{p} / d\alpha) / (\theta_{K1} - \theta_{K2})$

which showes it to shift leftward as before. This implies that the relative price of commodity 2 is raised by the technical progress under the K-T regime but that it is not necessarily so under the L-T regime if $\sigma_1 > \theta_{L2}$ because the shift in the $p(w_1)$ - curve is represented by $\hat{w}_1 / d\alpha = 1 - (\theta_{K1}/\theta_{L1})\hat{r}_1 / d\alpha$. Using the elasticities of p along the $p^*(w_1^*)$ - and $p^*(r_1^*)$ - curves I can get the relative position of new equilibrium prices under both regimes: $(\hat{p} / d\alpha)^K - (\hat{p} / d\alpha)^L = (\theta_{K2}^* - \theta_{K1}) / \theta_{K1}$, the RHS of which is positive, regardless of the value of the substitution elasticity.

III. Choice between the L-T and K-T Regimes

In this section I introduce the conditions of inter-industry and inter-country factor allocations into analysis and show that the results derived in the previous section are useful to determine which international economic regime is more advantageous to a country with a particular condition of technologies and factor endowments. Let K and L denote a country's total demand for capital and labor respectively and let $k = K/L$, then they are represented in per capita terms as the sums of the demands from industries 1 and 2 in each country:

(21)
$$l_1 + l_2 = 1 \qquad l_1^* + l_2^* = 1$$
$$l_1 k_1 + l_2 k_2 = k \qquad l_1^* k_1^* + l_2^* k_2^* = k^*.$$

In the initial situation of internationally identical technology in industry 1, the necessary and sufficient conditions for global diversification are

(22) $k_1 > k > k_2$ and $k_2^* > k^* > k_1^*$.

Let $\bar{K}$ and $\bar{L}$ denote a country's endowments of capital and labor respectively and $\bar{k}$ and $\bar{l}$ denote its ratios of capital to labor endowments and of demanded to supplied labors. Under the L-T regime the worldwide demand for labor is related to its total endowment by the equilibrium condition for international labor market, $L + L^* = \bar{L} + \bar{L}^*$, which is rewritten on per capita basis

$$(23) \qquad \bar{l} + \lambda \bar{l}^* = 1 + \lambda$$

where $\lambda = \bar{L}^* / \bar{L}$. Since each country's demand for capital equals its endowment of capital, $k = \bar{k} / \bar{l}$ and $k^* = \bar{k}^* / \bar{l}^*$. Substituting them for k and k* in (22) and summing them up yields the necessary condition for global diversification,

$$(24) \qquad \bar{k} / k_1 + \lambda \bar{k}^* / k_2^* < \bar{l} + \lambda \bar{l}^* < \bar{k} / k_2 + \lambda \bar{k}^* / k_1^* .$$

Under the K-T regime the worldwide demand for capital is related to its total endowment by the equilibrium condition for international capital market, $K + K^* = \bar{K} + \bar{K}^*$, which is represented in per-capita terms by

$$(25) \qquad k + \lambda k^* = \bar{k} + \lambda \bar{k}^* .$$

Since each country's demand for labor equals its endowment of labor, the sufficient condition for global diversification is now reduced to

$$(26) \qquad k_1 + \lambda k_2^* > \bar{k} + \lambda \bar{k}^* > k_2 + \lambda k_1^* .$$

I assume that the rental for home capital earned abroad and the rental for foreign capital earned at home are repatriated and spent in the capital-exporting country and further that so is the wage of home labor earned abroad and the wage of foreign labor earned at home. In this sense, immigration here is a temporary matter. Since national income equals the sum of the wage of endowed labor and the rental for endowed

capital in each country on these assumptions, per capita real incomes of the home and foreign countries are represented respectively by

$$(27) \qquad y = w_1 + r_1\bar{k} \qquad\qquad y^* = w_1^* + r_1^*\bar{k}^*.$$

In the initial situation each country can achieve the same level of real income under the L-T as well as K-T regimes because $w_1 = w_1^* = w_1^0$ and $r_1 = r_1^* = r_1^0$ there.

The technological progress in home industry 1 will change the level of home real income through its effects on the factor prices represented by (14) and (15) as long as the home country is incompletely specialized. Since the proportional change in y is the weighted average of the proportional changes in w_1 and r_1 with the weights equal to w_1 / y and $r_1\bar{k} / y$ respectively, it can be represented for a constant home capital-labor endowment ratio by

$$(28) \qquad \hat{y} / d\alpha = r_1\{ \theta_{L2} (\bar{k} - k_2) + \theta_{L1} (k_1 - \bar{k}) \hat{p} / d\alpha\} / [y (\theta_{K1} - \theta_{K2})].$$

The first term in the bracket in the RHS of (28) shows the income effect of the technical progress at a constant commodity price. It is positive, constant, or negative accordingly as the home factor endowment ratio is greater than, equal to, or smaller than the capital intensity of home commodity 2. The second term displays its income effect through the induced change in the relative price of commodity 2. It is negative, constant, or positive accordingly as the home factor endowment ratio is larger than, equal to, or smaller than the capital intensity of home commodity 1. w^*_1 and r_1^* are, on the other hand, affected only through the price change due to the technical progress so that, from (9) and (12), the change in foreign per capita real income can be represented for a constant foreign capital-labor endowment ratio by

$$(29) \qquad \hat{y^*} / d\alpha = [r_1^* \theta^*_{L1} (\bar{k^*} - k_1^*) \hat{p} / d\alpha\} / [y^*(\theta^*_{K2} - \theta^*_{K1})].$$

Thus, foreign real income is an increasing, constant, or decreasing function of the relative price, accordingly as the foreign factor endowment ratio is larger, equal to, or smaller than the capital intensity of foreign commodity 1.

Let us define that for a country

(i) if its capital-labor endowment ratio is greater than the capital intensity of its industry 1 the country is strongly capital-abundant;
(ii) if its capital-labor endowment ratio is less than the capital intensity of its industry 1 the country is strongly labor-abundant.

If the home country is strongly capital-abundant it will export capital under the K-T regime and import labor under the L-T regime. If the foreign country is strongly labor-abundant it will import capital under the K-T regime and export labor under the L-T regime.[10] If the home country is strongly labor-abundant, whether it imports capital under the K-T regime and exports labor under the L-T regime depends upon the partner's endowment position. Similarly, if the foreign country is strongly capital-abundant its pattern of trade in factors depends upon the home country's endowment position. Note that the home country is capital-abundant and the foreign country labor-abundant in the Heckscher-Ohlin terminology if the former is strongly capital-abundant and the latter strongly labor-abundant in the initial situation of internationally identical technologies, and vice versa.

For each country the levels of per capita real income realized under the K-T and L-T regimes, which are denoted by y^K and y^L respectively, are compared as a preliminary step to our objective of welfare comparison between the two regimes. Its position in the factor endowment involves the judgement.

THEOREM 3: Suppose that the same conditions for the home country's technological superiority as those of theorem 2 are satisfied together with (24) under the L-T

regime and with (26) under the K-T regime.

(i) If both home and foreign country are strongly capital-abundant, y^L is larger than y^K but y^{*L} is smaller than y^{*K}.

(ii) If the home country is strongly capital-abundant while the foreign country is strongly labor-abundant, y^L as well as y^{*L} are larger than y^K and y^{*K} respectively.

(iii) If the home country is strongly labor-abundant while the foreign country is strongly capital-abundant, y^L as well as y^{*L} are smaller than y^K and y^{*K} respectively.

(iv) If both home and foreign country are strongly labor-abundant, y^L is smaller than y^K but y^{*L} is larger than y^{*K}.

The results of theorem 3 reflect a simple principle that for each country an international economic regime which favors its abundant factor is more advantageous to it than the other. If the home country is strongly capital-abundant as in cases (i) and (ii) in the theorem, the L-T regime is to its advantage because, according to (18), it is favorable for home capital. Although the home country can earn higher rental than r_1^0 by exporting capital abroad under the K-T regime, it can earn even higher rental by importing foreign labor under the L-T regime because the relative price of commodity 2 is lower under the latter than under the former regime. If the home country is strongly labor-abundant as in cases (iii) and (iv), the K-T regime is to its advantage because, according to (19), it is favorable for home labor. It is obvious by similar reasoning that the L-T regime is advantageous to the foreign country if it is strongly labor-abundant as in cases (ii) and (iv) while the K-T regime is if it is strongly capital-abundant as in cases (i) and (iii).

If I assume that the two goods are consumption goods and that each individual who has an identical utility function spends his whole income on them so as to maximize his utility, the welfare level of each country is proportional to that of its

citizen. Assume that the individual's utility function is continuously differentiable, increasing in each argument and homogeneous of degree one. Let u and c_j denote the level of his utility and his consumption of commodity j respectively, the levels of utility of the home and foreign citizens are represented respectively by $u = u(c_1, c_2)$ and $u^* = u(c_1^*, c_2^*)$. Since they have homothetic preferences [Chipman (1974)], their demand functions can be written by

$$(30) \qquad c_1 / c_2 = c_1^* / c_2^* = h(p) \qquad h'(p) > 0$$

where c_j and c_j^* satisfy the home and foreign budget constraints respectively,

$$(31) \qquad c_1 + pc_2 = y \qquad\qquad c_1^* + pc_2^* = y^*.$$

Using (28), (30), and (31), I have the change in the home citizen's welfare, measured in terms of commodity 1, due to the technical progress,[11]

$$(32) \qquad \frac{du}{u_1 d\alpha} = \left[\frac{r_1 \theta_{L1}}{\theta_{K1} - \theta_{K2}} (k_1 - \bar{k}) - pc_2 \right] \frac{\hat{p}}{d\alpha} + \frac{r_1 \theta_{L2} (\bar{k} - k_2)}{\theta_{K1} - \theta_{K2}}$$

where $u_1 = \partial u / \partial c_1$. The first bracketed term in the RHS of (32) shows the elasticity of home utility in response to a change in the relative price of commodity 2 (E_{up}). When it is negative the level of home welfare is a decreasing function of the price, and vice versa. Since we know from theorem 2 that p^L is lower than p^K, it is crucial to comparison between the home welfare levels realized under the L-T and K-T regimes. Let m be the propensity to consume commodity 2 ($m \equiv pc_2 / y = pc_2^* / y^*$), u^L and u^K the levels of home welfare under the L-T and K-T regimes respectively. If the home country is strongly capital-abundant, E_{up} is negative and hence u^L is higher than u^K. If the home country is strongly labor-abundant, E_{up} becomes positive if m is sufficiently small so as to satisfy the condition[12]:

$$(33) \qquad m < (k_1 - \bar{k})\,\theta_L / (k_1 - k_2)$$

where θ_L denotes the share of home labor in national income. Therefore, u^L is lower than u^K under these conditions.

Similarly, the change in a foreigner's utility level can be represented by

$$\frac{du^*}{u_1 d\alpha} = \left[\frac{r_1^* \quad \theta_{L1}^* \quad (\bar{k}^* - k_1^*)}{\theta_{K2}^* - \theta_{K1}^*} \quad - pc_2^* \right] \frac{\hat{p}}{d\alpha} .$$

u^* is a decreasing function of p if the foreign country is strongly labor-abundant and an increasing function of p if the foreign country is strongly capital-abundant and if the foreign propensity to consume commodity 2 satisfies

$$(34) \qquad m^* < (\bar{k}^* - k_1^*)\,\theta_L^* / (k_2^* - k_1^*)$$

where θ_L^* denotes the share of foreign labor in national income. Thus I can have the following conclusions on welfare similar to theorem 3.

THEOREM 4: Suppose that the same conditions of inter-country technological difference and factor endowments are satisfied as in theorem 3.

(i) If the home as well as the foreign country with m^* satisfying (34) are strongly capital-abundant, u^L is higher than u^K but u^{*L} is lower than u^{*K}.

(ii) If the home country is strongly capital-abundant while the foreign country is strongly labor-abundant, u^L as well as u^{*L} are higher than u^K and u^{*K} respectively.

(iii) If the home country with m satisfying (33) is strongly labor-abundant while the foreign counry with m^* satisfying (34) is strongly capital-abundant, u^L as well as u^{*L} are lower than u^K and u^{*K} respectively.

(iv) If the foreign as well as the home country with m satisfying (33) are strongly labor-abundant, u^L is lower than u^K but u^{*L} is higher than u^{*K}.

Although I noted above that if the technologies of industry 1 are internationally identical each country is indifferent to the choice between the L-T and K-T regimes, theorems 3 and 4 indicate that if the technologies are internationally different as assumed in (13) the two international economic regimes result in different levels of real income and welfare for each country and that international conflicts of interest may sometimes occur. Whether they may occur under a given condition of technologies depends upon the pattern of relative factor endowments between the countries. If the home country is capital-abundant and the foreign country labor-abundant in the Heckscher-Ohlin sense as in case (ii) of the theorems, the L-T regime is more beneficial to both countries than the other from the viewpoint of each country's real income as well as welfare. This implies that if a set of countries, like the United States and Mexico or like Japan and Asian NICs, satisfy the conditions on technology assumed above, they can agree with the adoption of the L-T regime as a bilateral economic system or, in other words, any substantial restrictions on international labor mobility are inappropriate to cause illegal international flows of labor between them. No conflicts of interests occur between the countries under the K-T regime in case (iii) mutatis mutandis. In cases of (i) and (iv), where the relative factor endowments are not so distinguishable between the two countries as in the previous cases, different regimes favor different countries.[13] In case (i), for instance, the L-T regime is favorable to the home country while the K-T regime is to the foreign country from the viewpoint of each country's real income and, in addition, welfare provided that condition (34) is satisfied. This implies that if the home and foreign country can be taken as Japan and the United States respectively the United States policy to encourage Japanese capital to flow in is suitable to its national advantage while the Japanese policy to restrict American labor to flow in is not to its national advantage.

IV. Concluding Remarks

This paper has compared the welfare levels achieved under two international economic regimes, the K-T regime which allows free trade in capital and goods and the L-T regime which allows free trade in labor and goods, in the standard trade model. Its characteristics are prominent in the assumptions about inter-industry and inter-country differences in production technologies : for each country the absolute advantage in labor productivity of one industry over another, each evaluated at some level of commodity prices, is reversed at country-specific capital intensity from industry 1 to industry 2 in one country and from industry 2 to industry 1 in another, and for the technology in one of the industries one country is Hicks-nutrally superior to another.

The main results are that each country can achieve a higher level of real income under the regime which favors its abundant factor than otherwise and that the same thing is true for the level of welfare on additional assumptions of consumption. The fundamental reasons for this can be assigned to the inequality, which is caused by the international difference in technology, between the levels of a relative commodity price realized under the two regimes and the Stolper-Samuelson relation between commodity and factor prices. They have interesting implications that if one of the countries is capital-abundant and another labor-abundant in the Heckscher-Ohlin terminolgy both countries can gain under the same regime but if their relative factor endowments are not so distinguishable there occurs a conflict of interest between them : the regime under which one of the countries is more benefited is not the one under which the other country is.

In deriving these results, the present paper relies heavily upon the simplifying assumption that the rewards of capital and labor exported abroad are repatriated

to the exporting country. If, instead, emigrants do not send back their wages to their home country but spend them where they moved, the conclusions will become ambiguous because the level of total income realized by each country under the L-T regime now depends upon the level of its labor employment endogenously determined, its capital endowment exogenously given, and the rates of wage and rental while that under the K-T regime constantly depends upon its factor endowments exogenously given and the rates of wage and rental. Since the level of each country's labor employment is determined in an equilibrium for world commodity market under the L-T regime, it would be usually difficult to compare this level with its labor endowment without any knowledge of the quantitative properties of local excess demand functions for commodites.

Footnotes

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1. The results obtained in the model based on the other Uekawa condition can be seen in footnotes 3,6,9 and 13 below.

2. The conditions, $f_j(0) = g_j(0) = 0$ and $f_j'(\infty) = g_j'(\infty) = 0$ for $j = 1, 2$, can be relaxed to weaker forms of $f_j(0) / f_j'(0) = g_j(0) / g_j'(0) = 0$ for $j = 1, 2$, $f_2'(0) \geqq g_2'(0)$ and $g_1'(0) \geqq f_1'(0)$. See footnotes 5 and 3 in Uekawa (1972).

3. The simplified form of another Uekawa condition is : $f_1(k) \geqq g_1(k)$ for all $k > 0$, and there is a positive $\tilde{k}_2$ such that $f_2(k) > g_2(k)$ for $0 < k < \tilde{k}_2$, $f_2(k) < g_2(k)$ for $\tilde{k}_2 < k < \infty$, and $f_2(\tilde{k}_2) = g_2(\tilde{k}_2)$.

4. I use [a, b] to show a closed interval and (a, b) to show an open interval between points a and b.

5. The two countries can be at the point (w_1^0, p^0) even under a regime with free international commodity trade only, if their capital : labor endowment ratios take proper values within the range of values which ensure them incomplete specialization. This can be proved by examining the relationship of each country's demand for commodity 2 at p^0 to its capital : labor endowment ratio which satisfies (21) in the text and looking for a set of $(\bar{k}, \bar{k}^*)$ which satisfy the equilibrium condition for world market of commodity 2.

6. If the production functions of the industries in both countries satisfy, instead of (2), another Uekawa condition noted in footnote 3 and those of industry 1 remain to satisfy condition (13) in the text, the $p(r_1)$- and $p^*(r_1^*)$ -curves have a unique intersection where factor prices are internationally equalized when $f_1(k) = g_1(k)$ for all $k > 0$. Because then $k_2^* > k_2$ and $k_1^* = k_1$, there are three cases conceivable for the ranking of industries by factor intensity: (i) $k_1 = k_1^* > k_2^* > k_2$, (ii) $k_2^* > k_2 > k_1 = k_1^*$, and (iii) $k_2^* > k_1^* = k_1 > k_2$.

7. Since $w_1^* = \alpha^* \{f_1(k_1^*) - k_1^* f_1'(k_1^*)\}$ and $r_1^* = \alpha^* f_1'(k_1^*)$ in this case, $\hat{w}_1^* / d\alpha^* = (\theta_{K2}^* - \theta_{K1}^* \hat{p} / d\alpha^*) / (\theta_{K2}^* - \theta_{K1}^*)$ and $\hat{r}_1^* / d\alpha^* = - (1 - \theta_{L1}^* \hat{w}_1^* / d\alpha^*) / \theta_{K1}^*$, instead of (14) and (15) in the text. It follows that the $p^*(w_1^*)$ - and $p^*(r_1^*)$-curves shift rightward in Figure 2, resulting in $(\hat{p} / d\alpha^*)^K > 0$ and $(\hat{p} / d \alpha^*)^L > 0$. Along the $p(w_1)$ - curve the elasticity of p for a proportional change in w_1 is $(\theta_{K1} - \theta_{K2}) / \theta_{K1}$, so that $(\hat{p} / d \alpha^*)^L = [(\theta_{K1} - \theta_{K2}) / \theta_{K1}] \hat{w}_1^* / d\alpha^*$. Along the $p(r_1)$ - curve the elasticity of p for a proportional change in r_1 is $(\theta_{K1} - \theta_{K2}) / \theta_{L1}$, so that $(\hat{p} / d\alpha^*)^K = - (\theta_{K1} - \theta_{K2}) / (\theta_{L1} \theta_{K1}) + (\hat{p} / d \alpha^*)^L$, which is less than $(\hat{p} / d\alpha^*)^L$.

8. The effects of the technical innovation on per capita real incomes will be analyzed in the next section. See eq.(28) for its effect in the innovating country.

9. If, instead of condition (2), the other Uekawa condition noted in footnote 3 is assumed and condition (13) in the text is held, then theorems 1 and 2 must be modified, depending upon the assumption of factor-intensity ranking. If it is assumed that, for instance, $k_1 = k_1^* > k_2^* > k_2$ at an initial equilibrium with internationally identical technologies in industry 1, both $p(w_1)$- and $p^*(w_1^*)$- curves have positive slopes and the former cuts the latter from below at the intersection because the productivities of capital in industry 1 are equal in both countries but

the productivity of capital in industry 2 is higher in the home country than abroad. This implies that both $p(r_1)$- and $p^*(r_1^*)$- curves have negative slopes and the former cuts the latter from above at the intersection. The redistribution effects of technological progress in home industry 1 and the Rybczynski effects of international factor movement induced by it indicate that it shifts both $p(r_1)$- and $p(w_1)$- curves leftwards with the rate of shift in the former bigger than that in the latter. This implies that $p^0 > p^L > p^K$ and therefore $r_1^K > r_1^L > r_1^{*L}$, and $w_1^L > w_1^K > w_1^{*K}$ by the Stolper-Samuelson theorem. By similar reasoning, $p^L > p^K > p^0$, $r_1^L > r_1^{*L} > r_1^K$, and $w_1^K > w_1^{*K} > w_1^L$ in the case of $k^*_2 > k_2 > k_1 = k^*_1$, and $p^K > p^L > p^0$, $r_1^L > r_1^K > r_1^{*L}$, and $w_1^K > w_1^L > w_1^{*K}$, the same results as in the case analyzed in the text, in the case of $k^*_2 > k^*_1 = k_1 > k_2$.

10. This is because if the home country is strongly capital-abundant its factor endowment ratios satisfy $\bar{k} > k_1 > k$ under the K - T regime and $\bar{1} > 1$ under the L - T regime and if the foreign country is strongly labor-abundant its factor endowment ratios satisfy $k^* > k_1^* > \bar{k}^*$ under the K - T regime and $1 > \bar{1}^*$ under the L - T regime.

11. The expression (32) can be derived by differentiating $c_1 = hy / (p + h)$ and $c_2 = y / (p + h)$ and substituting them and (28) into $du / u_1 = dc_1 + pdc_2$.

12. Condition (33) can be derived by setting the first bracketed term in the RHS of (32) positive and using the relationship, $\theta_{K1} - \theta_{K2} < (k_1 - k_2) r_2 / f_2$.

13. If, instead of condition (2), the other Uekawa condition noted in footnote 3 is assumed, condition (13) in the text is preserved, and if no factor-intensity reversals exist between the two countries, then they encounter international conflicts of interest in the choice between the K-T and L-T regimes provided that their relative factor endowments are different from each other in the Hecksher-Ohlin

sense. If $k_1 = k^*_1 > k^*_2 > k_2$ at an initial equilibrium with internationally identical technologies in industry 1, a strongly capital-abundant country wants to choose the K-T regime while a strongly labor-abundant country wants to choose the L-T regime, and the reverse is true if $k^*_2 > k_2 > k_1 = k^*_1$ at the initial equilibrium. It should be noted that in the case with the former ranking of factor intensity the necessary condition for global diversification under the K-T regime, $k_2 + \lambda k^*_2 < \bar{k} + \lambda \bar{k}^* < k_1 + \lambda k^*_1$, is not satisfied when both of the countries are strongly capital-abundant and in the case with the latter ranking it is inconsistent with global diversification under the K-L regime that both countries are strongly labor-abundant.

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