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HUMAN CAPITAL AND ECONOMIC DEVELOPMENT

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This paper examines the role of education in the course of economic development by incorporating human capital formation in the traditional trade model. Skilled labor and unskilled labor are considered as distinct factors of production and an education sector is introduced which produces skilled labor. The possibility of two equilibria is explored in a two sector-two factor trade model when there exists a factor intensity reversal and the education sector shows increasing returns to scale. This provides a possible explanation of the contrasting economic development of the countries like Korea and Japan and the Latin American countries.

I. INTRODUCTION

Since the 1960s[1], when it was first emphasized that human capital accumulation plays an essential role in explaining several observed economic phenomena such as economic growth, income distribution and international trade, there have been many attempts[2] to incorporate human capital accumulation into the economic models. The most popular way of incorporating human capital into all of these economic models has been to introduce an education sector as a sector producing skilled labor. But most models did not provide a microeconomic analysis of the education sector as they did to the industrial sectors. They did not pay any attention to the educational technology in deriving the supply of skilled labor and unskilled labor from the education sector. Furthermore, no attempts have been made to derive the demand for skilled and unskilled labor under general conditions. Instead a particular relationship between skilled labor and unskilled labor in the production of goods was assumed on the basis of constant returns to scale technology. Recently, R.Findlay and H.Kierzkowski(1983)provided the first systematic human

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[1]T. Schultz (1962) and G. Becker (1962, 1964) played an innovative role in reviving the notion of human capital.

[2]H. Uzawa (1965). A. Razin (1972), J. Aarestad (1975), S.C. Hu (1976), R. Findlay and C.A. Rodriguez (1981), R. Manning (1982).

capital approach to explain the patterns of international trade by incorporating human capital formation into a two sector-two factor general equilibrium trade model. They tried to link the human capital theory[3] to the factor endowment theory of international trade, but their approach was not satisfactory in that they not only assumed constant returns to scale in the production of goods with inputs of skilled labor and unskilled labor, but also focused on the role of physical capital in determining the endowments of skilled labor and unskilled labor in each industry.

This paper attempts to achieve two goals. One is to incorporate human capital into a trade model. Each industry uses skilled labor and unskilled labor to produce goods and has a non-homothetic production function such that as the scale of production increases, the relative demand for skilled labor increases at a given relative wage of skilled labor. The supply of skilled and unskilled labor is derived as a function of wages using the education transformation curve which incorporates the educational technology. The supply curve of skilled labor can be upward or downward sloping depending on the pattern of returns to scale in the education sector.

The other goal is to develop a theoretical framework to explain the role of human capital and trade policies in the course of economic development. We focus on the trade-cum-education policies of two groups of developing countries. One is the import-substituting policies combined with low investment in education in the Latin American countries and the other is the export-promoting policies combined with high investment in eucation in the countries like Korea and Japan. Generally speaking, the countries like Korea and Japan are rich in endowments of skilled la-bor, while the Latin American countries have relatively less skilled labor, because the former have undertaken much more investment in education than the latter. This contrast between these two groups of the developing countries suggests that there exist two distinct equilibria corresponding to different relative endowments of skilled labor in an economy:One is associated with high relative kendowments of skilled labor and low relative wage of skilled labor, the other with low relative endowments of skilled labor and high relative wage of skilled labor. Given a factor intensity reversal between two industries and increasing returns to scale in the education sector, it is shown that there can be two equilibria in a two sector-two factor economy when human capital is an important of production.

Section 2 primarily focuses on the basic theories which are essential in this paper. A theoretical rationale is offered for the use of a non-homothetic production function when skilled and unskilled labor are used as factors of both decreasing returns to scale and increasing returns to scale in the education sector by deriving the education transformation curve in each case.

[3]G. Becker (1962) set up a full equilibrium condition which requires equality between the present values of return and cost from an investment in human capital.

Section 3 focuses on the second goal of this paper. First of all, it is demonstrated that if one industry has a non-homothetic production function such that there is no demand for skilled labor above a certain relative wage of skilled labor and the other industry shows constant returns to scale, then factor intensities between industries can be reversed with sufficient changes in the relative wage, because the elasticity of substitution between skilled and unskilled labor is higher in one in dustry than in the other industry. In order to show this, a unit cost curve is derived from a reconstructed Cobb-Douglas production function in the long-run equilibrium of a perfectly competitive industry. Then, the existence of two equilibria is explored in a two sector-two factor trade model with a factor intensity reversal and increasing returns in the education sector and the implications of different development strategies of two groups of developing countries are brought out. It is observed that trade policies (import-substituting or export-promoting) which protect skill-intensive industry have different effects on the wages and lead to different patterns of economic growth.

Section 4 provides a summary and conclusion.

II. MODEL

There are three sectors in a small open economy-two industrial sectors and an education sector. The industrial sectors produce traded goods using skilled and unskilled labor, and the education sector produces skilled labor using skilled labor(faculty and staff)and unskilled labor(janitors). The wages are assumed to be determined exogenously by the commodity prices and production technology.

1. Demand for Skilled Labor

The production function of the industrial sectors is not homothetic when skilled and unskilled labor are used as factors of production:an expansion in scale of production increases demand for skilled labor relatively more than unskilled labor at a given relative wage. This is because the scale expansion increases the division of labor between skilled and unskilled albor.

Applying the job ladder allocation theme of Bhagwati-Srinivasan[4], this nonhom otheticity will be derived by showing that even if a production function is homothetic in terms of skilled and unskilled services(s, u), it can be non-homothetic in terms of skilled and unskilled worker(S, U). Each unit of skilled(unskilled) labor is assumed to provide a unit of skilled(unskilled) service when employed in a skilled(unskilled) position, but an unskilled worker assigned to a skilled position provides less-than-one unit of skilled services. We assume further that the services

[4]Contrary to the case of their job-ladder model (1977), the uneducated workers are assumed to fill the jobs demanding skill in the case where an industry suffers from shortage of the educated workers.

from unskilled workers in skilled positions decreases as the scale of output expands. The last assumption is realistic, because as a firm gets larger, the administration gets more complex and the technical and administrative skills required are greater so the productivity of the unskilled worker in skilled work decreases.

Let F(s, u) be a production function which is homothetic in skilled and unskilled services and let G (ν, S, U) be the skilled services that are provided by the unskilled workers in skilled work positions the number of which are denoted by ν. G is also a function of the scale (S, U) of use of inputs. Then, we make the following assumptions on G(ν, S, U).

(1) $G_\nu > 0$, $G_U > 0$, $G_S < 0$
$G_{\nu\theta} < 0$, $G_{U\theta} < 0$, $G_{S\theta} > 0$, $G_\theta < 0$

where $G_x = \frac{\partial G}{\partial x}$ etc., and θ is a parameter representing the scale of production, so that $\frac{\partial}{\partial \theta} \equiv U\frac{\partial}{\partial U} + S\frac{\partial}{\partial S}$. These conditions imply that a proportional increase in S and U reduces the effectiveness of unskilled labor in providing skilled services by increasing the division of work between skilled labor and unskilled labor. Then, since the number of unskilled workers ν is chosen to maximize output at a given scale of production, the production function f(S, U) in terms of the number of skilled workers S and unskilled workers U is given by

(2) $f(S, U) \equiv \underset{\nu}{\text{Max}}\ F(S + G(\nu, S, U), u-\nu)$

where $s = S + G(\nu, S, U)$ and $u = U-\nu$. The marginal product of skilled labor can be obtained by the Envelope Theorem as:

(3) $MP_s = \frac{\partial f}{\partial S} = \frac{\partial F}{\partial s}(S + G(\nu, S, U), U-\nu)(1 + G_s)$

Similarly, the marginal productof unskilled labor can be derived as

(4) $MP_U = \frac{\partial f}{\partial U} = \frac{\partial F}{\partial s}(S + G(\nu, S, U), U-\nu)\, G_U + \frac{\partial F}{\partial U}$

Hence, the relative marginal product of unskilled labor is calculated from (3) and (4).

(5) $\frac{MP_U}{MP_s} = \frac{G_U}{1 + G_s} + \frac{F_U}{F_s(1 + G_s)}$

The first-order condition for the maximization problem given in (1) requires that:

$$(6)\ \frac{\partial F}{\partial v} = F_s G_v - F_u = 0 \text{ or } G_v = \frac{F_u}{F_s}$$

Since an increase in scale of production reduces the skilled services provided by an additional unskilled worker chosen for skilled labor positions ($G_{v\theta}<0$), a proportional rise in S and U increases the total unskilled services more than the total skilled services. This is because F (s, u) is homothetic and hence, a reduction in $\frac{F_u}{F_s}$ requires relatively less skilled services. The reduction in the proportion of skilled service comes from a less-than-proportional increase in v and G. This guarantees that the marginal product of skilled labor rises as scale of production expands. The substitution of (6) into (5) leads to:

$$(7)\ \frac{MP_U}{MP_S} = \frac{G_U}{1+G_S} + \frac{G_v}{1+G_S}\,\frac{G_U + G_v}{1+G_S}$$

By differentiating (7) with respect to θ and recalling conditions (2), we can prove that an expansion in scale of production increases the relative marginal product of skilled labor.

$$(8)\ \frac{\partial\,(MP_U/MP_S)}{\partial\theta} = \frac{(G_{U\theta} + G_{v\theta})\,(1+G_S) - (G_U + G_v)\,G_{S\theta}}{(1+G_S)^2} < 0$$

This result comes from the fact that an expansion in the scale of production increases the relative amount of unskilled services by increasing unskilled services proportionally more than skilled services.

In other words, as scale of production increases, the slope of isoquants gets flatter at given ratios of skilled labor and unskilled labor. It can also be inferred that if each factor is paid by its marginal product, then at given factor ratios the relative wage of a skilled worker rises as the scale of production increases, and that the demand for skilled labor increases more than proportionally while demand for unskilled labor increases less than proportionally or decreases at the given relative wage of skilled labor. From this standpoint we can infer that a country with large firms tends to have higher demand for skilled labor and hence, a higher equilibrium wage for skilled labor.

2. Supply of Skilled Labor

The supply of skilled labor is derived from the education transformation curve which summarizes the production technology for education by an analogy with the production possibilities frontier. The education transforms unskilled labor

(students) into skilled labor (graduates) through an education production process. In other words, the education sector produces skilled labor (graduates) out of students with the help of skilled labor (teachers and staff) and unskilled labor (janitors) in the same way as an industrial sector produces final goods out of raw materials with the help of factors of production.

The production function in the education sector is given by

$$(9)\quad N = F(S_e, U_e)$$

where S_e and U_e are the number of skilled and unskilled workers employed in the education sector, and N is the number of graduates. Assuming that an economy starts with initial endowments of skilled labor (S_0) and unskilled labor (U_0) with no population growth, the number of skilled workers (S) and unskilled workers (U) available in the industrial sector is given by

$$(10)\quad S = S_0 - S_e + F(S_e, U_e)$$
$$(11)\quad U = U_0 - U_e - F(S_e, U_e)$$

Since the education transformation curve gives the maximum number of skilled workers available in the industrial sector, given a certain number of unskilled workers available in the industrial sector, the format for investigating this problem is:

$$(12)\quad \text{Max } S = S_0 - S_e + F(S_e, U_e)$$
$$\text{s. t. } U = U_0 - U_e - F(S_e, U_e)$$

where U is a target number of unskilled labor in the industry.
The Lagrangian is

$$(13)\quad L = S_0 - S_e + F(S_e, U_e) + \lambda(U - (U_0 - U_e - F(S_e, U_e)))$$

Here, the Lagrange multiplier λ can be interpreted as the marginal rate of transformation of unskilled labor into skilled labor, or the slope of the education transformation curve.

The curvature of the education transformation curve, which is the change of the slope (λ) with respect to the change of the number of unskilled workers (U), can be obtained by applying the Implicit Function Theorem to (13).

$$(14)\quad \frac{d\lambda}{dU} = -\frac{1}{|\bar{H}|}(1+\lambda)^2\left(\frac{\partial^2 F}{\partial S_e^2}\frac{\partial^2 F}{\partial U_e^2} - \left[\frac{\partial^2 F}{\partial S_e\,\partial U_e}\right]^2\right)$$

where $|\bar{H}| > 0$ because $\bar{H}$ is bordered Hessian matrix of second partials of L.

To obtain more specific conclusions, suppose that the education sector has a Cobb-Douglas production function.

$$(15)\quad F(S_e, U_e) = S_e^{\alpha} U_e^{\beta}$$

where $\alpha+\beta < (>)\ 1$ if the the education sector shows decreasing (increasing) returns to scale.

Substituting the second derivatives of (15) into (14), we have

$$(16)\quad \frac{d\lambda}{dU} = -\frac{1}{|\overline{H}|}(1+\lambda)^2 (1-\alpha-\beta) S_e^{2(\alpha-1)} U_e^{2(\beta-1)}$$

Thus, if the education sector exhibits decreasing returns to scale ($\alpha+\beta<1$), then

$$(17)\quad \frac{d\lambda}{dU} < 0$$

Since λ is negative, (17) implies that the absolute slope of the education transformation curve becomes greater as U increases. Thus, if the education sector shows decreasing returns to scale, then the education transformation curve is concave to the origin. This curvature of the education transformation curve implies that the marginal rate of transformation of unskilled labor into skilled labor decreases as the supply of skilled labor increases. This is because the average cost of producing a skilled worker increases monotonically in case of decreasing returns to scale in the education sector.

On the other hand, if the education sector exhibits increasing returns to scale ($\alpha+\beta>1$), we have the following curvature of the education transformation curve from (17).

$$(18)\quad \frac{d\lambda}{dU} > 0$$

Since λ is negative, (18) implies that the absolute slope of the education transformation curve becomes less as U increases. Thus, if the education sector shows increasing returns to scale, then the education transformation curve is convex to the origin. With increasing returns to scale in the education sector, the average costs of education fall as the production of skilled labor increases. This implies that when the supply of skilled labor is high, giving up one more unskilled worker leads to a larger increase in skilled labor than when the supply of skilled labor is low.

In order to derive the supply functions of skilled labor from the education trans formation curve, we need to investigate the relationship between the two wages

and the average cost of education.

Rational decisions by a worker in a static model lead to the following equilibrium condition.

$$(19)\quad w_1\text{-}w_2\text{-}f\text{-}d = 0$$

where d is the opportunity cost of education before he decide to get education as an unskilled worker, f is educational fees, w_1 is wage of skilled labor and W_2 is wage of skilled labor. This is because an uneducated worker decides to be educated if the net benefit of education is positive.

Assuming that the wages of skilled and unskilled labor are exogenously determined by commodity prices and production technology, the wage structure determines education fees.

$$(20)\quad f = w_1\text{-}w_2\text{-}d$$

Suppose that for given w_1, w_2, government chooses skilled labor (S_e) and unskilled labor (U_e) in the education sector to minimize average cost of production of graduates and that it charges education fees equal to average cost of education.

$$f = \frac{w_1 S_e + w_2 U_e}{F(U_e, S_e)}$$

Then, since the adequate wage gap between skilled and unskilled labor is required to compensate skilled workers for the education fees which are equal to the average cost of education, the wage gap is closely related to average cost of education. Thus, the education costs are not fixed but depend on the wage gap between skilled and unskilled labor. For example, a low wage of skilled labor for a given wage of unskilled labor implies low costs of education due to a narrowed wage gap between skilled and unskilled labor. But it need not be a disincentive to education, because if wages close then the average cost of education falls so we can have lower education fees which increase incentive to education.

The supply of skilled and unskilled labor is determined by the wages depending on returns to scale in the education sector, because an increase in the wage of skilled (unskilled) labor which widens (narrows) the wage gap between skilled and unskilled labor implies a rise (fall) in the average cost of education. Assuming that the economy has a constant workforce, a higher (lower) supply of skilled labor and a lower (higher) supply of unskilled labor are associated whith a higher (lower) wage of skilled labor for a given wage of unskilled labor in the case of decreasing returns to scale in the education sector, because the average cost is monotonically increasing in the case of decreasing returns to scale. Hence, the supply curve of skilled labor is upward sloping in the case of decreasing returns to scale in the

education sector. On the other hand, the supply curve of skilled labor is downward sloping in the case of increasing returns to scale in the education sector. A higher (lower) supply of skilled labor and a lower (higher) supply of unskilled labor are associated with a lower (higher) wage of skilled labor, because the average cost is monotonically decreasing in the case of increasing returns to scale.

Hence, we have the following supply functions of skilled and unskilled labor.

(21) $S^s = S^s(w_1, w_2)$

(22) $U^s = U^s(w_1, w_2)$

where $\frac{\partial S^s}{\partial w_1}, \frac{\partial U^s}{\partial w_2} > (<) 0, \frac{\partial U^s}{\partial w_1}, \frac{\partial S^s}{\partial w_2} < (>) 0$ if the education sector shows decreasing (increasing) returns to scale. We can derive a relationship between the two wages and the production of skilled labor in each case of returns to scale using the equilibrium condition for education that the supply of skilled labor is equal to the demand for education at a given cost of education. Since the average cost of education rises (falls) as more skilled workers are produced in the case of decreasing (increasing) returns to scale, the average cost curve SS ("supply curve of skilled labor") in the education sector is upward(downward) sloping.

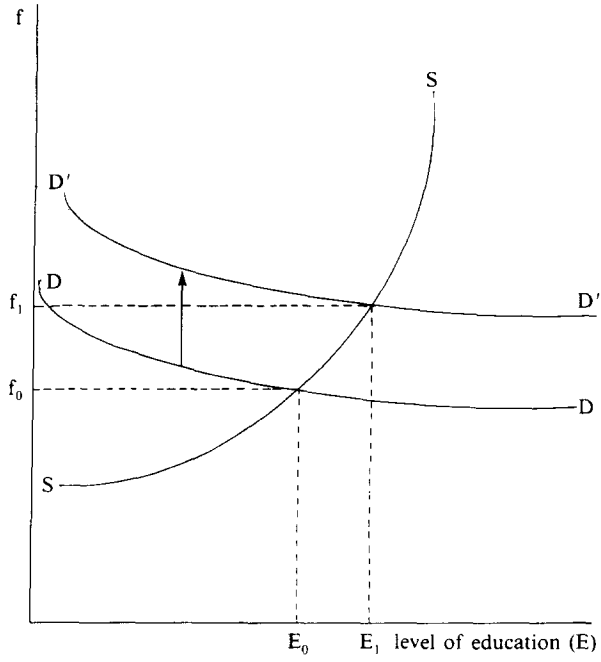
The demand for education is determined by wages of skilled and unskilled labor, and education fees. A rise in the wage of skilled labor or a fall in the wage of unskilled albor as well as lower education fees increases the demand for education by increasing the net benefit of education. Thus, the demand curve for education DD is downward sloping.

(23) $D_E = D_E(w_1, w_2, f)$ where $\frac{\partial D_E}{\partial w_1} > 0, \frac{\partial D_E}{\partial w_2} < 0, \frac{\partial D_E}{\partial f} < 0$

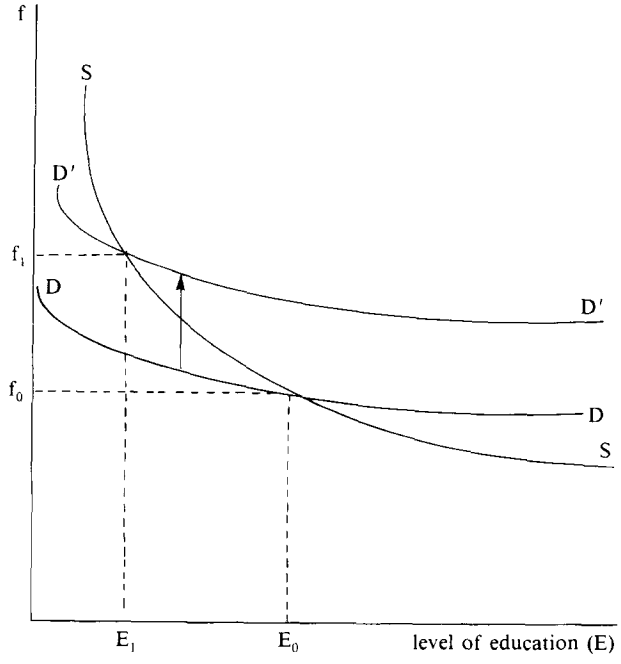
Suppose the wage of skilled labor rises for a fixed wage of unskilled labor. Then, it shifts up the demand curve from DD to D'D'. This leads to an increase in the production of skilled labor, as well as an increase in education fees in the case of decreasing returns to scale(Figure 1), while it leads to a reduction in the production of skilled labor with an increase in education fees in the case of increasing returns to scale, assuming the demand curve is flatter than the supply curve(Figure 2).

III. MULTIPLE EQUILIBRIA AND ECONOMIC DEVELOPMENT

This section is devoted to demonstrating the existence of two equilibria in two sector-two factor trade model when factor intensity reversal is allowed and education sector exhibits increasing returns to scale. By use of the framework of two equilibria we compare two different development stategies in the two groups of



[Figure 1]



[Figures 2]

the developing countries:import-substituting policies and low investment in the education sector in the Latin American countries countries and export-promoting policies and high investment in the education in the countries like Korea and Japan.

1. Factor Intensity Reversal

Consider the Stone-Geary production function which is non-homothetic

(24) $y = (U-a)^{\alpha} (S-b)^{\beta}$ for $U \geqslant a$, $S \geqslant b$
$= 0$ otherwise

where a,b>0 represent the minimum fixed number of unskilled and skilled workers respectively required to start producing output. The cost functions are derived from this production function by solving the problem of total cost minimization which is given by:.

(25) Min $w_1 S + w_2 U$
s. t. $y = (U-a)^{\alpha} (S+b)^{\beta}$

Solving(25), we obtain the total cost of production and the unit cost of production.

$$(26) \quad \frac{C}{y} = K\, y^{\frac{1}{\alpha+\beta}-1}\, W_1^{\frac{\beta}{\alpha+\beta}}\, W_2^{\frac{\alpha}{\alpha+\beta}} + \frac{aW_2 - bW_1}{y}$$

where $K = \left[\frac{\alpha}{\beta}\right]^{-\frac{\alpha}{\alpha+\beta}} + \left[\frac{\alpha}{\beta}\right]^{\frac{\beta}{\alpha+\beta}}$

The level of output y* which minimizes unit cost is obtained by the first-order condition for minimizing (26)

$$(27) \quad y^* = \left[\frac{aw_2 - bw_1}{K\left(\frac{1}{\alpha+\beta} - 1\right)}\right]^{\alpha\beta} w_1^{-\beta} w_2^{-\alpha}$$

By substituting (27) into (26) we obtain a long-run unit cost function which is linearly homogeneous in w_1 and w_2 and scale-free.

$$(28) \quad c(w_1, w_2) = \frac{C(y^*(w_1, w_2), w_1, w_2)}{y^*(w_1, w_2)} = K' (aw_2 - bw_1)^{1-(\alpha+\beta)} W_1^{\beta} W_2^{\alpha}$$

$$\text{where } K' = \frac{K}{\left[K\left(\frac{1}{\alpha+\beta}-1\right)\right]^{\frac{1}{\alpha+\beta}-1}} + \left[K\left(\frac{1}{\alpha+\beta}-1\right)\right]^{-(\alpha+\beta)}$$

Since the slope of the unit cost curve denotes relative unit demand for skilled labor, the unit cost curve is drawn by observing the movement of relative unit demand for skilled labor when the relative wage of skilled labor changes. By Shephard's lemma, the relative unit demand for skilled labor is expressed in terms of relative wage.

$$(29)\ \frac{c_1(w)}{c_2(w)} = \frac{b(\alpha-1) + \beta a\left[\frac{w_1}{w_2}\right]^{-1}}{a(1-\beta) - b\alpha\left[\frac{w_1}{w_2}\right]}$$

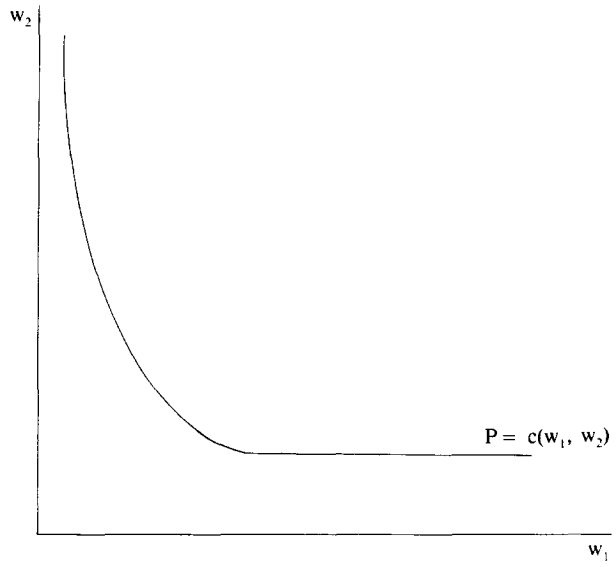
When $0 \leqslant \frac{w_1}{w_2} < \frac{\alpha\beta}{b(1-\alpha)}$, both unit demands are positive. In this region, an increase in the relative wage of skilled labor reduces the slope of the unit cost curve, because it reduces relative unit demand for skilled labor.

When $\frac{ab}{b(1-\alpha)} \leqslant \frac{w_1}{w_2} \leqslant \frac{a}{b}$, unit demand for unskilled labor is positive, but unit demand for skilled labor is zero. Thus, in this region the unit cost curve is horizontal, because its slope is zero(Figure 3).

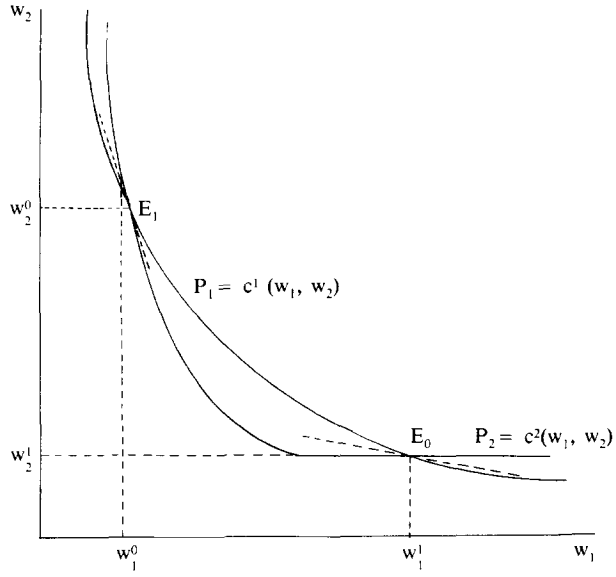
This result tells us that even if constant returns to scale technology is derived from a non-homothetic production function in the long-run equilibrium of a perfectly competitive industry, unit demand for skilled labor reduces to zero above a certain level of relative wage of skilled labor. The preservation of this property increases the possibility of factor intensity reversal, because the elasticity of substitution between skilled and unskilled labor(s) becomes suddenly infinite at a certain level of relative wage of skilled labor.

2. Human Capital and Multiple Equilibria

The inherent factor intensity reversal generates two equilibria in our two industry-two factor trade model, because the two intersections of the unit cost curves provide two sets of equilibrium wages. This permits us to provide a realistic explanation of the role of human capital formation in the course of economic development. As we see in Figure 4, at a high relative wage of skilled labor like E_0,industry 1 is more skill-intensive than industry 2. This results from the fact that skilled labor is used only in industry 1 at a high relative wage of skilled labor.



[**Figure 3**]



[**Figure 4**]

At a low relative wage of skilled labor like E_1, the industry 2 becomes more skill-intensive than the industry 1. This result comes from the fact that the industry 2 substitutes towards skilled labor more easily than the industry 1 at a low relative wage of skilled labor.

Since a country can produce both goods with full employment only when the relative endowments of skilled labor lie between the different skill-intensities of the two industries, each equilibrium is associated with a certain range of the relative endowments of skilled labor. Thus, a country with fixed endowments of skilled and unskilled labor can attain only one of the two equilibria, because both full employment conditions can not be satisfied simultaneously because of the convexicity of the unit cost curves. Two countries with different endowments of skilled and unskilled labor can be at distinct equilibria, so the relative wages differ. But if labor endowments are not given but change through education, then a country starting with exogenous labor endowments arrives at one of the two equilibria by choosing its relative different endowment ratios of skilled labor. Or two countries starting with same relative endowments of skilled labor wind up with different equilibria depending on the level of education.

In Figure 4 one equilibrium E_1 is associated with high endowment of skilled labor and low absolute and relative wage of skilled labor. The other equilibrium E_0 is associated with high absolute and relative wage of skilled labor and low endowment of skilled labor. This phenomenon of two equilibria is well explained by incorporating an education sector which exhibits increasing returns, because the supply of skilled labor is negatively related to the wage gap between skilled and unskilled labor. Hence, at equilibrium E_1 where the wage gap between skilled labor and unskilled labor is small, a country produces a large number of skilled workers, because the average cost of educating the unskilled people is low. On the other hand, at equilibrium E_0 where the wage gap is large, it produces a small number of skilled worker, because the average cost of education is high. Thus, with both a factor intensity reversal in the industrial sector and increasing returns to scale in the education sector we can obtain two equilibria in our model.

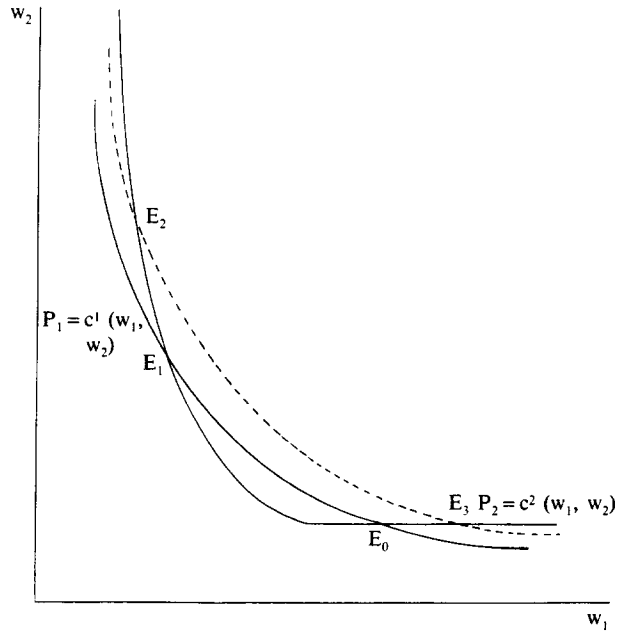
We can also mention that a low level of education with high costs of education gets the economy into a "low level trap" like equilibrium E_0 in the course of economic development, because it has a low supply of skilled labor. Thus, some education policies may be justified to push the economy beyond this low level trap by reducing educational costs, so that the economy attains the other equilibrium with high endowment of skilled labor (E_1). Appropriate education policies may be education subsidies and protection of certain industries with stable demand for skilled labor.

3. The Effects of Trade Policies in the Developing Countries

In the previous section, we explained the possibility of two equilibria by assuming

a factor intensity reversal and increasing returns to scale in education. We also emphasized the role of education in the course of economic development as a producer of skilled labor. This section is devoted to analyzing the effects of trade policies within the framework of two equilibria previously discussed and applying our analysis to different economc features between two groups of the developing countries, both of which pursued trade policies of protecting skill-intensive industries but differ in their endowments of human capital. One group includes the Latin American countries (Mexico, Brazil, Argentina) which depend mostly on import-substitution policies for industrialization but are poor in the endowments of skilled labor because of low investment in education. The other group includes Korea and Japan which have pursued export-promoting policies for industrialization with high investment in education.

When a factor intensity reversal occurs, the Stolper-Samuelson theorem which discusses the consequences of the protection on factor prices does not necessarily apply, because no sector is unambiguously intensive in either factor at any relative factor prices. Figure 5 demonstrates that the protection of a skill-intensive industry may reduce the wage of skilled labor because of a factor intensity reversal, contrary to the Stolper-Samuelson result. If we confine attention to a small change in the equilibrium E_0 where sector 1 is "locally" more skill-intensive than sector 2, the move from E_0 to E_3 leads to a Stolper-Samuelson type conclusion: the pro-



[**Figure 5**]

tection of skill-intensive sector(sector 1) raises the wage of skilled labor but reduces the wage of unskilled labor. When we take into account the presence of a factor intensity reversal, we could move to different equilibrium E- with a "large" jump reversing the Stolper-Samuelson type conclusion: the protection of skill-intensive industry reduces the wage of skilled labor but raises the wage of unskilled labor. The possible reversal of Stolper-Samuelson result in the presence of a factor intensity reversal has previously been regarded only as a theoretical curiosity. However, our analysis suggests that it has an important interpretation on the different features of economic development between two groups of the developing countries.

One of the most frequently used import-substitution policies in the Latin American countries is to protect the skill-intensive sector by imposing tariffs. By the Stolper-Samuelson theorem, the protection of a skill-intensive sector brings about a higher wage of skilled labor and a lower wage of unskilled labor by moving the equilibrium from E_0 to E_3 in Figure 5. The change in the wages not only shrinks the education sector because of higher costs of education, but also leads the industry to have small-size firms. This is because a firm reduces the optimal scale of production to decrease the unit demand for the skilled labor whose price has risen to economize on the unit cost of production. Also, in the Latin American countries the higher wage of skilled labor induces foreign skilled labor to immigrate rather than causing much of an increase in the supply of domestic skilled labor, because the government did not undertake much investment in education. If the foreign skilled labor were directly taxed to discourage immigration, then the skilled wages would rise and the supply of domestic skilled labor would increase. In theis sense, a tariff plus an education subsidy duplicates the effects of optimal taxation on foreign labor.

On the other hand, the countries like Korea and Japan have not only pursued export-promoting policies by subsidizing export industries, for example, by providing low preferential interest rates and tax rates but also subsidized the education sector to increase human capital. The protection of exporting industries, which are mostly skill-intensive, increases the output of the exporting sector but, unlike the case of the Latin American countries, reduces the wage of skilled labor. This is because they possess high endowment of skilled labor due to the high investment in education. The lower wage of skilled labor not only stimulates the education sector by reducing education costs but also increases firm size. This is because a firm expands the optimal scale of production to increase the unit demand for skilled labor which has fallen to economize on the unit cost of producion. The results which are contrary to the Stolper-Samuelson Theorem are obtained in this case because of a factor intensity reversal and a higher endowment of skilled labor in the countries like Korea and Japan as indicated in the move from E_0 to E_2. Unlike the case of the Latin American countries, immigration of foreign skilled labor is discouraged and blocked, not only by the low wage of skilled labor, but

also by the education subsidy which raises the domestic supply of skilled labor.

In conclusion, the combination of education subsidy and export-promoting policies enabled Korea and Japan to accomplish better economic development than the Latin American countries. The Latin American countries remain in a low level trap because the supply of skilled labor is low and firm size is small. However, the countries like Korea and Japan could get out of a low level trap thanks to high supply of skilled labor and large-sized firms.

IV. CONCLUDING REMARKS

In this paper we developed a theoretical framework to deal with some issues in the area of international trade and economic develepment. The incorporation of human capital in the traditional trade model involves some interesting modifications of the model such as a non-homothetic production function and endogenous factor supplies. In order to explain the differences in economic features between the Latin American countries and the countries like Korea and Japan, we explored the possibility of a factor intensity reversal and found that two equilibria can exist which are dependent on the supplies of skilled and unskilled labor. Assuming two equilibria and increasing returns to scale in the education sector, we could explain the differences in the economic development of two groups of the developing countries. The Latin American countries remain in a low level trap where high relative wage of skilled labor reflects high education costs while the countries like Korea and Japan could get out of this trap because they undertook much higher investment in education than the former countries. The tariffs on the import-substituting sector in the Latin American countries bring about higher wage of skilled labor which not only stimulates foreign skilled labor to immigrate by shrinking domestic education sector because of high costs of education, bu also re-duces firm size to economize on higher unit costs of production. On the other hand, the export subsidies in the countries like Korea and Japan lead to a lower wage of skilled labor which not only contributes to the enhancement of education together-as education subsidies-by reducing costs of education, but also increase firm size.

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