Skill Formation, Capital Adjustment Cost and Wage Inequality

Yabuuchi, Shigemi and Chaudhuri, Sarbajit

Nagoya University, University of Calcutta

30 March 2009

Skill Formation, Capital Adjustment Cost and Wage Inequality*

Shigemi Yabuuchi[a],* and Sarbajit Chaudhuri[b]

Abstract: The paper employs a three-sector general equilibrium model for examining the consequences of an infrastructure development scheme to the education sector and an inflow of foreign capital on the skilled-unskilled wage inequality in a developing economy. The education sector faces a capital adjustment cost for which the effective unit cost of capital depends positively on the amount of capital employed. Although both infrastructure development scheme and inflows of foreign capital lead to higher skill formation, the policies produce incongruent effects on the wages of skilled and unskilled labour. Furthermore, the effects of the policies on the skilled-unskilled wage inequality depend crucially on the relative factor intensities of the low-skill and high-skill sectors. Finally, which of the two policies should the country adopt depends on the technological, institutional and trade related factors.

JEL classifications: F13, F16, J31.

Keywords: Skill formation, skilled labour, unskilled labour, wage inequality, foreign capital, capital adjustment cost.

[a] Dept. of Economics, Nagoya City University, Yamanohata, Mizuho, Nagoya 467-8501, Japan. Email: yabuuchi@econ.nagoya-cu.ac.jp.

[b] Dept. of Economics, University of Calcutta, 56A, B.T. Road, Kolkata 700 050, India. E-mail:

sceco@caluniv.ac.in , sarbajitch@yahoo.com

* Corresponding author.

Skill Formation, Capital Adjustment Cost and Wage Inequality

1. Introduction

Education is becoming vital in the new world of information. Knowledge is rapidly accredited replacing raw materials and labour as the most critical input for survival and success. Higher education enhances a country's capacity for participation in an increasingly knowledge-based world economy and has the potential to enhance economic growth and reduce poverty. Thus higher education has assumed even greater significance for developing countries, especially for those like India experiencing services-led growth.[1] Therefore spread of higher education and formation of skill have been the top priorities in a developing economy which is typically described as scarce of skilled labour. Now with the progress of economic liberalization, as the role of services sector is predominant, the question of shortage of skilled labour arises in a more pronounced way. That is why with a sense of urgency; the government of India has initiated the national skill development mission. The policymakers have been doing intensive exercise as to how this mission could be brought into existence and the skill deficit could be mitigated.

The governments of different countries play an important role in spreading education all over the world and devote substantial resources to their education sector. This is especially true in developing countries. In some of the developing countries there are statutory bodies of the governments for monitoring the functioning of the higher academic institutions. For example, in India there is the University Grant Commission (UGC) that has been co-ordinating, determining and maintaining standards of university education and teaching in the country for the last five decades or so. The UGC allocates grants to the universities and colleges out of its own funds for their development or other general purpose and advises the central and state government on disbursing grants to the universities out of the Consolidated Fund of India. Moreover, the policymakers of the developing countries like India of late are toying with the

---

[1] See Sharma (2007).

idea of permitting foreign investment in higher education[2] so as to promote competitiveness among the public and private institutions and improve the quality of education.

In a typical developing country there is scarcity of both capital and skilled labour. Therefore, economic growth induced by foreign capital inflows[3] and skill formation are equally important from the perspective of these nations. But these countries are plagued by a significant degree of wage inequality among skilled and unskilled labour and this inequality has increased considerably over the last two decades. However, it is beyond any doubt that inflows of foreign capital and expansion of higher educational facilities and skill formation must have important consequences on the relative wage inequality of the country in question.

There is a large theoretical literature that examines the consequences of liberalized economic policies including the role of foreign capital in explaining the increasing skilled-unskilled wage inequality during the liberalized regime. It includes works of Feenstra and Hanson (1996), Marjit and Acharya (2003), Marjit, Beladi and Chakrabarti (2004) and Chaudhuri and Yabuuchi (2007). However, none of these papers analyzes the process of endogenous skill formation and considers the possibility of foreign capital inflow in education.[4] There is, however, a paper by Kar and Beladi (2004) that has studied the welfare implications of skill formation and international migration of both skilled and unskilled labour using a four-sector

---

[2] The Government is for allowing 100 percent foreign direct investment (FDI) in higher education and hinted at making reservation mandatory in the institutions to be set up by foreign universities in the country. As part of India's WTO commitments made in 2003, the government has proposed 100 percent FDI in higher education all institutions. See Hindustan Times dated 06.02.2007.

[3] Despite satisfactory progress in liberalizing foreign investment policies, the international mobility of capital into or from the developing economies is still far from being perfect. There is an FDI regulatory authority in such a country that judges the merits and demerits of any new FDI proposal before granting final approval. For example, in India investment in all industries except those in the negative list is permissible. Additionally, there are sectoral caps for investing in certain industries. FDI is not permitted beyond these caps. FDI can be brought into India through the Automatic Route under the Reserve Bank of India and for certain activities through government approval.

[4] As related studies, Stark (1998), Chau and Stark (1999) and Fan and Stark (2007) have studied skill formation and international migration by paying attention to skill acquisition incentives created by the prospect of migration.

general equilibrium framework. But, they have not taken into consideration the capital adjustment cost faced by the education sector, infrastructure development scheme of the government and the possibility of foreign capital inflow in the education sector. Besides, they have neither explicitly discussed policy implications of their results nor have suggested appropriate measures that can improve relative wage inequality in the economy in the presence of skill formation and inflows of foreign capital.

The present paper develops a three-sector general equilibrium model for examining the outcomes of an infrastructure development scheme of the government to the education sector and inflows of foreign capital on the skilled-unskilled wage inequality in a developing economy in the presence of endogenous skill formation. There is a low-skill sector that produces an export commodity using unskilled labour and capital. In another sector of the economy a high-skill commodity is produced with the help of skilled labour and capital. There is a skill formation sector (universities) as well where one unit of unskilled labour and some amount of capital are required to produce one unit of skilled labour. The education sector faces a capital adjustment cost due to which the price of capital depends positively on the amount of capital employed. There is a provision for government financial assistance to this sector that lowers the unit capital cost. The economy starts with given endowments of both types of labour. The endowment of skilled labour increases and that of unskilled labour goes down due to skill formation. This theoretical analysis leads to some interesting results. While both the financial assistance policy and the inflows of foreign capital lead to higher skill formation, the policies produce dissimilar effects on the wages of skilled and unskilled labour. An infrastructure development scheme lowers both the wages while the entry of foreign capital produces just the opposite effects on the wages. Furthermore, the effects of the policies on the skilled-unskilled wage inequality depend crucially on the relative factor intensities of the low-skill and high-skill sectors. The financial assistance scheme improves the relative wage inequality when the high-skill sector is capital-intensive while an inflow of foreign capital lowers the wage inequality only when the low-skill sector is capital-intensive. Which of the two policies the country should implement, therefore, depends on the technological, institutional and trade related factors.

2. The model and assumptions

Let us consider a small open economy in which there are three sectors with provision for endogenous skill formation. One sector is a low-skill (say, an agricultural) sector and produces good X. The second sector is a high-skill (say, manufacturing) sector that produces an industrial good Y. The third sector, S, is the skill formation sector where one unit of unskilled labour and capital together produce one unit of skilled labour. It is supposed that sector X uses unskilled labour and capital, sector Y uses labour and capital, and sector S uses unskilled labour and capital.

The notations and the equations of the GE model are as follows;

W = unskilled wage rate;

W_S = skilled wage rate;

R = effective return to capital in sector S;

r = return to capital;

β = financial assistance given to education sector;

L_U = given endowment of unskilled labour;

L_S = given endowment of skilled labour;

K = given endowment of capital;

Under perfect competition, we have

$$Wa_{LX} + ra_{KX} = 1 \tag{1}$$

$$W_S a_{SY} + ra_{KY} = P_Y \tag{2}$$

$$Wa_{LS} + Ra_{KS} = W + Ra_{KS} = W_S \ \square^{5} \tag{3}$$

---

[5] Note that $a_{LS} = 1$.

where a_{ij} is the amount of the *i*th factor used in the *j*th industry to produce one unit of the output and P_Y is the price of good *Y* in terms of good *X*. We assume that good *X* is *numeraire*, and then the price of good *X* is unity.

The education sector can also get capital at the competitive rate, r, but in order to use this capital effectively they need to spend an additional amount, $f(a_{KS}S)$ with $f(0) = 0; f'(.), f''(.) > 0$, to "adapt" the capital stock rented[6] where $a_{KS}S$ is the amount of capital employed by this sector. This sector also receives a matching development grant from the government.[7] If this sector borrows $a_{KS}S$ amount of capital from the market a fraction β of the amount, $a_{KS}S$, is provided by the government as grant. So effectively total cost of capital is given by $(ra_{KS}S + f(a_{KS}S) - \beta a_{KS}S)$ which is equated to $Ra_{KS}S$ where R is the effective interest rate. Then we have

$$(r - \beta)a_{KS}S + f(a_{KS}S) = Ra_{KS}S$$

or,

$$R = (r - \beta) + (f(a_{KS}S)/a_{KS}S) \qquad (4.1)$$

From (4.1) it is easily seen that

(i) $\qquad R \neq r$

(ii) $\qquad (\dfrac{\partial R}{\partial a_{KS}S}) = (\dfrac{1}{a_{KS}S})[f'(a_{KS}S) - (f(a_{KS}S)/a_{KS}S)] > 0$

$\qquad$ (Note that $[f'(a_{KS}S) - (f(a_{KS}S)/a_{KS}S)] > 0$ as capital $\qquad\qquad$ (4.2)

$\qquad$ adjustment costs are assumed to be convex i.e. $f''(.) > 0$.)

(iii) $\qquad (\dfrac{\partial R}{\partial \beta}) = -1 < 0$

Exogenously given endowments impose the following resource constraints.

---

[6] It could be that a machine rented needs special adjustments before it can be used in the university. For example, for installation of computers and LCD projectors for students there is need to set up a laboratory that involves a substantial cost. Besides, there is an additional cost to develop some specific computer programs or unique equipments for academic research. It could be a program to solve the famous mathematical theorem or a large-scale radio telescope.

$$a_{LX}X + a_{LS}S = a_{LX}X + S = L_U \tag{5}$$

$$a_{SY}Y = L_S + S \tag{6}$$

$$a_{KX}X + a_{KY}Y + a_{KS}S = K \tag{7}$$

where L_U, L_S and K are the initial endowments of unskilled labour, skilled labour and capital, respectively.

This completes the specification of our model with the fixed factor endowments and the internationally determined prices. We have seven endogenous variables, W, W_S, R, r, X, Y and S which are simultaneously solved from seven independent equations; namely, equations (1) – (7). The values of the endogenous variables are obtained in terms of the system parameters, P_Y, L_U, L_S, K and β.

It may be worth mentioning the characteristic features of the production structure of the model. Using (6) equations (5) and (7) can, respectively, be rewritten as follows.

$$a_{LX}X + a_{LS}a_{SY}Y = L_U + L_S \tag{5'}$$

and,

$$a_{KX}X + \tilde{a}_{KY}Y = K + a_{KS}L_S, \tag{7'}$$

respectively, where $\tilde{a}_{KY}Y = a_{KY} + a_{KS}a_{SY}$ is the amount of capital required to produce one unit of good Y directly and indirectly (through skill formation) and $a_{LS}a_{SY} = a_{SY}$ is the amount of "unskilled" labour used in sector Y indirectly through skill formation. Thus, sector S is vertically integrated with sector Y. The vertically integrated sector Y uses capital and "unskilled" labour to produce its output.

---

[7] In India this grant is usually provided by the UGC.

Assumption 1: We assume that

      (i) $(a_{LX}/a_{KX}) > (a_{LS}/a_{KS})$ **or** $(a_{LX}a_{KS} - a_{LS}a_{KX}) > 0$

      (ii) $(a_{LX}/a_{KX}) > (a_{SY}/a_{KY})$ **or** $(a_{LX}a_{KY} - a_{KX}a_{SY}) > 0$.

X, *Y* and *S* are agricultural, manufacturing and education sectors, respectively. Thus, it is sensible to assume that sector *X* is less capital-intensive relative to both sectors *S* and *Y*. Assumption 1 summarizes the factor-intensity conditions in the usual physical sense.

Here, we define λ_{ij} as the proportion of the *i*th factor employed in the *j*th sector ($i = L_U, L_S, K$; $j = X, Y, S$), for example, $\lambda_{LX} = a_{LX} X / L_U$. These are called the allocative shares. On the other hand, θ_{ij} is the distributive share of the *i* th factor in the *j* th sector, for example, $\theta_{SY} = W_S a_{SY} / P_Y$. It can be seen that the factor intensity condition (i) can be expressed in terms of allocative shares as

      (i') $\Lambda_{XS} \equiv (\lambda_{LX}\lambda_{KS} - \lambda_{LS}\lambda_{KX}) > 0$,

and that the factor intensity condition (ii) can be expressed in terms of distributive shares as[8]

      (ii') $\Theta_{XY} \equiv (\theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}\theta_{LS}) > 0$.

These factor intensities play very important role in the following analysis.

3. Comparative statics

      Differentiating (1) to (7) and writing in a matrix notation we obtain

---

[8] See the Appendix II for the derivation.

$$
\begin{bmatrix}
\theta_{LX} & 0 & \theta_{KX} & 0 & 0 & 0 & 0 \\
0 & \theta_{SY} & \theta_{KY} & 0 & 0 & 0 & 0 \\
\theta_{LS} & -1 & 0 & \theta_{KS} & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & -\phi_S \\
\lambda_{LX}S_{LL}^X & 0 & \lambda_{LX}S_{LK}^X & 0 & \lambda_{LX} & 0 & \lambda_{LS} \\
0 & \lambda_{SY}S_{SS}^Y & \lambda_{SY}S_{SK}^Y & 0 & 0 & \lambda_{SY} & -\lambda_S \\
\lambda_{KX}S_{KL}^X & \lambda_{KY}S_{KS}^Y & A & 0 & \lambda_{KX} & \lambda_{KY} & \lambda_{KS}
\end{bmatrix}
\begin{bmatrix}
\hat{W} \\ \hat{W}_S \\ \hat{r} \\ \hat{R} \\ \hat{X} \\ \hat{Y} \\ \hat{S}
\end{bmatrix}
=
\begin{bmatrix}
0 \\ 0 \\ 0 \\ \phi_\beta \hat{\beta} \\ 0 \\ 0 \\ \hat{K}
\end{bmatrix}
\tag{8}
$$

where $\hat{Z} = dZ/Z$ for any variable Z, $A = (\lambda_{KX}S_{KK}^X + \lambda_{KY}S_{KK}^Y) < 0$,

$\phi_S = [a_{KS}X_S/R][\partial R/\partial(a_{KS}X_S)] > 0$, $\phi_\beta = (\beta/R)(\partial R/\partial\beta) < 0$, $\lambda_{LS} = a_{LS}S/L_U = S/L_U$, and

$\lambda_S = S/(L_S + S)$; S_{ji}^k = the degree of substitution between factors j and i in the k th sector,

$j, i = L, S, K$; and, $k = X, Y, S$. For example, $S_{LK}^1 \equiv (r/a_{L1})(\partial a_{L1}/\partial r)$,

$S_{LL}^1 \equiv (W/a_{L1})(\partial a_{L1}/\partial W)$ etc. $S_{ji}^k > 0$ for $j \neq i$; and, $S_{jj}^k < 0$.

Solving (8) for $\hat{W}$ and $\hat{W}_S$ with respect to $\hat{\beta}$, we have equations (9) and (10).

$$
\hat{W}/\hat{\beta} = \theta_{KX}\theta_{SY}\theta_{KS}\phi_\beta(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_S)/\Delta < 0
\tag{9}
$$

$$
\hat{W}_S/\hat{\beta} = \theta_{LX}\theta_{KY}\theta_{KS}\phi_\beta(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_S)/\Delta < 0 ,
\tag{10}
$$

where $\Lambda_{XS} = \lambda_{LX}\lambda_{KS} - \lambda_{KX}\lambda_{LS}$; and,

$$
\begin{aligned}
\Delta = \Theta_{XY}(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_S) + \theta_{KS}\phi_S[\theta_{LX}\theta_{SY}\lambda_{LX}\lambda_{SY}\{\lambda_{KX}(-S_{KK}^X + S_{LK}^X) \\
+ \lambda_{KY}S_{SK}^Y\} + \theta_{LX}\theta_{KY}\lambda_{LX}\lambda_{KY}\lambda_{SY}(-S_{SS}^Y + S_{KS}^Y) + \theta_{KX}\theta_{SY}\lambda_{LX}\lambda_{KX}\lambda_{SY}(-S_{LL}^X + S_{KL}^X)]
\end{aligned}
\tag{11.1}
$$

It may be checked from (11.1) that

$\Delta > 0$ if (i) $\Lambda_{XS} = \lambda_{LX}\lambda_{KS} - \lambda_{KX}\lambda_{LS} > 0$; and, (ii) $\Theta_{XY} = \theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}\theta_{LS} > 0$ (11.2)

Now we define the factor intensity in a special sense.

Definition 1: Sector X is less (more) capital-intensive relative to sector Y in a special sense[9] if and only if $(\theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}) > (<)0$.

Here sectors X and Y use two different types of labour. However, there is one intersectorally mobile input which is capital. So, these two industries cannot be classified in terms of factor intensities which is usually done in the Hechscher-Ohlin-Samuelson model. Despite this, a special type of factor intensity classification in terms of the relative distributive shares of the mobile factor i.e. capital may be used for analytical purposes. The industry in which this share is higher relative to the other may be considered as capital-intensive in a special sense.

It may be worth mentioning the relation between the usual factor intensity (Assumption 1 (ii)) and the factor intensity in a special sense. It can be easily shown that if sector X is less capital-intensive in a special sense, i.e., $(\theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}) > 0$, then sector X is less capital-intensive also in the usual sense, i.e., $(\theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}\theta_{LS}) > 0.$ This is because $\theta_{LS} < 1$ and hence $\theta_{KX}\theta_{SY} > \theta_{KX}\theta_{SY}\theta_{LS}$. On the other hand, sector X can be more *capital*-intensive in a special sense, i.e., $(\theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}) < 0$, even if sector X is less capital-intensive in the usual sense. This happens when W_S and $\theta_{SY}(= W_S a_{SY} / P_Y)$ are sufficiently large.

We define the inequality measure as $(W_S / W) \square$[10]. Thus, the change in relative inequality is $(\hat{W}_S - \hat{W})$. Subtracting (9) from (10) we obtain the following expression.

$$(\hat{W}_S - \hat{W}) / \hat{\beta} = \theta_{KS} \phi_\beta (\theta_{LX} \theta_{KY} - \theta_{KX} \theta_{SY})(\lambda_{SY} \Lambda_{XS} + \lambda_{LX} \lambda_{KY} \lambda_S) / \Delta \tag{12}$$

With the help of (11.2) from (12) the following proposition can be easily established.

Proposition 1: The infrastructure development scheme designed for skill formation lowers the skilled-unskilled wage inequality if $\theta_{LX} \theta_{KY} > \theta_{KX} \theta_{SY} > \theta_{KX} \theta_{SY} \theta_{LS}$, while it increases the inequality if $\theta_{KX} \theta_{SY} > \theta_{LX} \theta_{KY} > \theta_{KX} \theta_{SY} \theta_{LS}$.[11]

Totally differentiating (1) to (3), and collecting terms we can write

$$\theta_{LX} \hat{W} + \theta_{KX} \hat{r} = 0 \tag{13}$$

$$\theta_{SY} \theta_{LS} \hat{W} + \theta_{KY} \hat{r} = -\theta_{KS} \theta_{SY} \hat{R} . \tag{14}$$

It is assumed that an increase in β lowers the price of capital, R, required for skill formation. The decrease in R has the cost reduction effect in the integrated sector Y. This has qualitatively the same effect as the increase in the price of sector Y (i.e. P_Y). By applying the Stolper-Samuelson theorem from (13) and (14) it follows that the fall in R raises r and lowers W if $\theta_{LX} \theta_{KY} > \theta_{KX} \theta_{SY} \theta_{LS}$ i.e. if $\Theta_{XY} > 0$. From the zero-profit condition for sector Y (equation (2)) it follows that the skilled wage, W_S , also falls as r rises. So both W and W_S fall as the capital cost rises in both sectors X and Y. Which one of the two wages will fall more should depend on the distributive shares of capital in the two sectors. If $\theta_{LX} \theta_{KY} > (<)\theta_{KX} \theta_{SY}$ i.e. if $\theta_{KY} > (<)\theta_{KX}$ the capital cost will increase more (less) in sector Y than in sector X and consequently the relative wage inequality improves (worsens).

We have already mentioned that cost reduction effect in the vertically integrated sector Y resulting from a fall in R will have qualitatively the same effect as the increase in the price of commodity Y. This produces a Stolper-Samuelson effect which is followed by a

---

[10] The absolute skilled-unskilled wage gap is $(W_S - W)$.

[11] It should be noted that $\theta_{LX} \theta_{KY} > (<)\theta_{KX} \theta_{SY}$ implies that $\theta_{KY} > (<)\theta_{KX}$ as $(\theta_{LX} + \theta_{KX}) = 1 = (\theta_{SY} + \theta_{KY})$.

Rybczynski type effect as production technologies are of variable coefficient type. Consequently, the capital-intensive vertically integrated Y sector expands and the labour-intensive sector X contracts. This leads to expansion in both sectors Y and S. So the following results are obtained.[12]

$$(\hat{X}/\hat{\beta}) < 0; (\hat{Y}/\hat{\beta}) > 0 ; \text{ and, } (\hat{S}/\hat{\beta}) > 0 . \tag{15}$$

Now let us consider the consequences of an exogenous inflow of foreign capital.[13] The effect of foreign capital inflows on wage inequality is qualitatively the same as the increase in domestic capital with respect to the positive aspect of the changes. Then, the effect of foreign capital inflow on the relative wage inequality can also be derived by solving (8) as follows.

$$(\hat{W}_S - \hat{W})/\hat{K} = \theta_{KS}\phi_S\lambda_{LX}\lambda_{SY}(\theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY})/\Delta , \tag{16}$$

From (16) the following proposition readily follows.

Proposition 2: An inflow of foreign capital increases the skilled-unskilled wage inequality if $\theta_{LX}\theta_{KY} > \theta_{KX}\theta_{SY} > \theta_{KX}\theta_{SY}\theta_{LS}$ while it decreases the inequality if $\theta_{KX}\theta_{SY} > \theta_{LX}\theta_{KY} > \theta_{KX}\theta_{SY}\theta_{LS}$.

Capital inflow decreases its rental, r. Thus, it can be seen from (1) and (2) that both W and W_S must increase. If $\theta_{LX}\theta_{KY} > (<)\theta_{KX}\theta_{SY}$ i.e. if $\theta_{KY} > (<)\theta_{KX}$, saving on capital cost will be more (less) in sector Y than in sector X. Hence the wage inequality rises (falls) following an inflow of foreign capital under the condition as stated in the proposition.

An inflow of foreign capital produces a Rybczynski effect and leads to an expansion of sector S and a contraction of sector X as the former (latter) sector is capital (unskilled labour) intensive (i.e. $\Lambda_{XS} = \lambda_{LX}\lambda_{KS} - \lambda_{KX}\lambda_{LS} > 0$). The vertically integrated Y sector also expands

---

[12] These results have been mathematically derived in Appendix III.

[13] See footnote 3 in this context.

as $\Theta_{XY} > 0$. As the return to capital, r, has fallen and the two wages have increased producers in both Y and X sectors substitute labour by capital. It is easy to check that a_{KY} rises and a_{SY} falls. Then from (6) it follows that Y sector expands due to factor substitution effect. So both the Rybczynski effect and the factor substitution effect move in the same direction and raise the production of Y. But the effect on sector X is not so obvious as the Rybczynski effect and the factor substitution effect move in the opposite directions to each other. The following results can therefore be proved.[14]

$$(\hat{X} / \hat{K}) = ?; (\hat{Y} / \hat{K}) > 0; \text{and } (\hat{S} / \hat{K}) > 0. \tag{17}$$

From (15) and (17) the following proposition can now be established.

Proposition 3: An infrastructure development policy to the education sector and/or an inflow of foreign capital would promote skill formation and lead to expansion of the high-skill sector.

4. Policy implications of results and concluding remarks

The developing countries have been giving top priority to skill formation for overcoming the scarcity of skilled labour. Apart from subsidization of the education system they are contemplating with the idea of allowing the entry of foreign capital into the education sector. In the circumstances, two pertinent questions are as follows: (i) how will the entry of foreign capital affect the process of skill formation and the relative earnings of different groups of workers? (ii) Is it a better policy option vis-à-vis the traditional policy of subsidizing the education sector through provision of infrastructure development grants under all situations? The present paper is designed to provide answers to the above questions in terms of a three-sector general equilibrium model with endogenous skill formation. The analysis has found that both foreign capital inflows and provision of infrastructure development funds promote

---

[14] See Appendix IV for detailed derivations.

skill formation and produce expansion of the high-skill sector. However, the latter policy lowers both the skilled and unskilled wages while the entry of foreign capital produces completely opposite effects on the two wages. The effects of the two policies on the skilled-unskilled wage inequality, on the other hand, depend crucially on the relative factor intensities of the low-skill and high-skill sectors. If the high-skill sector is capital-intensive in a special sense financial assistance program improves the wage inequality while a liberalized investment policy is counterproductive. On the contrary, if the low-skill sector is capital-intensive the entry of foreign capital is preferable to a credit support program especially when the country's objective is to alleviate the problem of rising wage inequality. As factor intensities of the different sectors depend on technological, institutional and trade related factors of the economy the choice between the two alternative policies must ultimately hinge on these factors.

References:

Chau, N. and Stark, O. (1999): 'Migration under asymmetric information and human capital formation,' *Review of International Economics* 7(3), 455-483.

Chaudhuri, S. and Yabuuchi S. (2007): 'Economic liberalization and wage inequality in the presence of labour market imperfection', *International Review of Economics and Finance* 16, 592-603.

Fan, C. Simon, and Oded Stark (2007): 'International migration and "educated unemployment",' *Journal of Development Economics* 83, 76-87.

Feenstra, R.C. and Hanson, G.H. (1996): 'Foreign investment, outsourcing and relative wages', in R. Feenstra, G. Grossman and D. Irwin (eds.), Political Economy of Trade Policies: Essays in Honor of J. N. Bhagwati, Cambridge, , MA: MIT Press.

Jones, R.W. and Neary, P. (1984): 'Positive theory of international trade', in Jones, R.W. and P. B. Kenen (eds.), *Handbook of Development Economics* Vol. 1, North-Holland, 1-62.

Kar, S. and Beladi, H. (2004): 'Skill formation and international migration: welfare perspective of developing countries', *Japan and the World Economy* 16, 35-54.

Marjit, S., Beladi, H. and A. Chakrabarti, (2004): 'Trade and wage inequality in developing countries'. *Economic Inquiry* 42, 295-303.

Marjit, S. and Acharyya, R. (2003): *International Trade, Wage Inequality and the Developing Countries: A General Equilibrium Approach*. Heidelberg: Physica/Springer Verlag.

Sharma, K. (2007): 'FDI in higher education : aspirations and reality', *Mainstream* 45(25).

Stark, O. et al. (1998): 'Human capital depletion, human capital formation and migration: a blessing or a curse',' *Economics Letters* 60(3), 363-367.

Appendices:

Appendix I: Factor intensity

The factor intensity in the usual sense is expressed as

$$
\begin{aligned}
& a_{LX}a_{KY} - a_{KX}a_{SY} \\
& = \{(Wa_{LX})(ra_{KY}/P_Y) - (ra_{KX})(W_S a_{SY}/P_Y)(Wa_{LS}/W_S)\}(P_Y/Wr), \\
& = \theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}\theta_{LS}
\end{aligned}
\tag{A1}
$$

considering the price of good X is unity and $a_{LS} = 1$.

Appendix II: Changes in factor prices

Solving (8) by Cramer's rule we get

$$
(\hat{W}/\hat{\beta}) = \theta_{KX}\theta_{SY}\theta_{KS}\phi_\beta(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_S)/\Delta < 0
\tag{9}
$$

$$
(\hat{W}_S/\hat{\beta}) = \theta_{LX}\theta_{KY}\theta_{KS}\phi_\beta(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_S)/\Delta < 0,
\tag{10}
$$

$$
(\hat{W}/\hat{K}) = \theta_{KX}\theta_{SY}\theta_{KS}\lambda_{LX}\lambda_{SY}\phi_S/\Delta > 0,
\tag{A2}
$$

$$
(\hat{W}_S/\hat{K}) = \theta_{LX}\theta_{KY}\theta_{KS}\lambda_{LX}\lambda_{SY}\phi_S/\Delta > 0.
\tag{A3}
$$

To obtain changes in r and R after totally differentiating equations (1) – (3) we get the following expressions.

$$
\hat{W}\theta_{LX} + \hat{r}\theta_{KX} = 0
\tag{A4}
$$

$$
\hat{W}_S\theta_{SY} + \hat{r}\theta_{KY} = 0
\tag{A5}
$$

$$
\hat{W}\theta_{LS} + \hat{R}\theta_{KS} = \hat{W}_S.
\tag{A6}
$$

Since $(\hat{r}/\hat{\beta}) = -(\theta_{LX}/\theta_{KX})(\hat{W}/\hat{\beta})$ using (9) we find

$$(\hat{r}/\hat{\beta}) = -(\theta_{LX}/\theta_{KX})(\hat{W}/\hat{\beta})$$
$$= -(\theta_{LX}/\theta_{KX})\ \theta_{KX}\theta_{SY}\theta_{KS}\phi_{\beta}(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_{S})/\Delta > 0 \tag{A7}$$

Similarly,

$$(\hat{r}/\hat{K}) = -(\theta_{LX}/\theta_{KX})(\hat{W}/\hat{K})$$
$$= -(\theta_{LX}/\theta_{KX})\ \lambda_{LX}\lambda_{SY}\theta_{KX}\theta_{SY}\theta_{KS}\phi_{S})/\Delta < 0 \tag{A8}$$

From (A5) and (A6) after using (A7) and (A8) we obtain

$$\hat{R} = (\hat{W}_{S} - \hat{W}\theta_{LS})/\theta_{KS} = (\Theta_{XY}/\theta_{KS})\hat{W} \ . \tag{A9}$$

By substituting the expressions for $(\hat{W}/\hat{\beta})$ and $(\hat{W}/\hat{K})$ into (A9), we have

$$(\hat{R}/\hat{\beta}) = (\Theta_{XY}/\theta_{KX})(\hat{W}/\hat{\beta})$$
$$= (\Theta_{XY}/\theta_{KX})\ \theta_{KX}\theta_{SY}\theta_{KS}\phi_{\beta}(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_{S})/\Delta < 0 \tag{A10}$$

$$(\hat{R}/\hat{K}) = (\Theta_{XY}/\theta_{KX})(\hat{W}/\hat{K})$$
$$= (\Theta_{XY}/\theta_{KX})\ \lambda_{LX}\lambda_{SY}\theta_{KX}\theta_{SY}\theta_{KS}\phi_{S})/\Delta < 0 \tag{A11}$$

Appendix III: Changes in output composition due to change in β

Solving (8) for $\hat{X}, \hat{Y}$ and $\hat{S}$ with respect to $\hat{\beta}$, we have

$$(\hat{X}/\hat{\beta})\Delta/\theta_{KS}\phi_{\beta} = \theta_{LX}[\theta_{SY}\{\lambda_{KX}\lambda_{SY}(\lambda_{KS}S_{LK}^{X} - \lambda_{LS}A)$$
$$+ \lambda_{KY}(\lambda_{SY}\lambda_{LS}S_{SK}^{Y} + \lambda_{KX}\lambda_{S}S_{LK}^{X})\}$$
$$+ \theta_{KY}\lambda_{LS}\lambda_{SY}\lambda_{KY}(S_{KS}^{Y} - S_{SS}^{Y})]$$
$$+ \lambda_{KX}\theta_{KX}\theta_{SY}\{\lambda_{SY}(\lambda_{LS}S_{KL}^{X} - \lambda_{KS}S_{LL}^{X}) - \lambda_{KX}\lambda_{S}S_{LL}^{X}\} < 0 \tag{A12}$$

$$(\hat{Y}/\hat{\beta}) = -\theta_{KS}\phi_\beta[\theta_{LX}\{\theta_{SY}\lambda_{KX}\lambda_S(\lambda_{KX}S_{LK}^X - \lambda_{LX}S_{KK}^X)$$
$$+ \theta_{KY}\lambda_{LX}\lambda_S\lambda_{KY}S_{KS}^Y + \Lambda_{XS}\lambda_{SY}\theta_{LX}(\theta_{SY}S_{SS}^Y - \theta_{KY}S_{SK}^Y)\} \qquad (A13)$$
$$+ \lambda_{LX}\theta_{KX}\theta_{SY}(\lambda_{LX}S_{KL}^X - \lambda_{KX}S_{LL}^X)]/\Delta > 0$$

$$(\hat{S}/\hat{\beta}) = \theta_{KS}\phi_\beta[\theta_{LX}\{\theta_{SY}\lambda_{LX}\lambda_{SY}(A - \lambda_{KX}S_{LK}^X - \lambda_{KY}S_{SK}^Y)$$
$$+ \theta_{KY}\lambda_{LX}\lambda_{SY}\lambda_{KY}(S_{SS}^Y - S_{KS}^Y)\} \qquad (A14)$$
$$+ \lambda_{LX}\lambda_{KX}\lambda_{SY}\theta_{KX}\theta_{SY}(S_{LL}^X - S_{KL}^X)]/\Delta > 0$$

where

$$\Delta = \Theta_{XY}(\lambda_{SY}\Lambda_{XS} + \lambda_{LX}\lambda_{KY}\lambda_S) + \theta_{KS}\phi_S[\theta_{LX}\theta_{SY}\lambda_{LX}\lambda_{SY}\{\lambda_{KX}(-S_{KK}^X + S_{LK}^X)$$
$$+ \lambda_{KY}(-S_{KK}^Y + S_{SK}^Y\} + \theta_{LX}\theta_{KY}\lambda_{LX}\lambda_{KY}\lambda_{SY}(-S_{SS}^Y + S_{KS}^Y) + \theta_{KX}\theta_{SY}\lambda_{LX}\lambda_{KX}\lambda_{SY}(-S_{LL}^X + S_{KL}^X)]$$

$$(11)$$

$\Delta > 0$ under the assumptions that $\Lambda_{XS} = \lambda_{LX}\lambda_{KS} - \lambda_{KX}\lambda_{LS} > 0$ and
$\Theta_{XY} = \theta_{LX}\theta_{KY} - \theta_{KX}\theta_{SY}\theta_{LS} > 0$.

Hence a credit subsidy policy designed for skill formation leads to expansion of both Y and S sectors and a contraction of sector X under the assumptions: Λ_{XS}, $\Theta_{XY} > 0$.

Appendix IV: Changes in output composition due to change in K

Differentiating the input-output coefficients and using the expressions for $\hat{W}_S, \hat{W}$ and $\hat{r}$ it can be easily shown that we obtain

$$\hat{a}_{SY} = S_{SS}^Y\hat{W}_S + S_{SK}^Y\hat{r} < 0 \qquad (A15)$$
$$\hat{a}_{KY} = S_{KS}^Y\hat{W}_S + S_{KK}^Y\hat{r} > 0 \qquad (A16)$$
$$\hat{a}_{LX} = S_{LL}^X\hat{W} + S_{LK}^X\hat{r} < 0 \qquad (A17)$$

So a_{SY} and a_{LX} decrease and a_{KY} increases following an increase in K.

Solving (8) for $\hat{X}$, $\hat{Y}$ and $\hat{S}$ with respect to $\hat{K}$, we have

$$(\hat{X}/\hat{K}) = \lambda_{SY}[\lambda_{KX}\theta_{SY}\theta_{KS}\phi_S(\theta_{LX}S_{LK}^X - \theta_{KX}S_{LL}^X) - \lambda_{LS}\lambda_{KY}\Theta_{XY}]/\Delta > (<)0 \qquad (A18)$$

according to the condition $\theta_{KS}\phi_S\lambda_{KX}\theta_{SY}(\theta_{LX}S_{LK}^X - \theta_{KX}S_{LL}^X) > (<)\lambda_{LS}\lambda_{KY}\Theta_{XY}$.

$$(\hat{Y}/\hat{K}) = -\lambda_{LX}[\lambda_{SY}\theta_{LX}\theta_{KS}\phi_S(\theta_{KY}S_{SS}^Y - \theta_{SY}S_{SK}^Y) - \lambda_S\Theta_{XY}]/\Delta > 0 \qquad (A19)$$

and,

$$(\hat{S}/\hat{K}) = \lambda_{LX}\lambda_{SY}\Theta_{XY}/\Delta > 0. \qquad (A20)$$

Hence an inflow of foreign capital leads to expansion of both Y and S sectors under the assumptions: Λ_{XS}, $\Theta_{XY} > 0$. However, the effect on sector X is ambiguous.