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Resumen

La teoría estándar del comercio sugiere que la liberalización comercial produce efectos opuestos sobre la acumulación de capital humano en países desarrollados y en desarrollo, reduciendo los incentivos a invertir en educación en los países con escasez de recursos calificados. ¿Cómo pueden modificarse los resultados establecidos si se introduce un sector de provisión pública de educación en el modelo estándar? Este documento desarrolla un modelo simple con ese propósito, mostrando que cuando la formación de capacidades depende de la provisión pública de educación, la liberalización comercial afecta el proceso de acumulación de capital en función de la estructura económica, por tanto, contrariamente a la literatura previa, este marco analítico explica tanto episodios de convergencia o divergencia en la acumulación de calificaciones entre los socios comerciales.

Palabras clave: educación pública, liberalización comercial, Heckscher–Ohlin

Clasificación JEL: F11 I20 O15

Abstract

Standard trade theory suggests that trade liberalization produces opposite effects on human capital accumulation in developed and developing countries, reducing the incentives to invest in education in skill-scarce countries. How would conventional wisdom be modified if we introduce public provision of education in the standard framework? This paper develops a simple model for this purpose, showing that when skills formation depends on public provision of education, trade liberalization affects the human capital accumulation process depending on the economic structure; thus, in contrast to the previous literature, this framework explains convergence or divergence in the accumulation of skills between trading countries.

Keywords: public education, trade liberalization, Heckscher–Ohlin

JEL classification: F11 I20 O15

1: INTRODUCTION

Standard theoretical results indicate that opening up to trade leads to a reduction in the return to human capital in skill-scarce countries; thus, trade reduces incentives to invest in education in developing countries, whereas the opposite happens in the developed world, leading to divergence in stocks of skills. For instance, in the extended version of the Heckscher–Ohlin model by Findlay and Kierzkowski (1983) with endogenous endowments, trade, by modifying incentives to invest in education, leads to a divergence in the accumulation of endowments across countries. However, Findlay and Kierzkowski do not take into account the fact that skills are also used in the production of education (they consider instead education using specific factors), a point raised, for instance, by Cartiglia (1997), Eicher (1999), and Ranjan (2001). In their models, skills are used to produce skills as education is skill-intensive; trade reduces the cost of producing education in the skill-scarce country, so it favors the production of skills, contrary to Findlay and Kierzkowski´s predictions. Other studies on endogenous skill formation in an open economy also include those of Owen (1999), Flug and Galor (1986), Davis and Reeve (1997), and Stokey (1996).

In contrast to this literature, in this paper it is assumed that education is publicly provided – a relevant fact in almost every country (see for instance, UNESCO, 2007) – and, in the modeling it is assumed that the activity suffers systemic inefficiencies (e.g., low quality, high rates of early dropout) – a typical situation in developing countries (see for instance, UNESCO, 2008). So, as in Glomm and Ravikumar (1998, 2003) and Jung and Thorbecke (2003), education is publicly provided and financed by taxation, but the model presented here remains close to the static version of the Heckscher–Ohlin model, with the advantage of a well-established and simple framework for the results obtained.

The model presented in this paper shows that when skills formation depends heavily on public provision, the transmission of price changes affects the human capital accumulation depending on the economic structure. Some general results are derived; in particular, it is shown that, in contrast to the previous literature, the effects of trade liberalization on the factor accumulation process in developing or developed countries depend on the specific features of trading partners.

The rest of the paper is organized as follows. Section 2 describes the education sector. Section 3 considers a stylized general equilibrium model *à la* Heckscher–Ohlin with public provision of education; some properties are derived and the implications are discussed. Section 4 offers some conclusions. Supplementary results are presented in the Appendix.

2: EDUCATION SECTOR

Education is skill-intensive and publicly provided. The education budget is exogenously determined and financed by taxes. Education is the only public service provided by the government, and the government pays market wages to the skilled and unskilled labor employed in the sector.

i. The production of education

The education output, following the tradition in the education production function literature (for instance see Levačić and Vignoles, 2002, for a survey), is given by $Q_j = F_j(G_j, E_j)$, where sub-index $j = b, h$ indicates the level (basic or higher education), G_j are resources (value added), E_j are students, and Q_j is the output of the activity.

The function F_j is subject to constant returns to scale, so the output per student, q_j, can be written as $q_j = Q_j / E_j = F_j(g_j)$, where g_j measures the resource intensity per student, and $\partial q_j / \partial g_j > 0$. Successful students acquire an amount q_j of the output, which builds up their human capital. Following Hanushek (1979), students' acquired knowledge, q_j, measures the "schooling quality."

Basic education "produces" both unskilled workers and students qualified to enter higher education, and higher education "produces" skilled workers from qualified student inputs. It is assumed that progress inside the system depends on school quality; hence, early exit rates (θ) are an inverse function of the output per student. The production of endowment depends on the productivity acquired by students through education and time of exit. The inflow of labor (in efficiency units) to the market (dL_z) is given by

$$dL_U = \theta E_b f_b$$

$$dL_S = E_h f_h$$

where θ represents the early exit rate, the subindex $i = S,U$ corresponds to skilled and unskilled labor produced, and f_j measures the accumulation of q_j during schooling, where j is the last level passed.

The productivity acquired through schooling will be low when education quality is low, and in this case also the inflow of new labor will be dominated by unskilled labor (high rates of early dropouts). It is apparent that expanding the funds allocated to education enables an increase in resources applied per pupil, thus improving the quality of education. As student performance is positively associated with the education quality, the expansion of the budget improves systemic efficiency, and thus the production of skills.

ii. The education budget

The total budget for education (B) can be expressed as $B = \sum_i w_i L_{iE}$, where L_{iE} represents the employment of labor type i in the education sector, w_i is the respective wage rate, and $B = \sum_j B_j$.

The value added to education is given, assuming a Cobb Douglas function, by $G_j = A_j L_{Sj}^{\alpha_j} L_{Uj}^{1-\alpha_j}$, where L_{ij} is the employment of factor i in education at level j, and $L_{iE} = \sum_j L_{ij}$. Once the budget is determined, education authorities derive factor demands by the minimization of unit cost program, resulting in

$$l_{Uj} = \frac{1}{A_j}\left(\frac{w_S}{w_U}\frac{1-\alpha_j}{\alpha_j}\right)^{\alpha_j} \tag{1}$$

$$l_{Sj} = \frac{1}{A_j}\left(\frac{w_U}{w_S}\frac{\alpha_j}{1-\alpha_j}\right)^{1-\alpha_j} \tag{2}$$

where l_{ij} are the unit factor demands. Then, the education budget can be written as

$$B_j = \left(w_S l_{Sj} + w_U l_{Uj}\right) G_j \tag{3}$$

where G_j identifies the amount of resources applied to education (value added in real terms).

3: GENERAL MODEL AND PROPERTIES

There are two tradable sectors, X and Y, and a non-tradable sector, education, E, publicly provided, which produce endowments. All sectors use skilled and unskilled labor, markets are competitive, and the production functions are subject to constant returns to scale. The factor market clearing conditions imply that $L_{iX} + L_{iY} + L_{iE} = L_i$, for $i = S,U$, where L_i are the total endowments of skilled and unskilled labor, respectively; and L_{ih} ($h = X,Y$) is the employment in the tradable sectors.

For the tradable sectors, from the zero-profit conditions results $P_h = \sum_i w_i l_{ih}$, where l_{ih} are the unit factor demands. Differentiating this expression and using the cost minimization condition that ensures that $dl_{Sh}/dl_{Uh} = -w_U/w_S$, the following expression is obtained:

$$\hat{P}_h = \sum_i \Theta_{ih} \hat{w}_i \tag{4}$$

where a hut (^) placed over the variables denotes rate of growth., and Θ_{ih} is the cost share of factor i in the production of good h, i.e.,

$$\Theta_{ih} = \frac{w_i l_{ih}}{P_h} \tag{5}$$

and $\sum_i \Theta_{ih} = 1$. For given prices, the solution for $\hat{w}_i$ in (4) is given by

$$\hat{w}_S = \frac{\Theta_{UY}\hat{P}_X - \Theta_{UX}\hat{P}_Y}{\Theta_{UY} - \Theta_{UX}} \tag{6}$$

$$\hat{w}_U = \frac{\Theta_{SX}\hat{P}_Y - \Theta_{SY}\hat{P}_X}{\Theta_{UY} - \Theta_{UX}}. \tag{7}$$

The properties of the model and its implications are discussed in the rest of this section.

Property 1: *Changes in factor returns directly affect the purchasing power of the educational budget; such changes will require an adjustment in the budget given by* $\hat{B}_j = \Theta_{Sj}\,\hat{w}_S + (1-\Theta_{Sj})\hat{w}_U$ *if the education quality is to remain at the pre-shock level.*

This can be shown by differentiating (3) taking G_j (real value-added) constant, and using (1), (2), and expressions (A2) and (A3) in the Appendix, resulting in

$$dB_j = G_j\, d\left(w_S l_{Sj} + w_U l_{Uj}\right) = \left[\alpha_j\,\hat{w}_S + (1-\alpha_j)\hat{w}_U\right]B_j \tag{8}$$

Rearranging (8), results $\hat{B}_j = \alpha_j\,\hat{w}_S + (1-\alpha_j)\hat{w}_U$. Also, using (A4) in the Appendix results in

$$\hat{B}_j = \Theta_{Sj}\,\hat{w}_S + (1-\Theta_{Sj})\hat{w}_U \tag{9}$$

which determines the required modifications on the budget for education caused by changes in factor returns when policymakers intend to maintain the purchasing power of the budget, i.e., the quality of education at the pre-shock level.

Property 2: *Changes in factor returns directly affect the education sector by modifying the purchasing power of the budget (and thus resources applied to the activity) if the budget remains fixed; such changes will affect the quality of education determined by* $\hat{G}_j = -\left[\Theta_{Sj}\,\hat{w}_S + (1-\Theta_{Sj})\hat{w}_U\right]$.

If the budget was to remain fixed after the shock in prices, then the real value added (G_j) would adjust. Differentiating (3) results in

$$dB_j = G_j\, d\left(w_S l_{Sj} + w_U l_{Uj}\right) + \left(w_S l_{Sj} + w_U l_{Uj}\right)dG_j = 0$$

From here, using (3) and (8) results in $\hat{G}_j = -\left[\alpha_j\,\hat{w}_S + (1-\alpha_j)\hat{w}_U\right]$. Substituting (A4) in the Appendix in this expression results in

$$\hat{G}_j = -\left[\Theta_{Sj}\,\hat{w}_S + (1-\Theta_{Sj})\hat{w}_U\right]. \tag{10}$$

Expression (10) shows the effects of changes in prices on real value added if the budget remains fixed. The comparison of (9) and (10) shows the opposite effects of changes in prices on B_j and G_j.

Property 3: *The effects of trade liberalization on the human capital accumulation depend on the economic structure of trading countries.*

To show this, expression (10) can be rewritten using (6) and (7) as follows:

$$\hat{G}_j = \frac{\left(\Theta_{SY} - \Theta_{Sj}\right)\hat{P}_X + \left(\Theta_{Sj} - \Theta_{SX}\right)\hat{P}_Y}{\Theta_{UY} - \Theta_{UX}} \tag{11}$$

From (11), it can be seen that the effect of the changes in prices depends on the relative factor intensities. Note that assuming that sector X is relatively more skill-intensive than Y, $\Theta_{UX} < \Theta_{UY}$ (see Section 2 in the Appendix), so the denominator in (11) is positive. Also, $\Theta_{SX} > \Theta_{SY}$ when the sector X is relatively more skill-intensive than Y (see Section 2 in the Appendix); similarly $\Theta_{Sj} > \Theta_{Sh}$ if the education sector is more skill-intensive than sector h.

Thus, to determine the sign of the effects of changes in prices, the sign of the numerator of (11) needs to be determined. To progress in this direction, different scenarios of changes in prices may be considered, it seems relevant to analyse the price effects of trade liberalization such as:

i) Scenario 1: $\hat{P}_X > 0 > \hat{P}_Y$ in skill-abundant countries,

ii) Scenario 2: $\hat{P}_Y > 0 > \hat{P}_X$ in skill-scarce countries.

The effects of changes in prices on resources applied to education if the budget remains fixed, when X is more skill-intensive than Y, resulting from (11), are presented in Table 1. In Scenario 1 $\hat{P}_X > 0$ and $\hat{P}_Y < 0$, so when education is less skill-intensive than both productive sectors, the numerator is positive (column 1 and case 1 in Table 1), thus the effect is positive; the purchasing power of the budget increases relative to the pre-shock

level and thus resources applied to education increase. The other cases for Scenario 1 in Table 1 are obtained similarly, as well as for Scenario 2.

Table 1 Trade liberalization: effects on real value-added with a constant budget

Factor intensities	Scenario 1	Scenario 2
Case 1: $\Theta_{SX} > \Theta_{SY} > \Theta_{Sj}$	$\hat{G}_j > 0$	$\hat{G}_j < 0$
Case 2: $\Theta_{SX} > \Theta_{Sj} > \Theta_{SY}$	Ambiguous	Ambiguous
Case 3: $\Theta_{Sj} > \Theta_{SX} > \Theta_{SY}$	$\hat{G}_j < 0$	$\hat{G}_j > 0$

Note: Describes all possible results for expression (11) in the text

From (9), following a similar procedure as before, the effects of prices on $\hat{B}_j$ are obtained, which result in

$$\hat{B}_j = \frac{\left(\Theta_{Sj} - \Theta_{SY}\right)\hat{P}_X + \left(\Theta_{SX} - \Theta_{Sj}\right)\hat{P}_Y}{\Theta_{UY} - \Theta_{UX}} \tag{12}$$

From (12), the required adjustments in the education budget to keep education quality constant to the pre-shock level, when X is more skill-intensive than Y, are presented in Table 2. In Scenario 1 $\hat{P}_X > 0$ and $\hat{P}_Y < 0$, so when education is less skill intensive than both productive sectors, the numerator is negative (column 1 and case 1 in Table 2); thus the effect is negative, and the required adjustment is a reduction of the budget to maintain its purchasing power at the pre-shock level. The other cases are obtained similarly; all the possible results for expression (12) are summarized in Table 2.

Table 2 Trade liberalization: adjustments in budget to keep education quality constant

Factor intensities	Scenario 1	Scenario 2
Case 1: $\Theta_{SX} > \Theta_{SY} > \Theta_{Sj}$	$\hat{B}_j < 0$	$\hat{B}_j > 0$
Case 2: $\Theta_{SX} > \Theta_{Sj} > \Theta_{SY}$	Ambiguous	Ambiguous
Case 3: $\Theta_{Sj} > \Theta_{SX} > \Theta_{SY}$	$\hat{B}_j > 0$	$\hat{B}_j < 0$

Note: Describes all possible results for expression (12) in the text

Properties (1) to (3) have the following implications.

Implication 1: *An otherwise Heckscher–Ohlin model except for the inclusion of public provision of education can accommodate episodes of convergence or divergence of accumulation of endowments across countries after trade liberalization.*

Both in developing and developed countries, the skill intensity of the education sector will be typically high, hence, cases 2 and 3 in Tables 1 and 2 will be representative, so the effects of trade liberalization on skills formation depend on the economic structure. If both countries were case 3, trade liberalization would lead to divergence in accumulation of endowments; however, if both countries were case 2, or a combination of cases 2 and 3, convergence or divergence could result.

Implication 2: *Protectionism in developing countries, if the education sector is the most skill-intensive in the economy and the budget remains unchanged, damages the accumulation process.*

It is possible to analyze a protectionist backlash in a developing country as a particular case of Property 3, corresponding to column 1 of Table 1. If case 3 represents the economic structure of a developing country, the property highlights a usually overlooked effect of protectionism: it would damage the accumulation process (i.e. $\hat{G}_j < 0$). If the budget remains fixed after the shock in prices, the production of endowments is damaged

by a poorer quality of education, also the composition of the inflow of new labor shifts towards a higher participation of unskilled labor (increase in the rates of early exit).

Implication 3: *An increase in the international price of the skill-intensive good, if the budget is allowed to adjust so as to maintain a constant quality of education, will require a rise in the budget equivalent to the otherwise decline in the value added.*

Actual effects of prices on the production of endowments will depend ultimately on the countries' capacity to finance the expansion of the budget of education if required (i.e., $\hat{B}_j > 0$). The difference on this matter across developing and developed countries may cause divergence in stocks of endowments.

4: CONCLUSIONS

The model developed in this paper shows that in a model *à la* Heckscher–Ohlin with public provision of education, the effects of prices and trade policy on the accumulation process depend on the economy's structure of trading countries. This framework also, contrary to the previous literature, accommodates episodes of both convergence and divergence in accumulation of skills across countries after trade liberalization.

In a model where education is publicly provided, changes in goods and factor prices have distinct characteristics on the process of accumulation of endowments. On the one hand, the resources applied to education activities will be altered when prices change and the budget remains unchanged, as it may occur when there is some inertia in budget adjustments. The resources applied to the activity have a direct effect on the quality of education, and as the systemic performance depends on the quality of education, the consequences are potentially vast. On the other hand, to maintain education quality to the pre-shock level, the budget needs to be adjusted. This, in practice, generates further differentiation in the effects of price changes as countries differ in their capacity to finance such expansions of the budget.

The analysis has policy implications, as changes in trade policy would directly affect the process of skill formation, a fact usually overlooked by policymakers. Moreover, as the

effects depend on the economic structure, an evaluation on case-by-case basis would be required.

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APPENDIX

1: Factor employment in the education sector

Total labor employment is given by

$$L_{ij} = l_{ij} G_j . \tag{A1}$$

From (1)–(3) in the main text and (A1), in equilibrium L_{sj} and L_{uj} are given by

$$L_{Sj} = l_{Sj} G_j = B_j \frac{l_{Sj}}{w_S l_{Sj} + w_U l_{Uj}} = \frac{\alpha_j B_j}{w_S} \tag{A2}$$

$$L_{Uj} = l_{Uj} G_j = B_j \frac{l_{Uj}}{w_S l_{Sj} + w_U l_{Uj}} = \frac{(1-\alpha_j) B_j}{w_U} . \tag{A3}$$

The parameter α_{sj} is the cost share of factor *S*: So, similarly as it is defined in the tradable sectors

$$\alpha_j = \frac{w_S L_{Sj}}{B_j} = \Theta_{sj} \tag{A4}$$

where $\Theta_{Sj} = 1 - \Theta_{Uj}$.

2: Factorial intensity and factor cost share

If sector X is relatively more skill-intensive than Y, then $\Theta_{UX} < \Theta_{UY}$ and $\Theta_{SX} > \Theta_{SY}$. This can be seen by considering the definition of skill intensity, $l_{UX}/l_{SX} < l_{UY}/l_{SY}$, which can be conveniently expressed as:

$$\frac{l_{UX} w_U P_X}{l_{SX} w_S P_X} < \frac{l_{UY} w_U P_Y}{l_{SY} w_S P_Y} .$$

Using definition (4) in the main text, this expression is equivalent to

$$\frac{\Theta_{UX}}{\Theta_{SX}} < \frac{\Theta_{UY}}{\Theta_{SY}}.$$

Noting that $\Theta_{Sh} = 1 - \Theta_{Uh}$, and using it in the above expression, the results are

$\Theta_{UX} < \Theta_{UY}$ and $\Theta_{SX} > \Theta_{SY}$.