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Facultad de Ciencias Sociales
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Public Education and Growth: Cost-effectiveness of Educational Policies in Developing Countries

Rossana Patrón

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Rossana Patrón
dECON, Universidad de la República
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Resumen

El documento analiza los efectos de las actividades de educación en el corto y largo plazo en una economía abierta, vinculando los costos y beneficios futuros de políticas de educación alternativas. Los ejercicios de simulación muestran que los efectos sobre el crecimiento son mayores para las políticas de educación que reducen la ineficiencia interna del sector y que por tanto aumentan la productividad del gasto. El análisis tiene implicancias para los diseñadores de políticas de educación en países en desarrollo que como Uruguay tienen fallas sistémicas en el sector educativo, ya que el mismo sugiere que los efectos sobre el crecimiento están mas vinculados al costo-efectividad de las políticas que al nivel de matriculación en el sistema o al monto de gasto en educación como habitualmente es testeado en regresiones de crecimiento.

Palabras clave: educación pública, crecimiento, países en desarrollo
Clasificación JEL: F I O

Abstract

The paper analyses the short and long term effects of education activities for an open economy, linking current costs to future benefits of alternative educational policies. The simulations find that growth effects are higher for those policies that reduce the internal inefficiency of the education sector thus improving the productivity of public expenditure. The analysis has implications for policymakers in developing countries like Uruguay with failing educational systems, as it suggests a relation between cost effectiveness of policies and growth and *not* a relation between enrolments and growth *or* between public expenditure in education and growth as it is usually tested in growth regressions.

Keywords: public education, growth, developing countries
JEL classification: F I O

1: INTRODUCTION

While there has been a successful policy towards the expansion of enrolments world wide not all countries benefit equally from this policy. During the period 1970-1997 African and Latin American countries enrolments in primary, secondary and tertiary education have increase well above world average rates, and Asian countries have increase enrolments above world averages in secondary and tertiary education (UNESCO, 2000). As there has been spectacular increase in educational attainment in developing countries there seems to be a tendency to convergence in stocks of skills worldwide. However, this convergence in educational attainment did no mean that less inequality. While the developed world per capita incomes grew at an average annual rate of 3.11% during the period 1990-2000, developing countries (excluding China and India) grew only at 0.69% (Salvatore, 2004). Moreover, the empirical evidence of the contribution of education to growth is mixed as surveyed for instance by Temple (2000).

Educational policies do play an important for growth, however, not all of them are equally effective and there is not a straightforward policy to promote growth. By the one hand, the quality of the education provided matters. As claimed for instance by Dessus (2001) massive enrolment in developing countries have deteriorated education quality, reducing significantly the capability of education to generate growth. Hanushek and Kim (1995) and Dessus (2001) provide empirical evidence that the link between education and growth is positive and significant once differences in educational quality are taken into account. By the other hand the composition of the expenditure in education also matters. Gemmel (1996), for instance, provides evidence that human capital effects on growth at primary level are more important in low income countries, at secondary level for higher income developing countries, and at tertiary level for developed countries. More in particular, Birdsall et al. (1998) argue that in Latin American countries the share of higher education in public expenditure tends to be too high (20% on average) in particular compared to the fast growing East Asian countries (15% on average), and Paus (2003) claims that failing to address adequately the development of human resources in Latin America has been a crucial factor in explaining the poor performance of these countries over the last decades.

In the case of Uruguay where in 2002 tests 33.7% of primary school students failed languages and 51.7% failed mathematics (World Bank 2005) it seem that there is still much room to improve the performance of the educational system. MEMFOD (1999) research indicates that high repetition rates in primary education have long-term effects on the students' schooling, as it causes over-age population in schools, and those who are over-age are more likely to repeat or dropout in further stages of the educational system; this has been identified as an important factor in explaining high repetition and dropout rates in secondary education. Due to high incidence of early dropouts in secondary education the inflow of new workers in Uruguay is dominated by unskilled and informal labour; also, the high repetition rates make the productivity of educational expenditure very poor. Besides this, the poor qualification at basic levels also propels inefficiency at higher stages in the system and the production of skills seems to have been comparatively more inefficient in Uruguay than in the rest of Latin America: while in Uruguay the population with tertiary education grew at an average of 2% during the nineties, in Argentina it grew at 5%, in Brazil at 4%, in Chile, Colombia and Paraguay at 6%, and in Mexico at 9% (World Bank 2005).

As such, there seems to be room for educational policy to improve the system performance not only in terms of internal functioning and productivity but also in terms of the links to the labour market and the broader economy, which is the subject of this paper. The paper analyses the short and long term effects of education activities for an open economy, linking current cost to future benefits of alternative educational policies. The analysis has implications for policymakers, as it suggests a relation between cost effectiveness of policies and growth and *not* between enrolments and growth *or* between public expenditure in education and growth as it is usually tested in growth regressions.

The organization of the rest of the paper is as follows. Section 2 describes the education sector are the central feature of the model. Section 3 develops an analytical presentation of short and long run effects of an expansion of education. Section 4 presents the results of the experiments for an extended version of the model, simulating alternative educational

policies. Section 5 concludes. An annex list the value of parameters used in the simulations.

2: EDUCATION SECTOR

Standard theoretical results indicate that open up to trade leads to a reduction of the price of the price of skills in developing countries, thus trade reduces the incentives to invest in education in developing countries while the opposite happens in developed countries. In the extended version of the Heckscher-Ohlin model due to Findlay and Kierzkowski (1983) with endogenous endowments, trade, by modifying incentives to invest in education, leads to 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), point that is raised by Cartiglia (1997) and Rajan (2001) for instance. In their models skills are used to produce skills, as education is skill intensive, when in the unskilled abundant country the cost of producing education is reduced it favours the production of skills and allows the catching up effect, while the opposite happen in developed countries, so these models predict trade with convergence in human capital stocks, contrary to F&K. A crucial feature in these models is the presence of income inequality and/or credit constraints to finance investment in education

This model is close to Findlay and Kierzkowski (1983) but presents as a distinctive feature the role of educational policies in the accumulation process. In contrast to Findlay and Kierzkowski' model education is publicly provided, uses skilled and unskilled labour to produce a new inflow of skilled and unskilled labour, and it suffers systemic inefficiencies in term of expected results (i.e. successful students). Endowment growth comes from the output of education activities that add value to entrants (students) cumulatively until they exit the system and enter into the labour market. Students' qualifications, which determine their productivity, depend on the quantity and quality of education received. Thus, the amount of efficiency units produced depends upon the educational system's performance. The supply side of the education sector is explicitly modelled, whereas the demand side is

made implicit by the assumption that students exit the system when the quality of education they receive is poor.

Education is skill intensive, being its budget exogenously determined and financed by (direct and indirect) taxes. Education is a multi-product activity. Basic education 'produces' both unskilled workers and students qualified to enter higher education, and higher education 'produces' skilled workers from qualified student inputs.

The education production function, generalising the Findlay and Kierzkowski (1983) function, is:

$$Q_j = F_j(G_j, E_j)$$

where sub-index j 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. Q_j represents the amount of knowledge provided by the service but not necessarily transmitted to students as there is some wastage due to inefficiencies in the system (repetition). Successful students will acquire an amount q_j of the output, which shows the 'schooling quality'. As Q_j is subject to constant returns to scale, q_j can be written as:

$$q_j = \frac{Q_j}{E_j} = F_j\left(g_j\right)$$

where g_j measures the intensity of resources per student, and $\frac{\partial q_j}{\partial g_j} > 0$.

The accumulation of q_j shows the path of building human capital on students which will be their productivity when entering the labour market. The indicator f_j sums up students' accumulation:

$$f_j = \sum_{v=1}^{v=j} q_v$$

where j is the last level passed. Assuming constant number of entrants and policies, both f and q are constant over time.

At entry level the amount of entrants is exogenous but exit rates determine the number of students reaching higher levels. As previous attainment enables future success, dropout and repetition are inversely related to school quality. Assuming constant number of entrants and exit and repetition rates the number of students at each level is given by:

$$E_j = E_{j-1}(1-\theta_{j-1})(1-\gamma_{j-1})$$

where θ_j is the exit rate, γ_j is the repetition rate, and $\frac{\partial \theta_j}{\partial q_j} < 0$ and $\frac{\partial \gamma_j}{\partial q_j} < 0$.

The process of accumulation of endowments in the economy depends on exit and repetition rates and on school quality as students carry with them the educational output accumulated.

The stock of accumulated output inside the system is given by:

$$L_j^T = f_j n_j$$

where n_j is the number of successful students given by $n_j = E_j(1-\gamma_j)$. So, the size and the composition of the inflow of units of labour to the market is given by:

$$L_U^N = \theta_B L_B^T$$

$$L_S^N = \theta_H L_H^T$$

where L_U^N and L_S^N are the inflow of units of unskilled and skilled labour respectively, and *B, H* correspond to basic and higher education respectively.

The pattern of endowment growth in the economy depends on the balance between basic and higher education which produce respectively unskilled and skilled labour as well as students' performances at every level. Expanding funds allocated to education enables an increase of resources applied per pupil, thus improving education quality. As student performance is positively associated with education quality, the expansion of the budget increase the demand at further stages which brings about an improvement in the internal efficiency of the system. However, as more students reach further studies the falling resource intensity per student tends to counteract the rise in the budget, so the school quality at those levels may rise or fall.

3: EDUCATION AND ENDOWMENT GROWTH

The expansion of education has short and long run effects on the economy. In the short run it reduces the availability of resources to other activities and in the longer term the level of skills is modified due to its activity. As noted by Manning (1982), educational policy affects the size and the shape of the production possibilities frontier. As Motuvu (2000) put it, the first is a direct effect identified as 'pure resource withdrawal', and the second one is indirect as this expenditure affects the accumulation process.

Sufficient and necessary conditions can be stated for the determination of the effect of education activities on productive sectors along the following lines. Considering two tradable sectors and a non-tradable education sector., where all sectors use skilled and unskilled labour ($i = S,U$), goods and factors markets are competitive and the production functions are subject to constant returns to scale, it is possible to extend Rybczynski theorem[1] to the case of an endogenous growth in factors, using Jones's (1965) approach.

From the factor market clearing conditions we have:

$$a_{iX}X + a_{iY}Y + a_{iE}G = L_i$$

[1] The 'standard' analysis of the theorem is carried out in physical units of endowments of homogenous factors; the analysis in this section applies to both physical and efficiency units.

where X and Y are the outputs of traded activities and G is the value added of education, L_i are total endowments of factors and a_{ih} are unit input coefficients. Total differentiation of the above expressions after some manipulation it gives:

$$\lambda_{iX}\hat{X} + \lambda_{iY}\hat{Y} + \lambda_{iE}\hat{G} = \hat{L}_i$$

where $\lambda_{ih} = L_{ih}/L_i$ is the proportion of the endowment of factor i used in the production of good h, and $\lambda_{SX} + \lambda_{SY} + \lambda_{SE} = 1$. As $\hat{G}$ is exogenously determined, this expression can be rewritten as:

$$\lambda_{iX}\hat{X} + \lambda_{iY}\hat{Y} = \hat{L}_i - \lambda_{iE}\hat{G}$$

Solving these set of equations for $\hat{X}$ and $\hat{Y}$ gives:

$$\hat{X} = \frac{\lambda_{UY}\hat{L}_S - \lambda_{SY}\hat{L}_U + (\lambda_{SY}\lambda_{UE} - \lambda_{UY}\lambda_{SE})\hat{G}}{|\lambda|} \qquad (1)$$

$$\hat{Y} = \frac{\lambda_{SX}\hat{L}_U - \lambda_{UX}\hat{L}_S + (\lambda_{UX}\lambda_{SE} - \lambda_{SX}\lambda_{UE})\hat{G}}{|\lambda|} \qquad (2)$$

where $|\lambda| = \lambda_{SX}\lambda_{UY} - \lambda_{UX}\lambda_{SY} = \lambda_{UX}\lambda_{UY}(\lambda_{SX}/\lambda_{UX} - \lambda_{SY}/\lambda_{UY})$. Assuming that sector X is more skill intensive than Y $|\lambda| > 0$.

Expressions (1) and (2) combine the standard Rybczynski results (long term) with the 'pure resource withdrawal effect' (short term) of the expansion of education activities. They show that the overall effects of education on the output of production sectors depend on the relative factor intensities in the three sectors and the relative size of the increments in the supply of each type of labour. These effects are analysed in the following sections.

3.1 Pure resource withdrawal effect

The 'pure resource withdrawal effect' of an expansion of education activities can be better analysed isolated from endowments' growth. Hence, from (1) and (2) when $\hat{G} > 0$ and $\hat{L}_S = \hat{L}_U = 0$ the effects on productive sectors (assuming that sector X is more skill intensive than Y) are as follows:

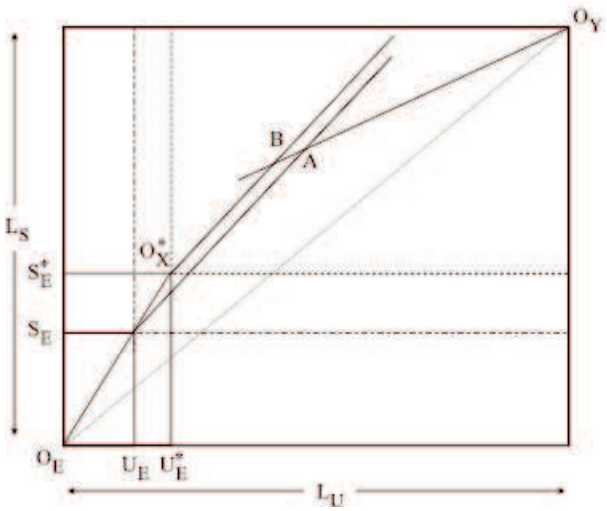
1) $\frac{\lambda_{SE}}{\lambda_{UE}} > \frac{\lambda_{SX}}{\lambda_{UX}} > \frac{\lambda_{SY}}{\lambda_{UY}}$, implying $\hat{X} < 0$, $\hat{Y} > 0$

2) $\frac{\lambda_{SX}}{\lambda_{UX}} > \frac{\lambda_{SE}}{\lambda_{UE}} > \frac{\lambda_{SY}}{\lambda_{UY}}$, implying $\hat{X} < 0$, $\hat{Y} < 0$

3) $\frac{\lambda_{SX}}{\lambda_{UX}} > \frac{\lambda_{SY}}{\lambda_{UY}} > \frac{\lambda_{SE}}{\lambda_{UE}}$, implying $\hat{X} > 0$, $\hat{Y} < 0$

From these results it can be concluded that the short term effects of an expansion of education on productive activities depend on the factorial intensity of the education sector. These effects can be analysed graphically. In Figure 1 in the initial equilibrium education employs U_E of unskilled labour and S_E of skilled labour; the corner defined by U_E and S_E is the origin for employment in the X sector (measured up and to the right from O_X), while O_Y is the origin for employment in the Y sector. The initial equilibrium for sectors X and Y is defined by the intersection of the rays O_X and O_Y, where the gradients of the rays are given by the skill-intensity in each sector. The expansion of education under these settings shifts the origin for X to O_X* (at constant factor prices) and the new equilibrium for the production sectors shifts to B. The output of the skill intensive sector is reduced and that of the unskilled intensive sector expands.

FIGURE 1



3.2 Rybczynski effects

When endowments change the standard Rybczynski effect indicates a shift in the production possibility frontier biased towards the sector intensive in the factor which grows relatively. To analyse this effect changes in endowments will be isolated from the resource withdrawal effect. Using again (1) and (2) but now when $\hat{G} = 0$ and $\hat{L}_i > 0$[2] changes in endowments affects productive sectors as follows (assuming X is more skill intensive than Y):

1) $\dfrac{\lambda_{SX}}{\lambda_{UY}} > \dfrac{\lambda_{SY}}{\lambda_{UY}} > \dfrac{\hat{L}_S}{\hat{L}_U}$, implying $\hat{X} < 0,\ \hat{Y} > 0$

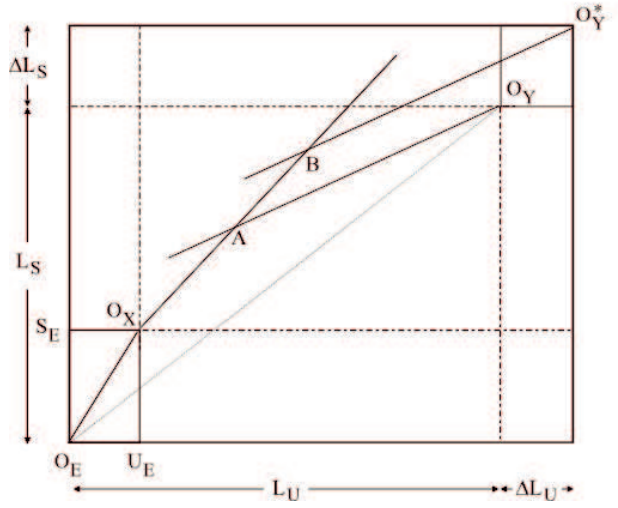
2) $\dfrac{\lambda_{SX}}{\lambda_{UY}} > \dfrac{\hat{L}_S}{\hat{L}_U} > \dfrac{\lambda_{SY}}{\lambda_{UY}}$, implying $\hat{X} > 0,\ \hat{Y} > 0$

3) $\dfrac{\hat{L}_S}{\hat{L}_U} > \dfrac{\lambda_{SX}}{\lambda_{UY}} > \dfrac{\lambda_{SY}}{\lambda_{UY}}$, implying $\hat{X} > 0,\ \hat{Y} < 0$

[2] Endowment growth is the result of education activities only as retirement from the labour force or demographic changes are not included in the analysis.

These Rybczynski results can also be analysed graphically. In Figure 2 the expansion of endowment corresponds to case 3. The initial equilibrium is given by A. The new endowments are added as ΔL_S and ΔL_U to the original box, where $\hat{L}_S / \hat{L}_U$ is higher than the factorial intensity of productive sectors (case 3). The additions to endowments shift the equilibrium to B. In the new equilibrium, the production of the skill intensive sector has expanded and that of the unskilled intensive sector has been reduced.

Figure 2



3.3 Overall effect

In the longer term the overall effect on the economy of an expansion of education activities depends on the balance between resource withdrawal effect and Rybczynski effects. The overall effect can be determined analytically again from (1) and (2), from where the bias in growth is determined as follows:

$$\hat{X} - \hat{Y} = \frac{(1 - \lambda_{UE})(\hat{L}_S - \hat{L}_U) + (\lambda_{UE} - \lambda_{SE})\hat{G}}{|\lambda|}$$

Growth will be biased towards sector Y to the detriment of sector X when the above expression returns a negative value. Sufficient conditions for this to happen are (assuming that sector X is more skill intensive than Y):

$$\lambda_{UE} - \lambda_{SE} < 0 \quad \text{i.e. } \frac{L_S}{L_U} < \frac{L_{SE}}{L_{UE}}$$

and

$$\hat{L}_S - \hat{L}_U < 0 \quad \text{i.e. } \frac{L_S}{L_U} > \frac{L_S^N}{L_U^N}$$

Then, sufficient conditions for the expansion of education to be detrimental of skill-intensive activities are met when: a) education sector is skill intensive (i.e. the relative intensity of skilled labour in education is higher than the skilled to unskilled ratio in the economy); and b) endowment's growth is unskilled biased (i.e. the ratio of skilled to unskilled in the inflow of new units of labour is lower than the skilled to unskilled ratio in the economy).

4: SIMULATIONS

For the simulations the general specifications presented in the previous section are extended to include non-tradable sectors and informal activities. The main features of the extended model are as follows. There are three tradable sectors (A, B and formal C), a non-traded sector informal C and the public sector. Sector A is an unskilled-intensive exporting activity, sector B is a skilled-intensive import-competing activity, and formal sector C is a skilled-intensive activity but with a low proportion of total production being exported. Exporting sectors charge different prices in domestic and foreign markets (product differentiation by destination as in Armington assumption). Public services are skill intensive, and informal activities are the most unskilled intensive.

There are two representative households: one that owns only unskilled labour and one that owns only skilled labour. The returns for the workers depend on their productivity (efficiency units of labour owned) and the relevant market wage per efficiency unit. The households make the choice between working formally or informally. Thus there are four factors in the economy: formally employed skilled and unskilled labour, and skilled and

unskilled labour working informally. The use of capital in economic activities is not explicitly modelled.

Basic education 'produces' both unskilled labour and students qualified to enter higher education, and higher education 'produces' skilled labour. As basic education is required for formal jobs, those who drop out of basic education necessarily go to the informal market. So an individual can enter the informal market either by choice if qualified for formal employment, or by necessity as a dropout does not have the qualifications required for formal work.

The experiments simulate a reduction of taxes on imports (skilled intensive) changes in educational policies. The experiments cover short and longer term: long run covers a sufficiently long period to process the adjustment to an increase in the budget allocated to education, so the final equilibrium show all variables adjusted to their steady state values.

The following scenarios are simulated: Scenario A – trade liberalization consisting in 50 % of reduction in tariffs on imports; scenarios A1, A2 and A3 – trade liberalization plus expansion of education with same-cost alternative policies (for simplification the expansion of the educational budget is financed against other public goods so as the government expenditure remained unchanged-no fiscal instruments are used). The detail of them are: A1 – trade liberalization and 10 % increase in the budget of education; A2 – trade liberalization and an increase in the budget of basic education equivalent (in monetary terms) to a 10 % increase in the overall budget; A3 – trade liberalization and a increase in the budget of higher education equivalent (in monetary terms) to a 10 % increase in the overall budget. From the analysis in the previous section it is expected an initial adverse effect of an expansion of education on some productive sectors (resource withdrawal effect) but a favourable effect on growth in the longer term which may be weaker or stronger depending of the balance between short and long run effects.

i Short term results

Table 1 present the effects on education activities for all the scenarios. Trade liberalization (scenario A), by increasing the purchasing power of the budget, leads to an improvement

of the performance of the education sector, though only slightly. As resources in real terms increase the students 'productivity' improves (less than 1% in both cases), which also causes better progression rates increasing slightly the number of students going to higher education.

The expansion of education has more complex effects. By one hand the output of education is favoured by allocating more monetary units to the activity. By the other hand, being education a skill intensive activity, its expansion raises relatively more the demand of skill labour partially offsetting the effects on returns of trade liberalization. Besides this the different strategies of expansion of education present conflict of interest in terms of school quality provided to different groups of students.

Increasing the budget (scenarios A1, A2 and A3) the performance of the education sector improves but very different across levels according to the allocation of the additional resources. Strategy A1 is the less conflicting as shown in table 1. Increasing proportionally the budget for the whole system (scenario A1) favours an increase in the productivity of both levels (around 8% and 6% in BE and HE respectively) as well the progression between the two levels (1.8%),

The rest of the scenarios (A2 and A3) are conflicting, as would be expected, favouring and increment of the productivity of only one level. In terms of progression between levels, A2 shows the highest increase of students going to higher education of more than 3%, significantly higher than the one produced by scenario A (1.8%). But this improvement in internal progression in scenario A2 cause a reduction of the quality at higher education (-1,3%). For analogous reasons scenario A3 both by allocating all new resources to higher education and also by producing the lowest increase in progression into that level, shows the highest productivity gains for students at HE.

Table 1 Effects on the education sector (percentages)

	A	A1	A2	A3
E_{HE}	0.20	1.80	3.08	0.19
q_{BE}	0.85	8.02	14.27	0.82
q_{HE}	0.64	6.15	-1.30	14.58

Note: E_{HE} students reaching higher education, q_{BE} and q_{HE} students productivity 'produced' by basic and higher education respectively.

The resulting effects on the production of endowments are presented in Table 2. The favourable environment for the production of skills generated by trade liberalization (scenario A) produce a mild change the composition of the output of education towards higher participation of skilled (1.07%) and unskilled (0.42%) labour and away from informal (-0.12%).

The rest of the scenarios reinforce this shift in the composition of the output. Scenarios A1 and A2 produce a clear improvement in the composition of the output with respect to case A, however, the allocation of additional resources to HE only (scenario A3) do produce a higher increase in the production of skills but the production of unskilled labour and the reduction of informality is lower than the case A. Measured by the increase in the value of endowment generated, scenario A3 produce the lowest increase while A2 gives the highest as this strategy has not only direct positive effects on the provision of basic education but also tend to favour the systemic outcome as it provides better inputs (more qualified) and more inputs (more students) to higher education. Accordingly, A2 results the strategy with the highest productivity of educational expenditure (efficiency units of labour produced by monetary unit of additional expenditure).

The strategy of favouring basic education (A2) although being the most cost-efficient it is also the one with generates the biggest inequalities in terms of the service provided, even more than the one favouring only higher education (A3). This is so as no more resources are allocated to higher education while more students reach the level as a consequence of the improvement of the service provided at basic level. But the strategy of favouring only

higher education produces the lowest increases of students reaching the level, even lower than when resources to education are not increased.

Table 2 Production of new endowments (percentages)

	A	A1	A2	A3
Skilled	1.07	10.24	5.54	14.77
Unskilled	0.42	3.91	6.93	0.40
Informal	-0.12	-1.06	-1.83	-0.11
V lab*	0.41	3.85	5.96	1.34

Note: * V lab: value of the output of labour produced by education is computed as the sum of each type of labour by its wage computed at original prices.

ii Long term results

Table 3 shows overall growth effects, where marginal changes in relation to the status quo (i.e. an scenario with no trade liberalization or expansion of education) are presented. The results from experiment A show that liberalization alone is not enough to produce significant growth effects (0.01%), due to the low value of the marginal educational output produced (see table 2). Instead, expansion of education do produce growth effects in spite of resource withdrawal effect, however, different strategies do produce different return in terms of growth.

As strategy A2 has the highest value of the output produced it has the highest potential to increase GDP as can be seen in table 3. The table shows that scenario A2 is the more favourable for growth accounting for a marginal 0.36 percentage points, while strategy A3 has the lowest with only 0.07. Under these simulations growth is linked to the efficiency by which they are produced, as available resources are used to produce new resources. In particular an strategy as A3 promoting the creation of skills, being cost-ineffective, produces poor growth effects as the resource withdrawal effect tends to dominate and might even have a negative effect on growth.

Table 3 Long term effects (percentages- marginal changes)

	A	A1	A2	A3
Y_1	-0.01	0.22	0.42	-0.01
Y_2	0.01	0.20	0.14	0.25
GDP	0.01	0.23	0.36	0.07

Note: Y_1 and Y_2 are real income of unskilled and skilled household (formal and informal) respectively, and GDP is gross domestic product at constant prices.

5: CONCLUSIONS

Being education a skill intensive activity the theoretical results trade liberalization would benefit developing countries long term growth. However, the simulations show that in a country like Uruguay where the bulk of education is publicly provided (free access at all levels) trade liberalization is unlikely to produce significant growth gains by facilitating the production of new skills. Thus growth convergence due to trade liberalization should not be expected in a developing country like Uruguay. Educational policies, however, in spite of short term costs are likely to produce significant growth gains, albeit with varied efficacy.

The model links endowment's growth to GDP, where endowment growth is measured by its capacity in produce GDP, i.e. physical units times its productivity which depends on the quality of the educational system. The effects of education on growth also depend on the relative use/production of factors by the system. For same-cost alternative policies the simulations find that growth effects are higher for those that reduce the internal inefficiency of the educational sector so improving the productivity of the public expenditure. Enhancing basic education improves systemic performance where more and better qualified students reach further stages, thus indirectly also promoting the production of skills at higher education; enhancing basic education also means that early dropouts are reduced thus weakening the road to informal jobs of poor productivity.

Thus the simulations suggest that there is a link between cost-effectiveness of educational policies and growth, and not between enrolments and growth (which is constant at entry

level for all the simulations) neither between public expenditure in education and growth (which in is the same across the experiments) which are the usual proxies of educational level in the growth regressions found in the literature. Accordingly, it seems that putting a high proportion of the expenditure in education in higher education in Latin America when there are inefficiencies still plaguing basic education, has not been an efficient way to promote growth, which may explain development differences with South East Asia for instance. Furthermore the strategy of allocating too many resources to higher education, by failing to address more acute needs at basic level with a limited budget, could be seen as favouring informal activities, which have flourished in Latin America in the last decade and a half.

The simulations show that expanding the provision of public education does produce growth effects; however, these are not dramatic. Similarly, Temple (2000) reviewing empirical research on education and growth has pointed out: "although increases in educational provision can yield a worthwhile increase in the growth rate, one should not necessarily expect an effect that is large relative to current rates of growth. For policy-makers who wish to raise the growth rate, policy on education remains a natural place to look, but it is by no means a panacea". In the case of Uruguay projections reported by the World Bank (World Bank 2005) show that that education could contribute 0.5 percentage points to growth. However, the cost-effectiveness of alternative educational policies should be taken into consideration by policymakers to avoid disappointment.

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ANNEXE

The appendix presents the main parameters used in the simulations, some are assumed and some are calibrated to a stylised Social Accounting Matrix (SAM) containing stylised features of the Uruguayan economy, consisting of four sectors (exporting, import competing, services –formal and informal- and public sector) and four factors (skilled and unskilled labour, formal or informal). The public sector is desaggregated in education and other services.

A.1 HOUSEHOLDS

The values of the parameters of the CES function for both households (1 and 2) representing the labour-leisure choice are presented in table A.1. The elasticity of substitution (σ) and the share of consumption (α) are given: lower values of the elasticity of substitution and higher values of the share of consumption to low wage earners.

Table A.1 Labour-leisure choice parameters

	σ	α
H1	0.50	0.99
H2	3.00	0.67

The values of the parameters of the CES function representing the option between consumption goods (A, B and C) are in table A.2. The elasticity of substitution (σ) is assumed to be equal across households. The share parameters for each good (δ) are given: higher wage earners (skilled) with lower share of the exportable good and higher share of services.

Table A.2 Consumption parameters

	σ	δ_A	δ_B	δ_C
H1	2.00	0.31	0.22	0.47
H2	2.00	0.22	0.24	0.54

The parameters of the CES function for the option between supplying labour to formal or informal markets are in table A.3. The elasticity of substitution (ξ) is assumed to be higher for unskilled workers. The rest of the parameters are calibrated.

Table A.3 Formal-informal labour choice parameters

	ξ	β_F	β_I
H1	4.00	0.46	0.54
H2	0.50	0.01	0.99

The parameters of the CES function that contains the option between consumption of goods from formal and informal markers is in table A.4. The share parameters (β) are calibrated and the elasticity of substitution (σ) is assumed to be higher for unskilled workers.

Table A.4 Formal-informal services consumption choice parameters

	σ	β_F	β_I
H1	2.00	0.66	0.34
H2	0.50	0.95	0.05

The parameters of the CES function representing the option between consumption of domestically produced or imported goods (the Armington assumption) are in table A.5. The share parameters (β) are assumed, giving higher share of imported goods to high wage earners (skilled). The elasticity of substitution (σ) is assumed to be equal across households.

Table A.5 Imported-domestic good consumption choice parameters

	σ	β_D	β_M
H1	4.00	0.60	0.40
H2	4.00	0.52	0.48

A.2 PRODUCERS

Producers in sectors A and formal C produce for domestic and foreign consumption. The parameters of the CET function for both producers representing the choice between domestic and foreign markers (Armington assumption) are in table A.6. The elasticity of substitution (σ) is assumed and the share parameters (α) are calibrated. The value of the elasticity of substitution is assumed to be low for producers in C.

Table A.6 Domestic-export option for producers

	σ	α_1	α_2
Sector A	-4.00	0.41	0.59
Sector C	-0.50	0.01	0.99

Table A.7 shows the parameters for all the activities in the private and public sector (excluding education). All production functions are Cobb-Douglas, and the parameters α (share of skilled labour in revenue) and A (scale parameter) are calibrated.

Table A.7 Parameters of Cobb-Douglas production functions

	α	A
Sector A	0.10	1.27
Sector B	0.28	1.76
Sector C Formal	0.32	1.85
Sector C Informal	0.08	0.93
Sector G	0.40	1.98

A.3 EDUCATION

The educational system is split in two subsystems: basic and higher education. Each subsystem comprises two levels: basic education comprises primary and lower secondary, higher education comprises higher secondary and university, in both cases this bottom level of disaggregation is identified with the numbers 1 and 2.

Each subsystem has a value added production function consisting in skill and unskilled labour, and the amount of resources allocated to each one will be subject to policy changes. The table A.8 shows the calibrated parameters, α (share of skilled labour in revenue) and A (scale parameter), to the value added in each subsystem, which are Cobb-Douglas functions.

Table A.8 Parameters of the valued added to education

	α	A
BE	0.72	2.00
HE	0.67	2.05

The number of students and value added allocated to each level determine the student's 'productivity' for given parameters. This productivity is accumulated through years of schooling, values for each level are presented in Table A.9. Productivity values across levels are not comparable as it is not agreed in the literature which level generates bigger shares of the total knowledge (or highest return), but for the purpose of the experiments the accumulated productivity is what matters.

Table A.9 Students productivity

	Q
BE	0.96
HE	1.73

Dropout (θ)and repetition (γ) rates in the education sector are presented in table A.10. For dropouts basic education complete (BE_C) are incomplete (BE_I) are separated, at higher education all exits are assumed to be complete. The values of the rates are average of each level, and the values for university are assumed as they are not available.

Table A.10 Dropout rates, values and parameters.

	γ	θ
BE_I		17,74
BE_C	13.64	41,07
HE	42.28	

Repetition rates assume the following functional form

$$\gamma_j = b_j q_j^{-\rho_{ijk}} \qquad 0 < \rho_j < 1 \quad , \quad b_j > 0$$

where b_j and ρ_j are level specific scalars.

Similarly, the dropout rates take the form:

$$\theta_j = a_j q_j^{-\delta_{ijk}} \quad 0 < \delta_j < 1 \quad , \quad a_j > 0$$

where a_j and δ_j are level specific scalars.

The value of the parameters of dropout and repetition rates are presented in table 11. The values of δ and ρ are given assuming that the responsiveness to resources is higher for repetition rates, the rest of the parameters are calibrated.

Table A.11 Dropout and repetition rates parameters

	a	δ	b	ρ
BEI	0.16	0.1	0.08	0.5
BEC	0.37	0.1	0.08	0.5
HE			0.37	0.5