



Departamento de Economía
Facultad de Ciencias Sociales
Universidad de la República

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Endogenous Skill Formation in Developing Countries

Rossana Patrón

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ENDOGENOUS SKILL FORMATION IN DEVELOPING COUNTRIES

Rossana Patrón
dECON, Universidad de la República
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Resumen

El documento presenta un marco flexible para analizar la provisión de servicios educativos y políticas públicas de educación, vinculando el impacto de los aspectos cuantitativos, cualitativos y de equidad sobre el mercado de trabajo y el sector externo. El diseño del modelo tiene en cuenta aspectos típicos en países en desarrollo que requieren distanciarse de la estructura estándar en modelos de comercio, y en particular incluye la presencia de actividades informales caracterizadas por baja nivel de calificación de la mano de obra. Los ejercicios de simulación permiten sugerir que políticas de educación más sofisticadas (“objetivos múltiples”) pueden incrementar la eficiencia del gasto en educación en términos de la cantidad-calidad de los resultados (calificación de nueva fuerza de trabajo). La capacidad de la educación y las políticas educativas de producir efectos de equilibrio general en la asignación, distribución y crecimiento es investigada en los ejercicios de simulación.

Palabras clave: educación pública, políticas educativas, países en desarrollo
Clasificación JEL: I, F

Abstract

The paper provides a flexible framework to deal with educational provision and public policies in developing countries, linking the impact of quality-quantity-equity of educational policies on labour markets and the external sector. The model includes typical aspects of developing countries that require some further deviations from the structure of a 'standard' single country model as the inclusion of informal activities, which are usually dominated by the poorest qualified workers. Simulation exercises allows us to argue that more sophisticated educational policies ("multiple targets") may increase the efficiency of the government expenditure in education in terms of the quantity-quality of the output (skills) delivered to the labour market. The potential of education and educational policies to produce allocative, growth and distributive effects is also shown in the simulation exercises.

Keywords: public education, educational policies, developing countries
JEL classification: I, F

1: INTRODUCTION

The characteristics of Uruguay, less skill abundant than developed countries and less unskilled abundant than, in particular, some Asian countries, leave the country in a particular situation. The skill level in Uruguay is still however relatively low, with only 14% of the active population with tertiary education -complete or incomplete- (INE, 2002) which is high in comparison to other Latin American countries but it is well below the values observed in developed countries (e.g. United States 33%, Germany 23%, United Kingdom 21%, data from OECD taken from Barro and Lee, 2001).

However, the wage gap increased during the nineties as wages for unskilled workers declined relative to those of highly skilled workers (Bucheli, 2000, Vaillant and Casacuberta, 2002). This phenomenon, widely observed in industrialised countries, occurs both in Uruguay in many of the other Latin American countries (Sanchez and Schady, 2003). Indeed, as suggested by Casacuberta and Vaillant (2002) and PNUD (2001) for the Uruguayan case, an explanation of rising wage inequality based only on changes in relative labour supply, while suitable for previous decades, is no longer sufficient in the context of a deep liberalisation process in the region during the nineties.

In the case of Uruguay, where exports use mainly unskilled labour and import-competing activities and services are more skill-intensive, trade liberalisation adjustment had complex effects on the demand for different types of workers. Due to openness, import-competing activities were damaged, while most traditional export activities grew moderately and the output of services grew vigorously during the nineties. As reported by

Casacuberta and Vaillant (2002) the effect of this adjustment on employment was that unskilled jobs were lost and, in spite of a low rate of growth in employment, medium and high skill jobs were created. Besides this, skills groups are differently characterised by unemployment and informality rates. Unemployment rate is a decreasing function of workers' qualifications and the informal labour market participation rate is higher in activities that require lower qualifications: during the 1990s the unemployment rate remained constant for university graduates, but rose by about 3% for those with lower qualifications and so increase informal working among the unskilled (Bucheli, 1998, 2000).

Human capital accumulation has been increasing over time in Uruguay. Human capital in the labour force, measured by years of schooling, grew at a cumulative rate of 1.6% per annum during the period 1988-1995 (Torello and Casacuberta, 1997), a phenomenon which was mainly driven by the fact that younger generations of workers bring with them higher qualifications. Participation in education (coverage) of the school age population (5-16 years old) has increased, but dropouts at secondary education remain at high levels. However, Birdsall et al (1998) shows that even when the levels of expenditure in Latin American countries are not low compared with other developing countries, the results are poorer. In particular these authors report that average schooling attainment is two years of what would be expected from the level of per capita income, while the gap between the region and East and South East Asia has risen from one to four years from 1970 to 1995.

The observed trends in employment and skill endowments suggest that the education system and education policies have a crucial role to play. However, it has been widely observed that the educational systems in developing countries present internal as well as

external inefficiency problems. On the one hand, the presence of high repetition rates increases the cost of producing skills. On the other hand, the presence of early dropouts lowers the qualification of the average individual joining the labour force relative to what is actually being demanded in the labour market.

Increasing the efficiency of the education system means that enrolments will be maintained throughout the system (lower dropouts) and delays due to repetition will be lowered. Trends in the stock of unskilled labour are inversely related to primary and secondary enrolments (see for instance Arndt, 2003), so enhanced internal efficiency implies that the growth of skilled relative to unskilled labour is increasing. This also implies enhanced external efficiency, as workers provided by the education system are more likely to meet the requirements of the labour market where the demand of skills is rising.

However, the formulation of suitable educational policies for developing countries is not straightforward. For instance McMahon (1997) and Green et al. (1999) suggest from the experience of South Asian countries that focusing on basic rather higher education is a more effective strategy to promote skill growth, contrasting with the experience of other developing countries that subsidise higher education at early stages of development.

This paper applies a model that deal with educational provision in developing countries, linking the quality, quantity and equity of educational policies to their impact on labour markets and the external sector. It follows the approach of trade models with endogenous skill formation, but introduces explicit links between trade and educational policies. A CGE application of the model to Uruguay is carried out, focusing on certain aspects of the

country's economy that require some deviation from the structure of the 'standard' single country model. The model explains the rise of the skill premium depending on trade *and* on the local conditions determined by the country's pattern of endowment growth. The role of education to produce allocative, growth and distributive effects is also assessed in the simulation exercises.

The rest of the paper is organised as follows. Section 2 introduces the main features of the model. Section 3 describes the qualitative properties of the model. Section 4 describes the simulation exercises performed and discusses the results. Section 5 concludes. The Annexe lists the parameter values.

2: MODEL DESCRIPTION

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 (which reflects the efficiency units of labour owned) and the relevant market wage per efficiency unit. Both households make a consumption-leisure choice, so that the supply of both types of labour is endogenous. The households also make the choice between working formally or informally. So, there are four factors in the economy: formally employed skilled and unskilled labour, and skilled and unskilled labour working informally. The participation of capital in economic activities is not explicitly modelled.

Households allocate their post-tax income between consumption goods. Each household consumes all three goods, A, B and C. Good B can be domestically produced or imported, good C is produced by both formal and the informal activity, and in both cases goods are imperfect substitutes for the household. The public good corresponding to public services

enters into the individual's utility function. Households do not allocate time to learning as schooling is taken as given. The supply side of the education sector is explicitly modelled whereas the demand side is made implicit by the assumption that students (who are not yet households) exit the system when the quality of education they receive is poor, i.e. dropouts are a decreasing function of educational quality.

There are three tradable sectors (A, B and formal C), a non-traded informal sector 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 export orientation out of total production. The economy is price taker in international markets, and exporting sectors charge different prices in domestic and foreign markets (Armington assumption). Public services are skill intensive, and informal activities are the most unskilled intensive in the economy. All production functions are subject to constant returns to scale. There are competitive markets for goods and factors.

Education activities are publicly provided. Basic education "produces" unskilled workers and students qualified to enter higher education, and higher education "produces" skilled workers from qualified student inputs. The output of education activities as a grade-level-type¹ specific flow variable, assuming a Cobb Douglas functional form is:

¹ A level is each p-art of the system (primary, secondary, etc.) and a grade is a year in that level, while type refers to individual characteristics (advantaged or disadvantaged)

$$Q_{ijk} = A_{ijk} K_{ijk}^{\alpha_{ijk}} E_{ijk}^{1-\alpha_{ijk}}$$

where K_{ijk} are resources and E_{ijk} is enrolment, while A_{ijk} and α_{ijk} are parameters that regulate the level and responsiveness to resources applied (sub-index i represents the grade, j the level, and k the student's group).

Q_{ijk} represents the amount of knowledge provided by the service, which is not necessarily transmitted to students, while q_{ijk} is the amount of knowledge embodied by successful students, which adds to his/her human capital. The variable q_{ijk} also measures “school quality”, given by:

$$q_{ijk} = A_{ijk} \left(\frac{K_{ijk}}{E_{ijk}} \right)^{\alpha_{ijk}}$$

This expression shows that the addition of human capital is grade-level-type specific. In particular it shows that students' characteristics affect the addition that education production makes to their human capital. For instance, individuals from poor socio-economic background (disadvantaged type) may require materials or additional support, so a given level of educational resources produces lower skills in individuals of the disadvantaged group (i.e. the group has a low value of the parameter A). But as suggested by the results presented by Sautu (1999) the provision of education may compensate the negative effects of poverty, or more generally a disadvantaged condition, so this group has a higher responsiveness to increased resources (i.e. a high value of the parameter α).

Previous attainment enables future success (or as Heckman and Masterov (2004) put it, skills begets skills), so students' attainment is the determinant of their success in the system. As such, students' attainment, which reflects school quality, is taken as the determinant of repetition and dropouts. A generic expression for dropouts and repetition rates takes the following form:

$$\gamma_{ijk} = \gamma_{ijk}(q_{ijk}) \quad \text{where} \quad \frac{\partial \gamma_{ijk}}{\partial q_{ijk}} < 0$$

So, poor school quality leads to students' poor performance. In time this leads to inefficiencies in the expenditure of education, measured both by the number of successful students and the skills (qualifications as measured by the indicator q) embodied by them. In other words, as a consequence of inefficiencies not all the educational output results in the accumulation of human capital.

Those who complete only basic education enter the market as unskilled labour, while those who complete higher education enter the labour market as skilled workers. Both groups carry with them the amount of knowledge acquired throughout the education process, which will then determine their productivity when working. Early dropouts tend to lower the average qualifications of entrants to the labour market, while high repetition rates make each entrant very costly.

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.

3: THE WORKING FRAMEWORK

3.1: The general framework

In the standard Heckscher-Ohlin (HO) model, growth in a small open economy's endowments has no effect on prices and factors returns and also, in this framework changes in international prices are fully transmitted to domestic prices. But the model presented in the previous section distances itself from the HO paradigm by introducing product differentiation by country of origin (the Armington assumption) and the presence of informal labour that is imperfect substitute of formal labour in non-traded activities. As a result, changes in local conditions, i.e. in the domestic supply and demand of skills, also affects product and factor prices. Moreover, the introduction of the labour-leisure option for households implies that the supply of factors is also affected by taxation and product and factor prices.

The standard theoretical HO results indicate that trade with industrial countries lowers the incentives to accumulate human capital in developing economies, as they lower the return of the relatively scarce factor. But in this model educational policies also have role in determining the outcome of the accumulation process by altering quantity, quality and composition of the public supply of educational services.

So, in this model as the “production” of new factors is endogenous it is unlikely that endowments of both factors will increase in the same proportion, so growth is unlikely to be balanced. Then the standard Rybczynski effect applies, with a shift in the production possibility frontier biased towards the sector intensive in the factor which grows relatively. Though human capital accumulation depends on the production of education, the

economy's effective supply of skills depends on individual's decisions on allocation of time, which varies with relative prices.

Consequently, in this model educational policies, by determining the production of skills, affect the country's pattern of trade and also have distributional effects. On the one hand, the composition of the inflow of new workers determines growth and consequently trade patterns. On the other hand, the output of the education sector alters the relative supply of skills affecting also relative wages. In a context where both local and international conditions determine relative wages a (relatively) greater supply of skilled labour may drive the wages of that labour down, reducing the wage gap and favouring the substitution of unskilled for skill labour.

Besides, in this model educational policies may alter the formal to informal ratio in the labour force. This is, education may reduce "natural" informal employment by reducing the number of unqualified individuals that arrive in the labour market with no choice but to work informally; it may however increase "preferred" informality due to increased returns in to informal labour when "natural" informality is reduced.

3.2: Specific issues on education

In this model the efficiency of educational expenditure depends on the allocation of resources across grades, levels, and students' group. However there is no straightforward policy option as the allocation of resources according to different criteria implies a compromise between quantity, quality and the composition of students being educated.

First of all, an issue frequently identified in the literature is whether the government's priority should be basic or higher education. This is an important issue in developing countries, where several weaknesses can be found in basic education that undermines the overall performance of the system and beyond (labour markets, society, etc.). So in this model the government allocate resources between levels recognising that the number of students at the higher level depends on completion rates at the lower level.

Secondly, the presence of student heterogeneity may impose a efficiency-equity dilemma on policymakers. Applying relatively more resources to the disadvantaged group leads to obtaining similar results across groups; however, this comes at the cost of sacrificing a better quality of education for the advantaged group. On the one hand, the efficiency in the production of knowledge is diminished when resources are diverted from those that assimilate it faster. On the other hand, efficiency is also diminished when resources are wasted by applying such insufficient amounts to some students (the disadvantaged) that they are unable to learn (they have to repeat), making the return to those resources equal to zero. On this point Birdsall et al. (1998) argue that universal access to primary education in Latin America has become a "false entitlement" for the poor as the education they receive is of such a poor quality that it gives little real benefit. Thus, in this model the educational authorities may choose between offering equal access to education or offering "equivalent learning opportunities" to individuals.

Finally, allocation of resources across grades may be an important issue when, as is often the case, some grades present a particularly difficult situation. For instance, in Latin American countries the first year of primary school has high rates of repetition (above 50% in some cases). In the case of Uruguay the first year of primary and the first years of

high school and of University have serious problems of repetition and dropout. So, in this model the education authorities may consider allocating the budget among grades favouring the first grade in order to maximise the number of people completing the level.

3.3: Pattern of endowment growth

The composition of the inflow of new labour units into the market is determined by the composition of the output of education activities. This flow in Uruguay (and typically in developing economies) is heavily dominated by unskilled labour, followed by informal unskilled labour, and this produces an unbalance growth of endowments.

These changes in factor supplies lead to a relative decline in the return to unskilled labour, both formal and informal. As unskilled labour is used intensively in the production of goods A and informal C, the decline in the return of unskilled labour leads to a relative decrease in the unit production cost of these goods thus favouring an increase in consumption. So the inflow causes growth biased towards exportables as well as informal non-tradables, both intensive in unskilled labour.

Increases in endowments biased towards unskilled labour widen the wage gap between skilled and unskilled workers, so that the income distribution is worsened by this pattern of growth. Thus education activities do produce distributional effects among wage earners but they do not produce *per se* a reduction in income inequality.

4: SIMULATIONS AND RESULTS

In this section I analyse the general equilibrium effects of education activities in a model with the characteristics presented in the previous sections. To this purpose stylised facts

from the Uruguayan economy are used as a benchmark. I discuss the links between trade, educational policies and fiscal policy by means of simulation exercises.

4.1: Trade and education

The links between trade and education go in both directions. To analyse the repercussions of this dual relationship I consider a scenario where the relative price of skill intensive goods rises in a context of openness, which reproduces the situation of the Uruguayan economy during the nineties.

In the simulation exercise then, the tariff on imported B is reduced while the international relative price of good C increases. Being these sectors skill intensive (in relation to exporting activities) these two shocks tend to produce opposite effects on factor demands, and the net effect depends on their relative strengths. For this reason firstly I show two possible alternatives to represent the situation of Uruguay during the nineties.

Table 1 shows the results for 'liberalisation' and 'globalisation', depending on whether the effects from the liberalisation process were more or less dominant than the relative rise in international prices of skill intensive goods (first column and second column of table 1, respectively).

In table 1 the first column reproduces quite close the effects of trade in the Uruguayan economy during the deep liberalisation process. This is, exporting activities and services were favoured, imports rose and import competing activities were reduced. But, with no changes in factor endowments this trade pattern leads to a decline in the skill premium and

to a decline in informal activities contrary to the observed facts. I shall further investigate this case.

Table 1 Openness scenarios

	liberalisation	globalisation
X _A	1.21	-1.24
X _B	-1.86	-0.64
EX _A	5.20	-4.12
EX _C	1.12	2.82
IM	15.29	4.12
X _{CF}	0.13	0.69
X _{CI}	-0.25	0.04
w _U	-0.82	0.64
w _{UI}	-0.90	0.65
w _S	-1.21	0.98
w _{SI}	-1.20	0.73

Notation: X denotes production, EX exports, IM imports and w wages. A, B, C are the productive sectors; U, S are unskilled and skill, and F, I are formal and informal.

Table 2 shows the effects on factor return and supply under this scenario comparing when there is no changes in endowments (first column) and when endowments change (dominated by unskilled labour, second column, dominated by skilled labour third column, dominated by informal workers, fourth column). Table 2 shows that an increase in endowments biased towards unskilled labour tend to increase the wage gap across types of labour, both formal and informal, while an increase in skills tend to reduce it. From where it can be seen that an increase in the wage gap observed in Uruguay is not consistent with neither no (or balanced) growth of endowments (as in table 2, first column) nor with endowment's growth dominated by skilled workers (as in table 2, third column). Indeed, it

is consistent with a pattern of endowments' growth dominated by unskilled workers (table 2, second column), as it is the case in Uruguay.

Table 2 Openness and endowment's growth-Effects on returns

	openness	growth unskilled	growth skilled	growth informal
L _{UF1}	0.04	1.04	0.04	0.55
L _{UI1}	-0.27	0.80	-0.31	-3.04
w _U	-0.82	-0.82	-0.70	-0.82
w _{UI}	-0.90	-0.88	-0.79	-1.72
L _{SF2}	0.02	0.14	0.91	0.09
L _{SI2}	0.03	0.17	0.88	0.28
w _S	-1.21	-0.31	-1.89	-0.76
w _{SI}	-1.20	-0.26	-1.95	-0.39

Notation: 1, 2 denotes households, L denotes labour supply and w wages. U, S are unskilled and skilled and F, I are formal and informal.

Table 3 also shows the allocative effects of the trade shock together with the different patterns of endowment growth. The simulation shows that growth biased towards unskilled workers reinforces the effects of trade liberalisation on traded activities and services but it generates additional stimulus to informal activities. This result, which is explained by the higher propensity of unskilled workers to go informal, is also consistent with the observed facts in Uruguayan economy.

Table 3 Openness and endowment's growth-Effects on sectors

	openness	growth unskilled	growth skilled	growth informal
X _A	1.21	2.11	1.09	1.64
X _B	-1.86	-1.24	-1.56	-1.58
X _{CF}	0.13	0.75	0.49	0.47
X _{CI}	-0.25	0.75	-0.22	1.52

Notation: X denotes production, A, B, C are the productive sectors F, I are formal and informal.

Finally, trade shocks also affect education activities. When the educational budget remains fixed, as is likely if there is inertia in public budgets, a rise in the wage gap affects negatively education activities as the sector is skill intensive. Thus a similar result than that predicted by the HO framework for developing economies, i.e. that trade with more developed economies affects negatively the accumulation of skills due to a reduction in the incentives to invest in education, is observed but in this case explained by rigidities in the public budget for education activities.

4.2: Expansion of education activities

Expanding the funds allocated to education activities enables an increase the resources applied per pupil, thus improving education quality. As students' performance is positively associated with education quality, the expansion of the budget brings about an improvement in the internal efficiency of the education system. However, as efficiency is enhanced more students reach further stages in the system, but as more students reach further studies the falling resource intensity per student tends to counteract the rise in the budget, thus the quality at those levels may rise or fall.

To analyse the effects on the labour market an expansion of 10% in the educational budget is simulated. The results are presented in table 4. The table shows that, as early dropouts are reduced, the composition of the inflow of new workers into the labour market changes towards a higher participation of skilled workers, even when the internal allocation of the budget is not modified.

Table 4 Changes in the composition of inflow of labour (percentages*)

	workers	efficiency units
skilled	2.20	3.93
unskilled	1.74	6.29
informal	-5.14	2.39

* percentages are computed on the values obtained in the scenario of no change in the size of the budget

But the benefits of an increase in education provision are not equally spread across the different type of workers as the productivity of new unskilled worker is increased but the productivity of new skilled workers shrinks, which explains the differences between the columns of table 4.

A measure of the return of the expenditure in educational activities may be given by the elasticity of the production of skills for changes in the budget of education, which is presented in table 5.

Table 5 Elasticity to educational expenditure

	workers	efficiency units
Elast skilled	0.22	0.39
Elast unskilled	0.17	0.63
Elast informal	-0.51	0.24

The elasticities presented in the table show low values in all three cases due to combined effects. For formal and informal unskilled labour the low values of the elasticities are explained by the improved internal efficiency in education that retains more students inside the system. In the case of higher education, as more students reach that level so the more the performance of the subsystem deteriorates and productivity is reduced. This low responsiveness to the expansion of the budget is consistent with observed characteristics of public investment in education in other Latin American countries, and may discourage further investment. However, the efficiency of the production of skills may be improved by specifically targeted educational policies, which is discussed below.

This pattern of endowment growth, as discussed before, acts towards reducing the wage gap. From table 4 we also have that the expansion of education activities not only tends to close the wage gap but also to reduce the ratio of unskilled (formal and informal) to skilled workers.

So the simulation exercise suggests that a policy that allocates more resources to education allows that activity both to improve its internal efficiency and to make a contribution towards meeting the requirements of the labour market, while also reducing inequality. Further to this, since the composition of the output of education (measured by the ratio of skilled/unskilled labour produced) also depends on the intra-sectoral allocation of educational budget, education policy can be targeted more specifically, which is discussed next.

4.3: Targeting education budget

How the budget is allocated within the education sector affects the composition of the output of education (the ratio of skilled/unskilled labour produced). The simulation exercise consists of an expansion in the education sector when the internal allocation of the budget is modified by placing different weights across grades, levels or types.

The results are presented in Table 9, which shows the characteristics of the “production workers”. The scenario where there are no changes in the internal allocation (first column, also the first column in table 7) is compared with other policies: a 10% increase in the share of basic education in the budget against the share of higher education (second column), a 10% increase in the share of resources allocated to teach disadvantaged students against the share of the advantaged ones (third column), a 10% increase in the share of resources destined to the first year against the share of rest of the years (fourth column). Various combinations of these policies are shown in the remaining columns.

As was discussed before, the expansion of education produces a shift in the composition of output towards the production of skilled workers and a reduction in that of informal workers, which is shown again in table 6. The table also shows that increasing the share both of basic education and of the disadvantaged group in the total budget improves the return of the educational expenditure measured in marketable output or, more precisely, formal workers. However, the increment of the share of the resources applied to the first year is not significantly better, mainly explained by the fact that a rise in resources allocated to the first year at a cost of resources applied to second year only causes a

postponement of repetition and dropouts to the second year, which does not help much in improving overall efficiency.

Table 6 Composition of inflow of workers-Different policies

	no intra change	B	D	1 st	B+D	B+1 st	B+D+1 st
skilled	2.20	3.04	4.33	2.20	5.16	3.04	5.17
unskilled	1.74	2.10	3.03	1.75	3.38	2.11	3.39
informal (u)	-5.14	-6.22	-9.07	-4.46	-10.13	-5.54	-9.46

In the B+D simulation the production of skilled and unskilled workers increases in comparison with the case when no changes in the internal allocation is made explained by the reduction in early dropouts and repetition rates in the most sensitive groups. Although the magnitude of the change depends on the elasticities assumed the direction of the change remains when it is assumed that basic educational and the disadvantaged group are more sensitive to increased resources (i.e. the elasticity is higher).

Both the number of workers produced by the education system and the qualification (productivity) they obtain from the system are important. Table 7 shows the effects on productivity in the same cases considered in Table 6. The increase in productivity due to increments in the overall budget is unequally spread as some group and levels are more sensitive to the amount of resources used, and, as shown by Table 7 (first column), productivity tends to increase more in basic education and for the disadvantaged group. A policy targeting both basic education and disadvantaged students (B+D) reinforces the effects, enhancing the productivity of these groups at the cost of the rest, but still produces positive effects on the aggregate productivity of all groups.

Table 7 Effects on productivity – Different policies

	no intra change	B	D	1 st	B+D	B+1 st	B+D+ 1 st
Q _{BF1}	0.99	1.20	-0.10	1.38	0.11	1.60	0.50
Q _{BF2}	1.02	1.24	-0.10	0.55	0.12	0.77	-0.35
Q _{BD1}	9.34	11.46	17.38	10.65	19.67	12.80	21.16
Q _{BD2}	7.77	9.52	14.40	5.95	16.29	7.65	14.25
Q _{H1}	0.77	0.40	0.67	1.23	0.30	0.87	0.76
Q _{H2}	0.58	0.31	0.50	-0.03	0.23	-0.30	-0.38

Notation: B, H denotes basic and higher education, F, D favourable or desfavourable group, and 1, 2 indicates first or second level in basic or higher education.

The combination of the production of workers and productivity gives a complete idea of quality-quantity of the output of the education sector. The elasticity of the production of skills to the expansion of the budget is presented in table 8. When the budget is increased the elasticity of the production of unskilled labour is higher due to enhancements in quantity and quality, and the elasticity of the production of skilled labour is lower due to weak increase in productivity. Table 8 shows that targeting the budget may also increase the production of units of labour of all types, being an exception the case when the first year only (1st) is targeted.

Table 8 Elasticity of production of labour – Different policies

	no intra change	B	D	1 st	B+D	B+1 st	B+D+ 1 st
Elast skilled	0.39	0.44	0.55	0.36	0.61	0.40	0.57
Elast unskilled	0.63	0.77	1.06	0.66	1.21	0.81	1.25
Elast informal	0.24	0.29	0.39	0.35	0.44	0.40	0.56

4.4: Expansion of education activities and fiscal policy

The overall results of the expansion of education activities depend on how the government finances that expansion. As indirect and income taxes affect the consumption-leisure choice by changing relative prices, changes in tax rates will affect the labour supply. Thus there is a possibility that a change in tax rates to finance an increase in the educational budget may undermine the benefits from higher production of endowments by causing a fall in factor supplies.

Table 9 shows the effects of expanding education under three different funding scenarios. The first column corresponds to the case when the additional budget is financed at expense of the other activities in the public sector. The second column shows the case when the increased budget is financed by higher income taxes on skilled workers, the third column when it is financed by higher income taxes on unskilled workers and the last one when it is financed by increased rates of indirect tax.

Income taxes affect both the total labour supply and the household's choice between formal and informal activities. As was shown above, an increase in the educational budget causes a shift in the composition of educational output towards skilled labour and against informal labour, but if the expansion of education is financed by income taxes the stimulus to move from formal to informal work rises. Alternatively, indirect taxes generate a substitution towards informal goods intensive in unskilled labour, thus also raising the demand for unskilled informal labour and thus its wage. In this case the prevailing wage will also depend on the labour supply effects caused by this change in relative wages.

Thus both types of taxes tend to lead to an increase in informal sector activity, which has a negative effect on tax revenue, and also tend to modify the relative supply of skilled and unskilled labour, which may partially offset the effects of the expansion in education activities. Since changes in tax rates affect the relative supply of factors, they also have allocative effects in the production sectors. The simulation suggests the possibility of a “bad tax reform”, where the intentions of reformers are not met by the results. Here a “common sense rule” seems to apply: the government should change tax rates in order to fund the expansion of education only if the expansion of endowments more than compensates the distortionary effects of taxation on factor supplies, i.e. the effects of changes in relative prices on factor supply do not offset the expansion of endowments.

Table 9: Education and fiscal policy – Different policies

	no tax change	tax skilled	tax unskilled	indirect tax
L _{UF1}	4.94	4.96	4.88	4.83
L _{UI1}	1.71	1.67	2.10	2.38
w _U	0.21	0.18	0.13	-0.15
w _{UI}	-0.57	-0.61	-1.07	-1.26
L _{SF2}	1.57	1.49	1.60	1.53
L _{SI2}	1.79	1.85	1.75	1.77
w _S	3.85	3.97	3.89	3.77
w _{SI}	4.30	4.16	4.21	4.25

Notation: 1,2 denotes households, L denotes labour supply and w wages. U, S are unskilled and skilled and F, I are formal and informal.

5: CONCLUSIONS

The simulations show the potential for education reform to produce economy wide effects. In particular, they show that the typical pattern of endowment growth dominated by

unskilled and informal workers tends to widen the wage gap between skilled and unskilled workers. This pattern of endowment growth tends to favour exporting and informal activities, both intensive in unskilled labour. The simulations show that the effects of trade and trade policy on the economy are modified by the pattern of endowment growth, which may help to explain the rise in the skill premium in Uruguay.

The simulations also show that the expansion of education activities leads to a change in the composition of the educational output towards a higher participation of skilled workers, due to improved internal efficiency. An important feature of the model is that the composition of the output of education (measured by the ratio of skilled to unskilled labour produced) is dependent on the intra-sectoral allocation of the educational budget. The simulation results allow us to argue that more sophisticated educational policies may increase the efficiency of the expenditure on education in terms of the quantity-quality of the output (skills) delivered to the labour market. However, there may be conflicts between targeting internal efficiency and productivity, as not all groups benefit equally.

Besides, how the government finances the educational budget may undermines the benefits from education when labour supply is elastic. As changes in taxation affect factor supplies they may reduce some of the benefits expected from the expansion in the educational activities. The simulation results also imply that as the skill/unskilled labour wage gap widens, if there is inertia in the educational budgets then there is a reduction in the output of education, reinforcing even further the inequality between income groups.

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ANNEXE :PARAMETERS

The parameters are calibrated to a stylised Social Accounting Matrix (SAM) containing main features of the Uruguayan economy. It consists in four sectors (exporting, import competing, services and public sector) and two factors (skilled and unskilled labour). The public sector is disaggregated in education and other services. An informal sector that accounts for about a third of total employment is merged with this data. In the SAM I consider only the factors skilled and unskilled labour, formal and informal.

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 assumed, giving 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_1	0.50	σ_2	3.00
α_1	0.99	α_2	0.67

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

Table A.2 Consumption parameters

σ_1	2.00	σ_2	2.00
δ_{A1}	0.31	δ_{A2}	0.22
δ_{B1}	0.22	δ_{B2}	0.24
δ_{C1}	0.47	δ_{C2}	0.54

The parameters of the CES function for the option between supplying labour to formal or informal markets are presented 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_1	4.00	ξ_2	0.50
β_{F1}	0.46	β_{F2}	0.01
β_{I1}	0.54	β_{I2}	0.99

The parameters of the CES function that contains the option between consumption of goods from formal and informal markers is presented in table A.4. The share parameters (β) are calibrated to a SAM where I have introduced an informal good that accounts for about 20% of the production of good C (consisting mainly of services), which is mainly consumed (about 75%) by the low income household (unskilled). The elasticity of substitution (σ) is assumed to be higher for unskilled workers.

Table A.4 Formal-informal services consumption choice parameters

σ_1	2.00	σ_2	0.50
β_{F1}	0.66	β_{F2}	0.95
β_{I1}	0.34	β_{I2}	0.05

The parameters of the CES function representing the option between consumption of domestically produced or imported goods (the Armington assumption) are presented 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_1	4.00	σ_2	4.00
β_{D1}	0.60	β_{D2}	0.52
β_{M1}	0.40	β_{M2}	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 markets (Armington assumption) are presented 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 sector C.

Table A.6 Domestic-export option for producers

Sector A		Sector C	
σ_1	-4.00	σ_2	-0.50
α_{11}	0.41	α_{12}	0.01
α_{21}	0.59	α_{22}	0.99

The 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. I consider different functions for formal and informal good C. Formal C consists of skill intensive traded activities and informal C are unskilled intensive non-traded activities.

Table A.7 Parameters of Cobb-Douglas production functions

sector A	α_A	0.10
	A_A	1.27
sector B	α_B	0.28
	A_B	1.76
sector C Formal	α_{CF}	0.32
	A_{CF}	1.85
sector C Informal	α_{CI}	0.08
	A_{CI}	0.93
sector G	α_G	0.40
	A_G	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

sector BE	α_{BE}	0.72
	A_{BE}	2.00
sector HE	α_{HE}	0.67
	A_{HE}	2.05

For the subsystem corresponding to basic education I introduce student differentiation by group. I did not introduce group differentiation in higher education mainly because when the students reach this level the constraints imposed by a poor socio-economic background can be also overcome by other means (loans, part-time jobs, etc.).

The information for the share of advantaged and disadvantaged students in the students population is not available so I assume that the share of disadvantaged group is roughly the same as the share of unskilled workers in the active population. I further assume that initially the value added applied to each group is proportional to the number of students in each group, so initially the resource intensity is the same across groups, which I consider to be a neutral assumption before the policy experiments.

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. Productivity across levels and grades are not comparable as it is not agreed in the literature which grades and levels generates bigger shares of the total knowledge. However, the productivity of the disadvantaged group is assumed to be lower than in the advantage group as the former have more resource intensive learning technology. The parameters are assumed as to reflect that the same amount of resources delivers lower productivity for the disadvantage group but the responsiveness to increased resources in

this group is higher, i.e. the scale parameter (A) is lower to disadvantaged students, while the share parameter (β) is higher. The values of the parameters are contained in table A.9.

Table A.9 Value added and students per level/group

	BE				HE	
	favourable		desfavourable		1	2
	1	2	1	2		
A	0.9	0.9	0.5	0.5	0.6	0.6
β	0.1	0.1	0.9	0.9	0.1	0.1
q	0.93	0.90	0.65	0.64	0.66	0.70

Dropout and repetition rates in the education sector are presented in tables A.10 and A.11. The table A.10 shows the values and parameters for dropout rates. The values of the rates are average of each level, and the values for university are assumed as they are not available, and the parameters are assumed. In table A.10 the elasticity (δ) is assumed to be higher for the disadvantaged group, and the scale parameter (c) is calibrated to adjust to the data.

Table A.10 Dropout rates, values and parameters.

	BE				HE	
	favourab		desfavourable		1	2
	1	2	1	2		
rate	0.02	0.06	0.18	0.33	0.40	0.40
c	0.02	0.06	0.12	0.22	0.32	0.30
δ	0.10	0.10	0.90	0.90	0.50	0.40

Table A.11 shows the values and parameters for repetition rates. The table shows average rates, and the values for university are assumed. Parameters are calibrated.

Table A.11 Repetition rates, values and parameters

	BE				HE	
	favourable		desfavourable		1	2
	1	2	1	2		
rate	0.07	0.22	0.14	0.30	0.30	0.15
b	0.07	0.21	0.12	0.22	0.26	0.04
ρ	0.57	0.25	0.42	0.70	0.3	3.40