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ABSTRACT

What is best strategy to reach the Millennium Development Goal of basic education for all will depend on the specific country context. This paper introduces an input-output method to estimate the financial inputs required to achieve the MDG for primary education and an additional target of enhancing access to secondary education.[1] As such the approach followed here is not new, but the innovative element is combining educational demand and supply variables considering both cost dimensions and quality of services as measured among others through test scores (outcomes), quality of school inputs and the nature of delivery of services (private-public, centralized or decentralized). We take the following analytical steps: (i) define a production function for specific education outputs (enrolment), (ii) isolate the main determinants of such output (considering both demand and supply factors); (iii) estimate costs per unit of producing such output, and – based on estimated elasticity's and unit costs ensuing from the education production function – (iv) calculate the financing needs of reaching key education goals. We find that determinants of access to schooling are significantly different for urban and rural and for poor and non-poor children. Furthermore, the determinants also differ when referring to access to primary or secondary education. Quality of school inputs does matter in all cases though to varying degree. Particularly, class size, shares of trained teachers and greater school autonomy (in hiring teachers and managing schools) are relevant. Quality of education outcomes, i.e. test scores, while very poor in Ecuador does not seem to influence school enrolment. The upshot is that with a more cost-effective use of resources for primary education, the MDG target of 100% of net primary school enrolment in urban areas is within reach in a period of 4 to 5 years at virtually no additional budgetary cost. Meeting the target for the rural population seems more complicated. In secondary education, important progress can be made to reach a target of 70% net enrolment (with important expected positive externalities for economic growth) by enhancing the share of trained teachers, expand coverage of school demand subsidies and improve class infrastructure. This target is within reach for the poor and non-poor urban population by 2007 at an estimated additional cost of

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between 0.1 and 0.6% of GDP, depending on alternative cost-effectiveness considerations. Reaching the 70% target for the rural population will require a much longer time period, but at similar additional annual budget implications.

CONTENTS

1 INTRODUCTION

The Millennium Development Goals (MDGs) include the target of reaching basic education for all by 2015. A recent study by Sachs et al. (2004) for 5 developing countries estimates the additional annual cost of reaching this MDG between US$ 12 and 18 in per capita terms. The similarity in the estimate range of these costs is remarkable, given important differences in initial conditions in educational performance of the set of low-income countries (Bangladesh, Cambodia, Ghana, Tanzania, and Uganda). Noteworthy, in the key, cost-effective budget scenario for Ecuador, a middle-income country, we estimate the additional annual cost for reaching primary education for all at about US$ 5 in per capita terms. Thus it seems hard to assume that there exist stylized facts about the required costs to reach the MDG for education. Rather, we expect that more likely the range will be much wider across different country contexts. What are the more cost-effective options will differ from country to country, as much as that financing gaps are likely smaller in countries which are already close to reaching the MDG than those with large deficiencies in access to primary education. More country studies are needed to shed light on this issue.

This study tries to contribute with a cost-effectiveness analysis for both primary and secondary education in Ecuador. The Ecuadorian government spends more on education than on any other public sector program. Ecuador has good coverage of primary education, but its quality is poor and transition to secondary education is low. Also inequality in access to education has increased between urban and rural population groups and between rich and poor. Only the gender gap in education appears to be by and large closed. The present government is committed to the MDGs as well as to improve management of education by distributing resources based on school age population, improve school access through targeted subsidy schemes, and shifting towards a more decentralized provisioning of education services. These priorities are partly based on the findings of this study. The reason to extend the analysis to secondary education is not merely given by already fairly high net enrolment rates for primary education. Analyses of rates of return to education for Ecuador and labour market studies show that deficient supply of workers with secondary education are a key factor in widening gaps between skilled and unskilled workers and a loss of competitiveness of Ecuador's industries after its process of

economic opening that started around 1990 (see Vos and Ponce 2004; and Vos and León 2003a).

The cost-effectiveness analysis in this study is based on the basic model of determinants of access to schooling (see e.g. Gertler and Glewwe 1990; Glewwe 1999), but instead of mainly focusing on demand factors such as income, the cost of education and socio-economic conditions of the households and children in school going age, we consider in addition (a) supply factors, and more in particular the quality of schooling inputs (as in e.g. Glewwe 1999); and (b) institutional aspects of the delivery of educational services (like centralized or decentralized teacher appointments). This modeling framework allows us to assess both demand and supply factors in identifying cost-effective interventions after linking the core determinants of access primary and secondary school to unit costs and integrating these into a results-oriented budget tracking model.

The remainder of this paper is organized as follows. In section 2 we summarize the performance of Ecuador's education system during the 1990s up to the early 2000s, looking at outcome indicators. Section 3 analyses the trends in the level and composition of education spending, quality of schooling inputs, and equity issues in the public expenditure pattern. In section 4 we analyze the determinants of access to primary and secondary education to inform more cost-effective uses of the education budget. These findings are subsequently used in section 5 for a scenario analysis of alternative education budget allocations aiming at reaching the Millennium Development Goals in education. This budget analysis also sets out the parameters for an education budget tracking system which should allow the government to prepare result-oriented, multi-annual budgets. Measuring outputs and outcomes will provide information to fine tune the public quality and effectiveness of provision of education services, such that it will enhance access to schooling towards the achievement of the MDG target.

2 ECUADOR'S EDUCATIONAL PERFORMANCE IN THE 1990s

Educational indicators for Ecuador have continued to improve during the 1990s and into the first decade of the new millennium. In comparison to previous decades though, the speed of educational improvement has slowed down and educational inequality has grown in many respects, except for the gender gap in

education which by and large has been closed. We detail several educational outcome indicators in this section.

The average level of schooling of the Ecuadorian population has increased continuously since the 1970s. According to the population census of 2001, the average Ecuadorian adult had 7.3 years of schooling completed, up from 6.7 years in 1990. Ecuador's average schooling level is above that of the Latin American mean and about the same as that of East Asia's population. Educational levels of the female population have risen much faster than that of males, such that by 2001 the gender gap in terms of years of schooling has practically been closed: 7.5 years for males against 7.1 years for females. In terms of net enrolment rates, girls already outperform boys at all educational levels (see table 1). Total net enrolment in primary education increased from 88.9 to 90.1% between 1990 and 2001 (according to population census data), approximating the Millennium Development Goal of primary education for all.

TABLE 1
Ecuador: Illiteracy rate and years of schooling of adult population (25 yrs and older) and net enrolment of population in school going age, 1990-2001

	ILLITERACY RATE		YEARS OF SCHOOLING		NET ENROLMENT PRIMARY		NET ENROLMENT SECUNDARY	
	1990	2001	1990	2001	1990	2001	1990	2001
BY GENDER								
Men	9.5	7.7	7.1	7.5	88.6	89.9	42.0	43.9
Women	13.8	10.3	6.3	7.1	89.2	90.4	44.1	45.4
BY AREA								
Rural	20.8	15.5	4.0	4.9	84.4	86.7	23.2	28.8
Urban	6.1	5.3	8.3	8.7	92.5	92.7	57.7	55.7
BY ETHNIC GROUP								
Indigenous	n.a.	28.2	n.a.	3.3	n.a.	86.1	n.a.	22.7
Blacks	n.a.	11.6	n.a.	5.9	n.a.	86.2	n.a.	36.9
Other	n.a.	7.4	n.a.	7.6	n.a.	90.8	n.a.	47.1
NATIONAL AVERAGE	11.7	9.0	6.7	7.3	88.9	90.1	43.1	44.7

This relatively favorable educational performance comes with a number of important qualifications.[2] *First*, the speed of educational performance has slowed down significantly during the 1990s as compared to the 1970s and 1980s (Vos, León

[2] See Vos and Ponce (2004) for a more detailed assessment. This is assessment formed part of the Public Expenditure Review conducted by the World Bank and the Inter-American Development Bank (World Bank and IDB 2004).

and Ramírez 2003). *Second*, the transition rates from primary to secondary education and from secondary to tertiary education are low and have not improved in any significant degree during the 1990s. *Third*, except for the gender gap, important disparities remain and by several measures educational inequality has been on the rise. The average level of schooling of the rural population is almost half that of the urban population (4.9 against 8.7 years) and this gap remained about the same during the 1990s. *Fourth*, the quality of education as measured by acquired knowledge is poor. The little information available on test scores shows that students are on average deficient in basic mathematical and language skills (See **table 2** and Vos and Ponce, 2004).

TABLE 2
Ecuador: Test scores for language and mathematics skills, 1996-2000

	1996	1997	2000
Second grade			
Spanish language skills	10.43	8.24	9.45
Mathematics	9.33	7.21	8.48
Sixth grade			
Spanish language skills	11.15	9.31	9.78
Mathematics	7.17	4.86	6.03
Ninth grade			
Spanish language skills	12.86	11.17	11.70
Mathematics	7.29	5.35	6.01

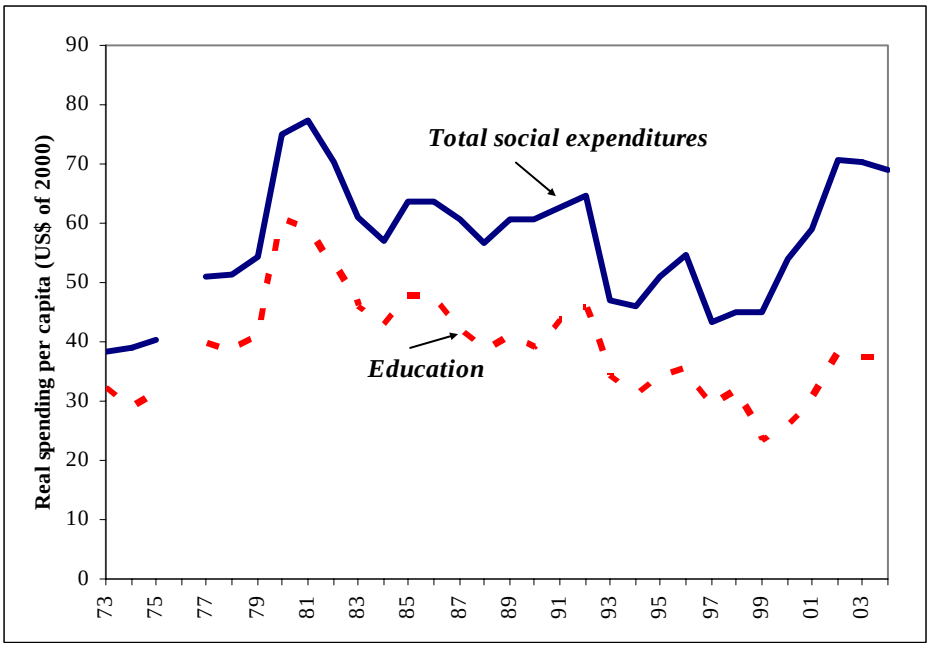
Source: APRENDO.
Notes: Test scores are on a scale of 20 with 13 considered as the pass grade.
Ninth grade refers to third year of secondary school.

3 TRENDS IN EDUCATION EXPENDITURES

Social expenditure levels are low in Ecuador compared to other Latin American countries, both as a share of GDP and on a per-capita basis (see Vos 2003). Real expenditures per capita have fallen more or less continuously over the past two decades. Ecuador spent approximately 4-5 percent of GDP (or on average about US$ 55 per capita) on the social sectors during the 1990s, compared to a Latin American

average of 12 percent (or US$ 550 per capita).[3] The per-capita figure for Ecuador improves to approximately US$ 130, or around 9% of GDP, when social security benefits are included. However, pensions are paid only to those retiring from jobs in the formal sector and mostly do not reach the poorer segments of society.[4] Real per capita social expenditure has fallen staggeringly since the early 1980s, and, although there has been a visible recovery since 2000, it currently stands below levels reached a quarter of a century ago (see figure 1).

FIGURE 1
Real social and public education spending per capita, 1973-2004
(US$, constant prices of 2000)



Source: Vos et al. (2003); updated for 2001-3 from Ministry of Economy-UNICEF fiscal data base. Public expenditures refer to central government budget only. Social expenditures include education, health, and social assistance (including cash transfer programs).

The decline in social expenditures has hit hardest on education and health spending. During the 1990s, the composition of social spending shifted in favor of targeted social protection programs (including the introduction of the cash transfer program *Bono Solidario*) and further against budgets for universal social services in

[3] Figures are in constant US dollars of 1997 as reported in ECLAC (2001) and, for Ecuador as estimated by Vos, León and Ramírez (2003). Data refer to spending by the central government only and do not include social security.
[4] This observation needs some qualification though as, after the 1999 crises, the real value of pension benefits plunged and financial assets of pensioners were decimated, turning many elderly into 'new poor'.

education and health. Between 2001 and 2003, education and health budgets increased significantly, mainly due to various rounds of salary increases for teachers and medical personnel in public service. Despite the recovery in recent years, by 2003 the real level of educational spending was forty percent below that of 1980.

How have educational services been affected by the decline in real public spending?[5] First, there could have been a shift in the structure of education spending, e.g. from more expensive tertiary to cheaper primary education. While we do not have consistent series by level of education for the 1990s, the available indicators for 1995-2002 suggest the shares of public spending by level have remained more or less constant with around 37% going to pre-primary and primary education, 37% to secondary and about 26% to higher education. Second, a shift towards private provisioning could be another reason of reduced public spending. Private school supply indeed expanded during the 1980s and 1990s, but private sector coverage in terms of primary and secondary school enrolment is currently no more than 23% and this share has remained unchanged since 1996. Hence, if anything, at best a reduced portion of the decline of educational expenditure can be attributed to a shift to private education. Third, school inputs may have deteriorated. Looking at student/teacher ratios in primary and secondary education, however, it appears that Ecuador scores rather favorably in comparison with other countries in the region and probably internationally and these ratios have improved during the 1990s: for primary education from 30 to 23 students per teacher and secondary from 13 to 11.[6] In other words, it seems hard to sustain that the fundamental cause in the declining trend in education expenditures (or the deterioration of the quality of education for that matter) lies with a lack of numbers of teachers.

More likely, the burden of the decline in education expenditure has fallen on the availability and quality of school infrastructure. While not easy to read from publicly available fiscal data, there seems to have been a decline in investment in new

[5] It would have been better to present the trend in education spending per student rather than per capita. However, for the reasons explained in the previous footnotes it is not possible to construct a consistent series for more than a few years in the 1990s and 2000s, given the lack of coherence in the breakdown over time of fiscal data by levels of education.

[6] These input indicators compare favourably to the rest of the region, particularly for secondary education. In Bolivia, Brazil, Chile, Colombia and Peru, for instance, the ratio is over 20 at this level. The ratio at the primary level is similar to that of neighbouring countries with the exception perhaps for Chile which has a pupil/teacher ratio of 31 in primary education (comparison based on UNESCO data).

school infrastructure and provisioning for maintenance of existing schools. Much of school maintenance and operation costs (including electricity and telephone bills) seem to have been passed on to parents. Such 'cost-sharing' has been on the rise as public schools were given greater autonomy. While offloading pressure on the government budget it most likely has negatively influenced school access and performance of children from poor families, as we shall see below.

As analyzed in Vos and Ponce (2004) and Vos et al. (2003), public spending on primary education is strongly pro-poor; spending on secondary education is distributed fairly evenly across quintiles of per capita household consumption, while spending on university training mainly benefits the richest segments of society.

Social transfers in education were equivalent to 6.1% of per capita consumption, about the same as what households are willing to spend out of their own pockets (table 3). In 1999, private expenditures on education amounted to 6.1% of

TABLE 3
Public transfers and private expenditures on education as a share of household consumption by deciles, 1999

Deciles	Primary	Secondary	Tertiary-Public	Tertiary-Private	Total
Public transfers					
1	17.9%	4.0%	0.0%	0.0%	21.9%
2	8.9%	4.3%	1.1%	0.0%	14.3%
3	6.0%	5.7%	1.2%	0.3%	13.1%
4	5.3%	4.7%	1.5%	0.0%	11.6%
5	3.4%	4.2%	1.9%	0.1%	9.6%
6	2.7%	4.0%	1.0%	0.5%	8.1%
7	1.8%	3.2%	2.7%	0.3%	8.0%
8	1.2%	2.6%	2.5%	0.8%	7.0%
9	0.6%	1.3%	2.0%	1.6%	5.5%
10	0.1%	0.3%	0.9%	1.2%	2.5%
Total Public	**2.0%**	**2.1%**	**1.5%**	**0.8%**	**6.4%**
Private spending[1]					
1	3.7%	1.1%	0.0%		4.8%
2	2.9%	1.4%	0.1%		4.4%
3	2.7%	1.9%	0.3%		5.0%
4	2.5%	2.0%	0.4%		4.8%
5	2.2%	2.0%	0.7%		4.9%
6	2.3%	2.4%	0.6%		5.3%
7	2.0%	2.0%	1.1%		5.2%
8	2.3%	2.5%	1.3%		6.1%
9	2.2%	2.4%	2.3%		6.9%
10	2.4%	2.2%	2.4%		7.0%
Total Private	**2.4%**	**2.2%**	**1.6%**		**6.1%**

Source: 1999 LSMS survey.
Note: 1. Share for 'Tertiary' is total for public and private universities.

household consumption. This share was 2.4% for primary, 2.2% for secondary and 1.6% for tertiary education. As one would expect, the richer households spend relatively more of their income on education as their children are more likely enrolled in private education and stay longer in the system. However, their relative willingness to pay for education does not exceed that of poor households by a wide margin. The poorest quintile spent about 4.5% on education compared to 7% for the richest quintile. As said, the private cost of education have been on the rise due to increasing pressure on families to share in the cost of both private and public schooling. In the next section we analyze to what extent this is hampering access to schooling and could be a problem in achieving the Millennium Development Goal for education.

4 COST-EFFECTIVENESS OF EDUCATION SPENDING

Ecuador has subscribed to the Millennium Development Goal of ensuring primary education for all by the year 2015. At unchanged population growth and if school enrolment would increase at the same speed as recorded during the 1990s that target would not be met. Projected net primary school enrolment would then be 91.7% in 2015 and that in secondary and tertiary education would be, respectively, 46.6% and 13.3%. Nonetheless, even considering this, 'business as usual' is not good enough in order to reach the target. Using the Barro-Lee perpetual inventory method to translate enrolment rates into years of school attainment, we find that if net school enrolment rates for primary, secondary and tertiary education remain unchanged, the average number of years of schooling of the population of 12 years and older would show a slight drop by the year 2007 (using 2001 as a base year).[7] Should the MDG target of 100% net primary school enrolment be achieved, then secondary school enrolment would need to increase to 70% (up from 45% in 2001) and retention rates would need to increase to 80% (up from 74%) in order to gain one year in the average level of education of the working population (assuming tertiary school enrolment remains constant). This is with 2007 as time horizon, roughly half-way the MDG reference period. Thus, while the net primary school enrolment target may seem

[7] See Barro and Lee (2000) for an exposition of the estimation method. Please note that these simulations estimate the average level of schooling for the population of 12 years and older. According to the 2001 population census data, the average educational level for the population of 12 years and older was 7.2 years, against 7.3 years for that of 24 years and older.

within reach (at least by 2015, but possibly also by 2007), increasing net secondary school enrolment to 70% seems a tall order given the past rates of improvement. But the above estimates also suggest that without improving access to higher education (currently at a 12% net enrolment rate) it may take a long time to make a substantial impact on the average educational level of the work force. Nonetheless, as a working hypothesis, we will set enrolment targets at 100% for primary and 70% for secondary education and analyze whether it is possible achieve these by making educational spending more efficient and/or what additional public investment would be required.

In order to know by how much the education budget would need to increase or how to make that spending more effective to reach the given goals, we need to analyze in greater detail the determinants of school enrolment. These determinants may be found in the physical accessibility of schools and the quality of school inputs (such as availability of textbooks, qualifications of school teachers, and so on). However, problems of access to schooling likely are not merely related to factors on the supply side, but important constraints are typically also found in the household conditions of the children. The education of their parents typically influences the decision to attend school, as much as the economic situation of the household. If a family is poor and there are significant direct costs to the household for each child attending school (school fees, uniforms, educational material, transportation costs), parents may decide not to enroll (some of) their children. Such circumstances may also lead to a situation where the contribution of children to family income is significant (especially in rural areas) and accordingly the opportunity cost associated with school attendance may be substantial. Attendance will suffer when parents perceive that the return associated with time spent in school does not justify the loss of a child's economic contribution. Also, parents tend to value the quality of educational outcomes. That is, if the quality of education is rated to be poor (for instance as measured through test scores), parents may be less likely to send their children to school.

We apply a schooling determinants model for Ecuador identifying the importance of such factors and quantify the impact of changes in such variables on school outcomes.[8] Our approach follows a basic extended human capital model

[8] This analysis builds on our earlier work, as presented in Ponce, Bedi and Vos (2003).

formulated by Glewwe (1999) and adapted, among others, by Bedi et al. (2004). An important advantage of these models as compared to the more traditional 'willingness-to-pay models' is that they include variables of school inputs and educational quality, next to demand variables associated with costs and income.[9] In addition to supply side variables, our model also considers institutional variables, such as school autonomy and decentralized teacher appointments. This dimension is of some importance, as discussed below, for the policy design of more cost-effective interventions in education.

4.1 Modeling the access to schooling

We start from a conventional human capital model to understand *the main factors that determine school enrolment* of children.[10] In this theoretical approach education is viewed as an investment that depends on the costs and benefits associated with enrolment. The costs associated with schooling are direct and indirect. The direct costs include inter alia uniforms, books, tuition fees and transportation. Indirect costs are defined as the reduction in household income due to the reduction of child labour. The expected addition to a child's human capital and its impact on future earnings are among the main benefits associated with schooling. A household will decide to send children to school if the (expected) marginal benefit to an additional year of education equals the marginal costs.

This initial theoretical formulation has been extended using dynamic models of earnings and the importance of human capital investments (Ben-Porath 1967 and Heckman 1976). Specifically for developing countries, Glewwe (1999) has formulated an 'extended human capital model' to understand government investments on school quality and its impact on future earnings. We adopt this model to formulate an 'extended human capital' model to school enrolment.

According to this approach, households will maximize the following utility function conditional to school enrolment:

$$U_1 = U(b, c_1) \qquad (1)$$

[9] See Gertler and Glewwe (1990) and Gertler and Van der Gaag (1988).
[10] See Schultz (1971) and Becker (1964).

where, U is the household utility conditional on school enrolment (denoted by subscript 1), b is a vector of benefits associated with attending school, and c is household consumption.

The main benefits associated with schooling, *b*, are defined by:

$$b = B(h, w, z) \tag{2}$$

where, *h* is a vector of individual child characteristics, *w* is a vector of households characteristics, and *z* is a vector of school characteristics (including quality of school inputs and institutional aspects).

The household maximizes utility against the following budget constraint:

$$y = c_1 + p \tag{3}$$

where y is household income, and p represents the total cost associated with enrolment. The utility function associated with not attending school yields:

$$U_0 = U(c_0) \tag{4}$$

The budget constraint is $y = c_0$. The household will choose the option associated with the highest possible utility, i.e.:

$$U^* = \max(U_1, U_0) \tag{5}$$

where U^* is the maximum utility. In this case the solution to the maximization problem is the probability that an alternative is chosen.

4.2 Empirical specification

Three different specifications of the utility function can be found in the literature: a linear form (Bedi et al. 2004), a semi-quadratic function (Gertler and Glewwe, 1990), and a logarithmic form (Younger et al., 1997). In our case, we decide to use a linear form because it is easier to interpret and there is a direct price effect, while in the others the price effect is either squared and/or interacted, making interpretation difficult.[11] In this case the utility function takes the following form:

[11] Results using the quadratic and semi-log specifications, as well as a discussion about the advantages and disadvantage of each specification can be found in Ponce, Bedi and Vos (2003).

$$U_1 = \beta_1 b + \beta_2 c_1 + \varepsilon_1 \quad (6)$$

where β's are the coefficients to be estimated and ε_1 is assumed to be a zero mean, normally distributed error term. From equation 3 we see that $c_1 = y - p$, the utility function can therefore be rewritten as follows:

$$U_1 = \beta_1 b + \beta_2 (y - p) + \varepsilon_1 \quad (7)$$

The utility function for not being enrolled in school is:

$$U_0 = \beta_2 y + \varepsilon_0 \quad (8)$$

Thus, an individual attends school if the utility associated with school enrolment is higher than that of not attending. In other words, an individual attends school if the following equation is satisfied.

$$\beta_1 b - \beta_2 p + \varepsilon_1 - \varepsilon_0 > 0 \quad (9)$$

The chances of attending school thus can be expressed as a function of socio-demographic individual and household characteristics, the quality of school inputs and the direct and indirect cost of school enrolment. In terms of a linear probability model this functional relationship may be written (after using equation 2) as:

$$\Pr[a = 1] = \Pr[\beta_1 B(h, w, z) - \beta_2 p + \varepsilon_a > 0] \quad (10)$$

where *a* is a binomial variable that takes the value of 1 for enrolment and 0 for non-enrolment.

4.3 Empirical results

Before running the econometric models, we applied several tests to find the appropriate model to be estimated. It is clear that people have the following choice structure: either not to attend school, attend a public school or attend a private school. This choice structure suggests that the appropriate econometric model would be a multinomial logistic model (MLM). However, this kind of models assumes the

independence of irrelevant alternatives (Greene, 2000).[12] If a subset of the choice set is irrelevant with respect to the other alternatives, omitting it from the model will not change parameter estimates systematically. Exclusion of these choices will be inefficient but will not lead to inconsistency. To confirm the independence of irrelevant alternatives a Hausman specification test was carried out. To do that, we first run the model using the MLM for the complete set of alternatives, and then we run it without the option of being enrolled in a private school. Finally, we run the Hausman test to analyze if the difference in estimated coefficients is statistically significant or not. The test result is that we cannot reject the null hypothesis. It means that there is no evidence that the assumption of independence of irrelevant alternatives has been violated. The difference in coefficients is not systematic, implying we can use a multinomial logistic model.

In addition, a Chi-square test was conducted to analyze if we should have two different regressions: one for urban and one for rural areas. The test results indicate that we should estimate models for urban and rural areas separately.

Finally, we performed several additional tests to verify if we should use a multinomial or a logistic regression. We applied the test for pooling states in the multinomial logit model (Cramer and Ridder 1991). In this case, we concluded for the urban area that we should use a multinomial model. We reach the same conclusion for rural areas. However, due to the low level of enrolment in private schools in rural areas (around 5%) and the low share of private supply in the rural educational service delivery, rural children have little choice what type of school to go to. Hence, we decided to use a probit model instead of a MLM for rural areas.

We refer to Ponce, Bedi and Vos (2003) for a more detailed description of the quantitative results and estimation procedures. As to data sources, the 1999 Living Standards Measurement Study (LSMS) survey is the most recent survey with national coverage with sufficient data to fully estimate the demand side variables of our model. We merge this data set with quantity and quality data of school inputs using the data base of the Ministry of Education (SINEC) for 1999-2000 and the 2000 census of teachers and teacher qualifications, also of the ministry. The educational supply data

[12] The independence assumption follows from the assumption that the disturbances are independent and homoscedastic. It basically means that the relative probabilities of various alternatives remain constant regardless of which alternatives are included in the model (Greene 2000: 865).

were merged with the household survey data after matching the household location identifiers with the location of schools.

We apply our model to analyze net enrolment determinants for basic and secondary education.[13] The detailed empirical estimates for the linear specification are given in tables A.1 and A.2.[14] We find that the relative importance of schooling determinants varies quite substantially between basic and secondary education, as well as that the decision-making behaviour differs for urban and rural and for poor and non-poor households.[15] In addition to the variables reported in the annex tables, we initially also included the pupil-teacher ratio in the models. Because of a strong correlation with the ratio of students per aula and low significance of the pupil-teacher ratio, we decided to exclude the latter variable from the model. Similarly, we tried to test for the influence of the quality of educational outcomes on the school enrolment decision. For this we used test scores for students for both language and mathematics at various grade levels. However, test scores are available only at the level of schools and not for individual cases of students which can be matched with the household survey data. Hence, we used average test scores at the parochial level and merged these with the survey data using the geographical location identifier of households.[16] However, alike in the case of the pupil-teacher ratio, we do not find significant results for test scores as a determinant of school enrolment decisions at the primary or secondary school level.

4.4 Cost-effectiveness in primary education

Different behavioural responses of rural and urban, and poor and non-poor households to demand and supply factors in primary education can be summarized as follows:

[13] Under the new schooling system in Ecuador, basic education comprises pre-primary, primary and lower secondary education.

[14] Results for quadratic and semi-logarithmic specifications can be obtained from the authors upon request. We use elasticities calculated based in the linear specification for budget simulations. Several models were used for urban and rural areas, as well for poor and non-poor people. Econometric and statistical tests that justify the use of those different models are explained in Ponce, Bedi and Vos (2003).

[15] Please note that, as indicated above, for urban areas the demand for schooling model is estimated in the form of a multinomial logit specification of household decisions to enroll children in either public or private education. In the results presented in the text we only report on the determinants for enrolment in public schools.

[16] 'Parroquías' (parishes) form the lowest administrative unit in Ecuador's political-administrative system. The parroquías are districts or communities within municipalities (cantons).

Schooling determinants in primary education

	Urban		Rural	
	Poor	*Non-poor*	*Poor*	*Non-poor*
Demand factors	Cost of education (-)		Cost of education (+)	Cost of education (+)
z	Education mother (+)		Education mother (+)	
				Gender: Female (+)
	Location: Quito (+)			
	Costa (-)	Costa (-)		
Supply factors	Students per class room (-)		Students per class room (-)	
	Share of trained teachers (+)	Share of trained teachers (+)		
		Centralized teacher appointment (-)	Centralized teacher appointment (-)	

The relevant elasticities for each of these factors are reported in table 4. On the demand side, the direct and indirect costs of education have a weak, but negative effect on primary school enrolment, particularly of poor urban households. For each 1% increase in cost, net enrolment of children from poor urban households is expected to fall by 0.2%. For the total urban sample though the link is much stronger

TABLE 4
Ecuador: Elasticities of determinants of net enrolment in primary education

	Urban			Rural		
	Total	*Poor*	*Non-poor*	*Total*	*Poor*	*Non-poor*
Socio-economic factors (demand)						
Cost of education	-1.32	-0.19	n.s.	0.06	0.06	0.00002
Education mother	0.08	0.13	n.s.	0.03	0.06	n.s
Sex (males =1)	n.s.	n.s.	n.s.	n.s.	n.s.	-0.000001
Quito	0.11	0.04	n.s.			
Costa	n.s.	-0.14	-0.34	n.s.	n.s.	n.s.
Education supply factors						
Students per class room	n.s.	0.08	n.s.	n.s.	-0.07	n.s.
Share of trained teachers	0.72	n.s.	1.63	n.s.	n.s.	n.s.
Centralized teacher appointments	-0.39	n.s.	-0.38	n.s.	-0.03	n.s.

Source*:* INEC, *Encuesta de Condiciones de Vida* (LSMS), 1999 and education input data. Revised estimates from Ponce, Bedi and Vos (2003) which estimate same relations for "basic" education, including pre-primary, primary and three years of lower secondary education. See Appendix Table A.1 for detailed model estimates.

showing a derived elasticity of -1.3.[17] For poor rural households the link is weak, but – unexpectedly – positive. It would suggest education is like an inferior good for the rural population. In any case the link is weak, such that costs do not seem decisive in the determination of rural school enrolment. For both urban and rural poor, the education level of the mother has a significant and positive effect on school enrolment. Being a boy or a girl hardly influences the primary schooling decision, consistent with the observations made earlier about the closing gender gap in education in Ecuador.

On the supply side of primary education, the share of trained teachers has an important influence on the decision of school enrolment in urban areas, particularly among non-poor households, while for rural households the determinant was not found significant. Poor rural households see packed classrooms as a negative sign of education quality and are more likely to enroll children in school at a lower ratio of pupils per class room. Next to trained teachers, also decentralized appointments of teachers (e.g. by parent committees) would influence school enrolment favorably. Local teacher appointments reflect greater school autonomy and influence of parents in school management. Ecuador has various programs geared at decentralizing delivery of public education (see Vos and Ponce 2004, for a further description). Based on evaluations of these programs, one may see the decentralized appointment of teachers as a proxy of a perception by parents of better delivery of education services (or at least a process they can influence), thereby a greater commitment to keep children in school and hence a likely positive effect on school enrolment. In the model results, this hypothesis is confirmed as reflected by the negative sign for the share of teachers that are centrally appointed, i.e. through the Ministry of Education. However, when decomposing the sample for poor and non-poor households, this variable seems to affect schooling decisions of non-poor urban households most and to a lesser extent the poor rural households.

The education policy implications of these findings would be that:

[17] The model results refer to demand for public education. As a larger share of non-poor are enrolled in private schools the sample for non-poor in primary schooling age is relatively small, which could explain the insignificant estimate for the schooling cost coefficient for this group. The economic interpretation could be though that since the non-poor children (or rather their parents) are more likely to prefer private schools, the cost of public schools is less likely to influence their decision of enrolment.

- It would appear to be more cost-effective to target the cash transfer program (*Beca Escolar/Bono Desarrollo Humano*) towards the urban poor, rather than to the rural poor.[18] Of course, given the fact that the cash transfer program is conditional upon school assistance, it may nonetheless stimulate primary school enrolment in rural areas. For urban areas, the cost-effectiveness model would suggest that the subsidy need not be conditional to stimulate school enrolment.
- Hiring of more trained teachers will positively affect school enrolment in urban areas. Given the earlier conclusions about the low quality of education as measured through test scores, this may also be a policy priority for rural areas. However, according to the cost-effectiveness analysis this measure is not expected to raise primary school *enrolment* among the rural population.
- More decentralized decision-making (e.g. assigning greater role of local communities in teacher appointments) is expected to promote school enrolment, more in particular among urban non-poor and rural poor.
- Reducing congestion in classrooms (i.e. ensuring there are sufficient, well-equipped classrooms for a given student intake) will also positively influence school enrolment. While the student-teacher ratio is on average rather favorable in Ecuador, infrastructural deficiencies are forcing oversized classes and hampering school enrolment and education quality. These problems are regionally concentrated. For instance, in some municipal areas (cantons) of the provinces Guayas and Los Rios average class sizes are well over 30 and in some cases over 40.
- As a long run policy, improvement of the level of female education should help improve access to primary education. This would require continuous efforts in improving school enrolment. In the short run, literacy campaigns

[18] In 1998 the unconditional cash transfer program, *Bono Solidario*, was introduced as a compensatory scheme for poor households in response to a reduction of subsidies on the price of cooking gas. In 2003 this benefit scheme was replaced by a conditional cash transfer program, first labelled as the *Beca Escolar* and subsequently renamed into the *Bono de Desarrollo Humano* (BDH). Receiving benefits from the BDH is conditioned to having children attending primary school and/or mothers and young children attending health centres for maternal and child care. Initially, as the *Beca Escolar* program, the cash transfer was only conditioned to school attendance. See Vos, León and Brborich (2001) and Parandekar, Vos and Winkler (2002) for a discussion of the eligibility criteria and the effectiveness of the Bono Solidario program; and see Vos and Ponce (2004) for a description of the BDH.

targeted at mothers with young children in rural areas (where illiteracy rates are highest) should be effective in this sense.

4.5 Cost-effectiveness in secondary education

Similar to primary education, we find important differences in determinants of secondary school enrolment decisions across urban and rural and across poor and non-poor households. The main determinants are found to be the following:

Schooling determinants in secondary education

	Urban		Rural	
	Poor	*Non-poor*	*Poor*	*Non-poor*
Demand factors	Cost of education (-)		Cost of education (-)	
	Education mother (+)		Education mother (+)	Education mother(+)
		Gender: Female (-)	*Gender*: Female (-)	
	Location: Quito (+)			*Location:* Costa (-)
		Costa (-)		
Supply factors		Students/class room (-)		
	Share of teachers with university degree (+)*	Share of teachers with university degree (+)		Share of trained teachers (+)

Note* Not significant separately for poor and non-poor, but significant for total sample.

The relevant elasticities are reported in table 5. The direct and indirect costs of education have a strong negative effect on secondary school enrolment, particularly on that of poor households. For each 1% increase in cost, net enrolment of children from poor urban households is expected to fall by 0.4%. For poor rural households the implied elasticity is also significant, but lower: -0.2. Among other demand factors, the educational level of parents, particularly that of mothers, is an important explanatory variable of secondary school enrolment in both urban and rural areas. Girls are not found to have a significantly higher or lower probability to access secondary education. On the supply side of secondary education, the share of trained teachers has an important influence on the decision of school enrolment in urban areas, particularly among poor households, while for rural households the determinant was only found significant for non-poor households. For each percentage point increase in the share of trained teachers, net enrolment among urban poor and rural non-poor is expected to rise by about 0.6%. Class size has a significant negative effect on secondary schooling decisions of urban non-poor households.

TABLE 5
Ecuador: Elasticities of determinants of net enrolment in secondary education

	Urban			Rural		
	Total	Poor	Non-poor	Total	Poor	Non-poor
Socio-economic factors (demand)						
Cost of education	n.s.	-0.399	n.s.	n.s.	-0.201	n.s.
Education mother	0.146	0.358	n.s.	0.635	0.647	0.339
Sex (males =1)	n.s.	n.s.	0.109	0.104	0.191	n.s.
Quito	n.s.	0.054	n.s.			
Costa	n.s.	n.s	n.s.	n.s.	n.s.	-0.101
Education supply factors						
Students per class room	-0.236	n.s	-0.032	n.s	n.s	n.s
Share of trained teachers	n.s	n.s	n.s	n.s	n.s	0.641
Share of teachers with university degree	0.382	n.s	n.s	n.s	n.s	n.s
Centralized teacher appointments	n.s	n.s	n.s	n.s	n.s	n.s

Source*:* Ponce, Bedi and Vos (2003: table 6.14). See appendix table A.2 for detailed model estimates.

The education policy implications of these findings would be as follows:

- It would be cost-effective to increase the coverage of the *Beca Escolar* (presently, *Bono de Desarrollo Humano*) program to poor households with children in the age group of 12-18 year olds. Particularly, in rural areas such policy (or any other measure reducing education cost to households) would be essential to enhance access of the poor to secondary education.
- Enhancing the share of teachers with a university degree seems critical to increase enrolment in urban areas and that of trained teachers (with pedagogical diploma) to positively influence enrolment decisions of non-poor households in rural areas.
- Class size per se, is not a major problem of access, except for certain urban areas where too large class sizes and insufficient schooling infrastructure seems to hamper enrolment.[19]
- As a long run policy, improvement of the level of female education should help improve access to secondary education. This would require continuous efforts in improving school enrolment in both primary and secondary

[19] As reported in Ponce, Bedi and Vos (2003), this is not merely a problem in urban public secondary schools. The same problem is found for enrolment in private schools.

education. In the short run, literacy campaigns targeted at mothers with young children in rural areas could be effective in this sense.

5 BUDGET IMPLICATIONS OF TRYING TO ACHIEVE EDUCATION TARGETS

Ecuador's government budget system long has been highly centralized, rule oriented and input based. The education budget forms a prime example. The input-based characteristic has led to incremental allocations (in nominal terms) according to cost changes of main education supply components. The wage bill has been in practice the centerpiece of education budget adjustments as rising student numbers were responded by hiring of new teachers, while teacher salaries mainly have increased in response to teacher union demands. In a way such adjustment is logical as teachers do form the main input of educational services anywhere. Government budget rules in Ecuador ever since the 1970s have included a host of fixed allocations from specified revenues (including the repartition of oil revenues) and fixed-share or growth rules, such as the rule that education should receive at least 30% of the government expenditures, whereas growth of health expenditures are not allowed to drop below the overall growth of public expenditures. Even though such rules have not been faithfully adhered to in practice and have not been able to prevent real education expenditures to fall for a prolonged period of time, they have imposed obvious rigidities in the spending pattern. Education expenditures have been capped by the 30%-rule, albeit a ceiling which would move pro-cyclically with aggregate government expenditures. The wage bill would typically eat into incremental changes, but leaving infrastructure and maintenance as the first item to accommodate downward budget adjustments when required. The highly centralized system of budget controls and personnel management distanced resource allocation further away from performance orientation.[20]

As discussed in the above, the Ecuadorian government has been making several efforts to move towards a more performance-oriented budgeting system in education trying to enhance efficiency and equity in education outcomes. The demand

[20] See Reid (1997) for a further analysis of this point and incentives to circumvent budget rules and control through off-budget activities and other devices.

subsidies provided through the *Beca Escolar/Bono Desarrollo Humano* should improve access to education for the poor. Greater autonomy for decentralized networks of schools should also help a more effective spending of resources, while a new formula for allocating the central education budget across provinces is expected to yield greater equity. However, it cannot be denied that these steps far from constitute a sufficient move towards a more transparent and coherent result-oriented budgeting system. First, the *Beca Escolar* is managed separate from the education budget as a social protection program. Second, the budgets in support of a more decentralized implementation of education policies (such as the *Redes Amigas* project) have been heavily dependent on external resources and managed as off-budget activities.[21]

A first step towards a more comprehensive result-oriented budgeting system would be to put together all programs and interventions aiming at improving educational outcomes and monitor each for their cost-effectiveness. In line with the MDGs, increased access to primary and secondary education is a priority target for the Ecuadorian government. In that vein, the results of the schooling determinants model of Section 4 may serve as a starting point for the development of a result-oriented expenditure tracking methodology.

The schooling determinants model serves to establish input-output relationships in education, i.e. between policy interventions and expected educational outcomes measured by net enrolment rates. The relative importance of each determinant discussed in Section 4 may be expressed as elasticities expressing the impact of a 1% change of a given determinant on school enrolment (see tables 4 and 5). After linking these to unit costs we obtain a basis for making budget projections for alternative resource allocations.

As a first approximation we perform *static* cost-effectiveness simulations, that is, we change effective inputs such that we approach a given target (say, 100% net enrolment) using the given elasticities and unit cost to estimate the costs of the interventions. In this exercise we do take account of certain interaction effects. For instance, an expansion of the conditional cash transfer program would lead to higher

[21] *Redes Amigas* is an IDB-funded educative program that aims to improve the quality of education in rural areas based on a decentralization strategy (transferring budgets from the provincial unit of the Ministry of Education to schools).

school enrolment, but also to a higher number of students per class room which has a negative effect on enrolment for some groups of the population in school-going age unless more is invested in class rooms. In the results reported below, we assume that the *pupil-teacher ratio is kept fixed* during the simulation period. Simulations are compared to a baseline scenario which keeps all inputs constant (although the number of teachers may rise as a result of the fixed pupil-teacher ratio assumption) and unit costs adjust for projected inflation only. In the baseline (no policy change), the primary education budget remains at 1.3% of GDP and that for secondary education at 1.2% of GDP, while net enrolment rates do not improve from 2003 levels.

5.1 Budget tracking and projections for primary education

Table 6 shows three budget scenarios. *First*, we increase the shares of trained teachers to 100% (up from 90% in 2003) and reduce the share of teachers with central appointment to 84% (down from 94%) by 2007. This scenario works to get all urban non-poor children in school by 2007 and would have induced urban poor to a net enrolment rate of 97% (up from 89% in 2003). The policy should also help to increase enrolment among the rural poor, but without additional investment in rural school infrastructure the effect will be more than offset by the ensuing increase in the number of pupils per class room. The budget implications of this policy are minimal. All other things being equal, it would require an increase of about 7% of the (nominal) education budget by 2007 or about US$ 30 million as compared to a baseline of no policy change. This policy can be as effective, but even cost-saving if we would drop the assumption of a fixed pupil-teacher ratio of 23 and allow the ratio to increase to 25 and implying a reduction of the number of teachers by 3% (or about 3,700 teachers).

Second, we expand the *Beca Escolar* program to cover all urban poor. The analysis of Section 4 suggests school subsidies (or reducing schooling costs) only significantly influence enrolment for this population group. As this group was not targeted initially by the *Beca Escolar* program, this would involve additional budgetary cost; not just of the increase in coverage of the cash transfer program, but also due to rising teacher costs as enrolment increases and the pupil-teacher ratio is kept fixed. In order to have all urban poor in school by 2007, this would involve a slightly smaller additional budget effort of 6% over the baseline projection by 2007 or about US$ 28 million (0.1% of GDP). The additional cost may be ‘financed’ through

cost saving by allowing for a slight increase in the pupil-teacher ratio to the same tune as in the first simulation.

TABLE 6
Reaching the MDG for education:
Static budget projections for primary education, 2003-7

	Increase trained teachers		*Increase school subsidy program*		*Combined: trained teachers, school subsidies and rural school infrastructure*	
	Additional costs as % Education budget	Additional costs as % GDP	Additional costs as % Education budget	Additional costs as % GDP	Additional costs as % Education budget	Additional costs as % GDP
2004	4.1%	0.1%	3.5%	0.0%	6.1%	0.1%
2005	5.4%	0.1%	4.0%	0.1%	9.0%	0.1%
2006	6.2%	0.1%	4.8%	0.1%	12.1%	0.2%
2007	7.1%	0.1%	6.2%	0.1%	14.6%	0.2%

	Increase trained teachers	*Increase school subsidy program*	*Combined: trained teachers, school subsidies and rural school infrastructure*
Additional budget requirements (in mln US$)			
2003	0	0	0
2004	16	14	24
2005	22	16	37
2006	27	21	52
2007	32	28	65
Total 2003-2007	97	78	177
Net enrolment rate by 2007			
Urban poor	0.97	1.00	1.00
Urban non-poor	1.00	0.94	1.00
Rural poor	0.87	0.86	0.88
Rural non-poor	0.93	0.93	0.93
Nation-wide	0.94	0.93	0.95
Urban total	0.99	0.97	1.00
Rural total	0.88	0.88	0.89

Source: Juan Ponce and Rob Vos (2004) *Budget projections model for Ecuador's education sector* (spreadsheet model). See text for explanation of the budget simulations procedure.

Third, we combine the two policies and also allow for an increase in rural school infrastructure by a sufficient amount such that the rise in the number of pupils per class room does not have a negative effect on enrolment of the rural poor. Given our model parameters and all other things being equal, we expect this combination of policies to lead to universal access to education for the urban population, but leave the rural population without any visible benefit. The cost would only be marginally higher than for the second budget scenario (additional annual cost of 0.2% of GDP or about US$ 4 – 5 in per capita terms), mainly due to the extra investment in schooling

infrastructure and the rise in demand for teachers as enrolment increases.[22] Again, this policy package could be financed by allowing for a gradual increase in the pupil-teacher ratio to 27.5 by 2007, but requiring reduction of about 9% of the current number of teachers (i.e. affecting about 11,000 teachers).

TABLE 7
Improving access to secondary education:
Static budget projections for secondary education, 2003-7

	Increase trained teachers		*Increase school subsidy program*		*Combined: trained teachers, school subsidies and rural school infrastructure*	
	Additional costs as % Education budget	Additional costs as % GDP	Additional costs as % Education budget	Additional costs as % GDP	Additional costs as % Education budget	Additional costs as % GDP
2004	2.4%	0.0%	3.1%	0.0%	13.1%	0.2%
2005	4.8%	0.1%	5.0%	0.1%	22.6%	0.3%
2006	7.0%	0.1%	8.1%	0.1%	38.2%	0.4%
2007	8.8%	0.1%	11.9%	0.1%	53.3%	0.6%

	Increase trained teachers	*Increase school subsidy program*	*Combined: trained teachers, school subsidies and rural school infrastructure*
Additional budget requirements (in mln US$)			
2003	0	0	6
2004	8	11	46
2005	17	18	83
2006	27	31	146
2007	35	47	212
Total 2003-2007	88	108	493
Net enrolment rate by 2007			
Urban poor	0.57	0.70	0.70
Urban non-poor	0.83	0.76	0.79
Rural poor	0.24	0.27	0.27
Rural non-poor	0.60	0.52	0.55
Nation-wide	0.56	0.58	0.59
Urban total	0.71	0.73	0.75
Rural total	0.32	0.33	0.34

Source: Juan Ponce and Rob Vos (2004) *Budget projections model for Ecuador's education sector* (spreadsheet model). See text for explanation of the budget simulations procedure.

5.2 Budget tracking and projections for secondary education

Using the cost-effectiveness analysis as a basic input, table 7 shows three budget scenarios for trying to make an important step towards reaching the target of 70% of net secondary enrolment by 2007. *First*, we increase the shares of secondary

[22] The additional costs amount to US$ 12 to 16 per student.

school teachers with a university degree and with a pedagogical degree to 100% (up from about 80% in 2003). This scenario would stimulate enrolment in urban areas and reach the target, except that it would mainly stimulate enrolment for the urban non-poor, leaving the urban poor still at some distance of the target of 70% net enrolment. The simulation would also predict enrolment of rural non-poor to be up at 60% by 2007 (from 52% in 2003). The rural poor are not expected to be induced to higher enrolment by such a policy. The policy would imply though that some 27,000 teachers in secondary schools would have to be trained or receive a university degree in a four year time span, which might be a steep order and may have to be spread out over a longer period. We estimate the extra budgetary cost at an annual US$ 35 million by 2007 or an increase of about 8% from the baseline budget for secondary education equivalent to 0.1% of GDP. The policy could also be made *budget neutral*, with the same expected effect on enrolment, by letting the pupil-teacher ratio in secondary education increase from 13 to15 between 2003 and 2007. In this case to total number of secondary school teachers could remain about constant at 2003 levels, but still about 15,000 would need to be trained or get a university degree.

Second, we expand the *Beca Escolar* program to cover all urban and rural poor household with children (potentially) in secondary school. The analysis of section 4 suggests school subsidies (or reducing schooling costs) will significantly influence enrolment for the poor households. As the *Beca Escolar* program has not been targeted originally at secondary education, this would involve additional budgetary cost; not just of the increase in coverage of the cash transfer program, but also due to rising teacher costs as enrolment increases and the pupil-teacher ratio is kept fixed. Under the given assumptions, the policy could work to reach the 70% target for the urban poor. However, secondary school enrolment for the rural poor is so low and the impact of the subsidy (of US$ 5 per student per month) is not large enough to increase enrolment massively for this population group. As discussed in section 4, increasing access for the rural poor to secondary education has to be part of a long-term effort of which targeted subsidies are at best only one element, but would further require improving the general economic conditions of rural households (requiring less child labour), improved achievement at the primary education level and improvements over time of parents education (especially of mothers). The additional budgetary cost of the school subsidy program as simulated would amount to 12% over the baseline projection or about US$ 47 million (0.14% of GDP) by 2007. To finance the

expansion of the *Beca Escolar* through a reduction of the teacher wage bill (as compared to the baseline scenario) the pupil-teacher ratio would have to increase to 15.3 by 2007.

Third, we combine the two policies and also allow for an increase in school infrastructure by a sufficient amount such that class size (pupils per class room) remains at 21 and therefore will not impact negatively on urban enrolment (see cost-effectiveness analysis). In this scenario we limit the increase in the share of teachers with a degree to 89%, implying about 9,700 teachers would have to be trained during the period. Given our model parameters and all other things being equal, we expect this combination of policies to lead to reach the 70% target for both urban poor and non-poor, but the rural poor would still fall short of this target for the reasons mentioned above. The additional infrastructure investment would, however, be substantial in this scenario creating an additional cost of around US$ 212 million by 2007.[23] During 2003-7 about 4,000 new class rooms would have to be constructed to keep the class size at 21. The extra cost would require the secondary education budget to increase by about 50%, an annual cost equivalent to 0.6% of GDP. It would thus also involve a much steeper increase in the pupil-teacher ratio (from 13 to about 18) if the policy is to be budget neutral. However, this would imply having to reduce the total number of secondary school teachers by 10,000 (12% of the current number) between 2003 and 2007, likely a tall order politically speaking and with uncertain effects on education quality.

In sum, there exist (financially) feasible scenarios to reach 100% of net primary school enrolment in urban areas in the medium run. Such a target may be reached without additional budget effort, if the additional cost of increasing the quality of teachers and increased coverage of demand subsidies is compensated by a slight reduction in the excess of the total number of teachers. Meeting the target for the rural population seems for complicated and the budget implications could not be quantified based on the cost-effectiveness model. In secondary education, important progress can be made to reach a target of 70% net enrolment (with important expected positive externalities for economic growth), again by enhancing the share of trained teachers, expand coverage of school demand subsidies and improve class infra-

[23] This is about US$ 17 in per capita terms and about US$ 55 per secondary school student.

structure. Again, the target is within reach for the poor and non-poor urban population by 2007 at a possible additional cost of between 0.1 and 0.6% of GDP, whether concentrating on just targeted demand subsidies or on a combined improvement in teacher quality, demand subsidy coverage and availability of school infrastructure. The latter option would also have a visible impact on secondary school enrolment in rural areas, but still far off target given the extremely low initial levels of schooling access in those parts of the country. Reaching the 70% target for the rural population will require a much longer time period. The required extra budget costs for enhanced secondary school enrolment are thus much more substantial than in the case of primary education. Again, however, one could consider adjusting upward the currently very favourable pupil-teacher ratio to free up resources for the more cost-effective budget allocation, but in doing so one has to consider the political and social cost of reducing the number of teachers.

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APPENDICES

TABLE A.1
Ecuador: Cost-effectiveness model estimates for net enrolment in primary education
Urban area (linear multinominal logit specification**)**

	Poor			Non-poor		
	Coefficient	ey/ex	Significance	Coefficient	ey/ex	Significance
Public primary schools						
Education costs	-0.000027	-0.1917	0.0000	-0.000001	-2.5837	0.7130
Sex	-0.5967	0.0114	0.2160	-0.3778	-0.0749	0.3980
Age	2.2607	-0.3932	0.1510	-0.7220	2.7793	0.4450
Age squared	-0.1155	0.2491	0.2460	0.0569	-1.1970	0.2630
Education level father	-0.0941	-0.1189	0.1270	-0.0618	-0.5482	0.4080
Education level mother	0.3205	0.1282	0.0000	0.1544	-0.2880	0.2100
Location: Quito = 1	1.0787	0.0366	0.0320	1.1219	0.1464	0.1580
Region (Costa =1)	-1.1744	-0.1365	0.0580	3.9791	-0.3372	0.0020
Students per class room	0.1237	0.1130	0.0180	-0.0106	-0.7235	0.9350
% teachers with pedagogical title	6.0027	0.0806	0.0290	17.8841	1.6331	0.0000
% teachers with university degree	-0.5159	0.0190	0.8410	-14.9457	-0.3393	0.0000
% teachers appointed by Min. of Educ.	-0.7781	-0.1414	0.7480	-13.6122	-0.3799	0.0000
Constant	-15.1981		0.0330	0.0907		0.9880
Private primary schools						
Education costs	0.0000	1.3234	0.0010	0.0000	0.7400	0.0000
Sex	-0.9755	-0.1890	0.0210	-0.2050	0.0207	0.6650
Age	3.3550	8.9130	0.0010	-1.1540	-0.8189	0.2700
Age squared	-0.1804	-4.6386	0.0070	0.0785	0.3583	0.1700
Education level father	0.0442	0.8302	0.5750	0.0033	0.1547	0.9670
Education level mother	0.2249	-0.4937	0.0250	0.1910	0.0884	0.0770
Location: Quito = 1	-0.3555	-0.2506	0.5340	0.2714	-0.0411	0.7480
Region (Costa =1)	0.6222	0.9598	0.4920	4.7639	0.1050	0.0000
Students per class room	0.1235	0.1054	0.0370	0.0208	0.2062	0.8740
% teachers with pedagogical title	6.8636	0.8397	0.0110	15.5642	-0.4099	0.0010
% teachers with university degree	-0.9919	-0.2450	0.7280	-14.2165	0.0665	0.0030
% teachers appointed by Min. of Educ.	3.5209	1.1420	0.2750	-12.0046	0.0941	0.0010
Constant	-25.9500		0.0000	-1.1238		0.8740

Rural area (linear probit specification)

	Poor		Non-poor	
	dF/dx	**Significance**	**dF/dx**	**Significance**
Education costs	0.0600	0.0000	0.000018	0.0000
Sex	0.0064	0.3610	-0.000001	0.0310
Age	1.5210	0.0000	0.000069	0.0260
Age squared	-0.6908	0.0020	-0.000033	0.0290
Education level mother	0.0618	0.0000	0.0000000	0.9860
Region	-0.0097	0.2990	-0.000001	0.4490
Indigenous	0.0069	0.1620	0.000000	0.4080
Distance to school (minutes)	0.0294	0.0000	0.000000	0.6500
Students per class room	-0.0726	0.0110	0.000001	0.7310
% teachers with pedagogical title	0.0130	0.8400	0.000006	0.5270
% teachers with university degree	0.0027	0.8800	0.000001	0.4390
% teachers appointed by Min. of Educ.	-0.0333	0.0980	0.000001	0.3220

Source: Model estimations based on 1999 LSMS survey. See text for model specifications.

TABLE A.2
Ecuador: Cost-effectiveness model estimates for net enrolment in secondary education
Urban area (linear multinominal logit specification)

	Poor			Non-poor		
Public secondary school	Coefficient	ey/ex	Significance	Coefficient	ey/ex	Significance
Cost of education	-0.000019	-0.3985	0.0000	0.000000	-0.8523	0.9340
Sex	-0.2796	-0.0290	0.3970	0.9066	0.1090	0.0180
Age	0.2487	-3.2119	0.9210	-1.7310	-5.4009	0.3420
Age squared	-0.0172	1.2286	0.8390	0.0418	2.4139	0.4910
Education level father	0.0045	-0.0218	0.9340	-0.0325	-0.2375	0.4610
Education level mother	0.1979	0.3577	0.0000	0.0470	-0.1493	0.4090
Location: Quito=1	1.2882	0.0542	0.0020	0.1468	-0.1099	0.7280
Region=1	0.0726	0.0356	0.8970	0.1988	-0.1817	0.5740
Students per class room	-0.0236	-0.1924	0.1740	-0.0318	-0.2183	0.0420
% teachers with pedagogical title	1.9620	0.3597	0.1770	0.1903	0.1735	0.9140
% teachers with university degree	2.4618	0.4110	0.1930	3.3823	0.3263	0.3070
% teachers appointed by MoE	-0.3782	-0.0406	0.6450	-0.4420	-0.4606	0.6670
constant	-1.2675		0.9460	15.8299		0.2360
Private secondary school						
Cost of education	0.0000	1.4028	0.0970	0.0000	1.1235	0.0000
Sex	-0.5317	-0.1644	0.1420	0.5234	-0.0756	0.0330
Age	6.4239	88.6001	0.0060	-1.1477	3.1634	0.4510
Age squared	-0.2314	-46.6608	0.0030	0.0227	-1.7566	0.6620
Education level father	0.1081	0.6119	0.2910	0.0141	0.2577	0.7160
Education level mother	-0.0512	-1.1985	0.5000	0.0886	0.2679	0.1230
Location: Quito=1	-1.4118	-0.2939	0.1040	1.2810	0.1491	0.0090
Region=1	-0.7381	-0.5100	0.3180	1.0006	0.2544	0.1010
Students per class room	-0.0235	-0.1897	0.4170	-0.0223	0.1143	0.4110
% teachers with pedagogical title	1.6887	0.1507	0.4160	-0.3030	-0.2046	0.8900
% teachers with university degree	4.3349	1.9768	0.2020	3.0135	0.0136	0.4170
% teachers appointed by MoE	-0.1866	0.0397	0.8960	2.1059	0.5753	0.0590
constant	-49.2689		0.0100	7.2154		0.5190

Rural area (linear probit specification)

	Poor		Non-poor	
	eF/ex	**P>|z|**	**eF/ex**	**P>|z|**
Cost of education	-0.2014	0.0960	0.084431	0.1410
Sex	0.1912	0.0170	0.006152	0.9040
Age	3.5508	0.7250	8.096060	0.3340
Age squared	-2.5069	0.6260	-4.157873	0.3210
Education level mother	0.6467	0.0000	0.3386719	0.0000
Region	-0.0057	0.9440	-0.100778	0.0520
Distance to school (minutes)	-0.0182	0.8970	0.016891	0.8190
Students per class room	-0.0814	0.6840	0.142810	0.1560
Students per aula	-0.1882	0.7550	0.641201	0.0140
% teachers with pedagogical title	0.1772	0.4730	-0.158695	0.4740
% teachers with university degree	-0.2770	0.2540	0.054971	0.6720

Source: Model estimations based on 1999 LSMS survey. See text for model specifications.