Education, Marriage and Adolescent Welfare: Challenges, Programs and Projections

UNFPA Project UNFPAUSA/14/037
Investment in Improving Health, Education and other Outcomes for Adolescents

Supporting Paper

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December 2015

2015
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1 Background and introduction

Education is one of the most important keys to many socio-economic improvements. Around the globe, the number of years that children and adolescents spend in school has been rising, uninterrupted for more than a century (Morrison and Murty, 2010). In the OECD, and in many Central- and East- Asian countries, children can expect 12 or more average years of schooling (excluding preschool), and in Latin America, the Middle East this level will be reached within a decade (extrapolation based on Barro and Lee, 2015). South Asia and Sub-Saharan Africa lag behind, but there too, years of schooling are rising, almost inexorably, towards the SDG education goal of full primary and secondary education for all. Despite such progress, in many developing countries, education opportunities for children and adolescents are constrained, and the outcomes are poor, including: large numbers of children never enter school, high portions of adolescents drop out early before finishing secondary, or even primary school; and low levels of learning. The situation is exacerbated for children from marginalized groups – in particular, those who are poor, rural, female, disabled, from a minority, or living in conflict zones (for three recent global reports see, e.g. UNESCO, 2015; UNICEF, 2015a; UIS and UNICEF, 2015).

Formal school education is a long process that starts in early childhood and can lengthen into early adulthood. There are particular challenges faced by persons in different age-groups – early childhood, pre-adolescence, adolescence and early adulthood. This report focuses on the formal education challenges of adolescents.

Three major hurdles exist to obtaining a full round of schooling: entering school, remaining in school, and *learning in school.* The first two of these map, fairly cleanly, to pre-adolescence, and adolescence respectively. The education challenges in pre-adolescence and in adolescence are quite distinct. For young children, education barriers relate to entry; for adolescents, the risks relate to early drop out. ***This study, which is focused on education risk for adolescents, concentrates on dropout risks.***

The remainder of this report explores the issues of adolescent school risks, how to mitigate them, and how much education prospects of adolescents would be enhanced as a result of a selected package of focused interventions. The report also discusses marriage, as this may be a substantial contributor to girl adolescent early school departure, although marriage is discussed more in a separate supportive paper (Rasmussen and Maharaj, 2015). The rest of the report is organized as follows.

Section 2 provides a brief comparative summary of the education challenge for adolescents in low-and middle- income countries, showing the range of the risks of dropping out, expected years of schooling, and learning (observed and estimated). Most of this review of school access and dropout is based on global education reports by UNESCO, UIS, and the Global Partnership for Education, and data from the UNESCO Institute of Statistics. This section also includes a discussion of estimates of learning achievement. Work by economists has shown that, as one might expect, learning levels or skills, are much more important predictors of economic output measures, than simply years of schooling (Hanushek and Woessmann, 2010; Barro and Sala-i-Martin, 2004: Ch 12). Unfortunately, measures of

learning achievement are spotty for low- and middle-income countries. In an attempt to get a more comprehensive picture, authors have created synthetic measures based on multiple international assessments (Hanushek and Woessmann, 2010; Altinok, 2012; Altinok, et al. 2014; Angrist, et al. 2013). Even these do not cover more than 40 low- and middle-income countries. EPDC (2010) estimated missing scores based on correlations of observed achievement with other, more commonly observed socio-economic variables. Section 2 includes the description of an updated estimate for missing scores developed for this project.

Section 3 is an analysis and discussion of risk factors for adolescent dropout. We know from earlier research that adolescents who are poor, are girls, live in rural areas, and are from particular nomadic minorities have much lower chances of reaching the end of secondary school. Most of the multi-country analysis of differential school access is descriptive in nature (e.g. EPDC, 2005; UNESCO, 2013; UIS, 2015; GPE, 2012 cover large groups of low- and middle-income countries). More detailed multivariate analysis of factors that contribute to early school dropout exist for individual countries, and tend to be focused on the primary school level – many, for individual countries can be found in the Country Education Status Reports published by the World Bank, Pole de Dakar and national education Ministries. This section contributes to this state of knowledge with a multi-national component analysis of the four risk factors appear as the most prominent determinants of adolescent school dropout: poverty, early marriage, girl sex, and rural location.

Section 4 provides a review of interventions that can reduce the risk of early dropout or of learning failure among adolescents. Overviews of what interventions work to Increase school access and improve learning have been summarized, e.g. in UNESCO (2004), UNICEF (2015), UIS and UNICEF (2015). In addition, there has been a recently flurry of comparative meta-analyses on learning (Conn, 2014; McEwan, 2012; Glewwe, et al. 2011; Kremer, et al. 2013; Krishnaratne, et al. 2013; Murnane and Ganimian, 2014) and two “meta-meta” analyses (Evans and Popova, 2015; UNICEF, 2015). Each meta-analysis includes its own set of studies; and, as Evans and Popova (2015) point out, there is not much overlap. However, one can also use this observation to expand the universe of vetted studies (UNICEF, 2015). Our analysis here is based on four meta-analyses and the “meta-meta” analysis of UNICEF, which also includes UNICEF’s Simulations for Equity in Education database. None of the analyses mentioned focuses specifically on adolescents or secondary school; most of the focus is on primary. This section is a first attempt to rectify this imbalance by selectively analyzing interventions specifically for adolescents in this literature. The “adolescent lens” also allowed us to identify two sets of interventions that have been completely ignored in the existing education interventions reviews, namely: programs to reduce child marriage rates, and comprehensive sexual education programs to reduce pregnancy rates.

Section 5 focuses on the model work. The adolescent education and marriage model allows us to put the initial data, risk groups, and interventions together in a consistent framework which can be used to make alternative projections of future education trajectories and costs, based on assumptions regarding intervention programs. The model developed for this project is brings together two broad streams of modeling. On the one side are traditional education models. These are *target-driven* models that project future numbers of pupils and education attainment based on assumptions regarding targets, such as

universal primary school attendance, and compute costs based on projections of the number of school age children and unit costs. Examples of this approach are: Colclough and Lewin (1993), Bruns et al. (2003), Delamonica et al. (2004), UNESCO (2008) and Wils (2015) used for UNESCO (2015). In contrast are global health models, such as the Marginalized Budgeting for Bottlenecks (MBB) and One Health Tool, project health outcomes – incidence, morbidity, and mortality – through assumed health packages. Say that a user is interested in reducing TB; in the TB module, they will identify to what level a health package will be scaled up (the percentage of the population to be covered). The model then computes the costs, based on a matrix of unit costs and the scale of the intended program, and the mortality reductions, based on the evidence of the effectiveness of the health package (e.g. WHO, 2013; Carrera et al. 2014). In 2011, UNICEF and the World Bank embarked on a project to develop a similar type of model for education, called the Simulations for Equity in Education (SEE). This is a country specific model that has been piloted in a small number of developing countries.

The target-led UNESCO (2015) costing model included the analysis and projection of 82 low- and lower-middle income countries. All of the background data for these countries are in the tool, and a user can define a set of global targets, which can then be applied to projections for all countries in a macro-run. Scenarios differ with regards to the targets posited, rather than how those targets are attained. The results are being used as the baseline for education costs of achieving the new SDG education goals.

While the target-led approach is useful to create a base case for the costs of achieving particular targets, its setup precludes an analysis of how different education intervention packages might lead to more cost-effective paths. In 2011, UNICEF decided to apply the intervention-led approach from health to education, and commissioned the development of the Simulations for Equity in Education model. It has been successfully piloted in a small number of countries (Ghana, Bolivia, Pakistan, Burkina Faso, and in others by the World Bank). The two main advantages of the SEE model are a) that alternative intervention packages can be compared and b) that interventions can be focused on marginalized groups.

For the UNFPA adolescent welfare project, aspects of these two education models were brought together, although most of the computations in the tool are entirely new. The result is a tool for making intervention- or target-led education scenarios for a large number of countries with a particular focus on interventions for adolescents. In the course of the project, interventions to reduce early marriage were also added, and this additional module is discussion separately below. Section 5 presents the new model, and the results of two scenarios – a base scenario with no interventions; and an interventions scenario.

2 Summary of the education challenge for adolescents in low- and lower-middle income countries

As mentioned above, there are three hurdles to receiving a full education: school entry, school retention, and learning while in school. The barrier to school entry is real. Of the 650 million primary school age children in the world today, 45 million will not enter school or will enter school late (25 and 20 million respectively, UIS, 2015), and if a child has not started school by age 11-13, the chances that he or she will do so at a later age are essentially nil. Most of the children who do not enter school are poor, rural, girls, nomadic, or disabled, or a combination of these factors (see e.g. UNESCO, 2015; UIS, 2015). That said, for the children who do have the opportunity to start school, the vast majority is able to remain in school until the onset of adolescence.

This study does not focus on this important issue of school entry, as it is outside the realm of adolescence. However, the consequences of failed school entry (i.e. the proportion of adolescents and young adults with no schooling) are important factors in low economic outcomes for adolescents, higher health risks, and higher marriage rates. In the projections, school entry is taken as an exogenous variable.

This section presents a broad picture of the state of adolescent schooling. To begin, this section provides some descriptive statistics of education for the 48 Countdown countries for which we obtained data from a DHS or a MICS household survey[1].

Figure 1 shows the distribution of education for children age 10-14 – at the beginning of adolescence – and age 15-19 – in the second half of adolescence, boys and girls together. The figures show five groups – adolescents who have never gone to school, those who are in school, those who have left with only primary, those who have left with incomplete primary, and a group who has completed secondary schooling. At age 10-14 (top panel), the vast majority of children is in school in all the countries shown, with the exception of a small group of countries with sizeable groups of children who have never gone to school – Afghanistan, Benin, Burkina Faso, Chad, Cote d'Ivoire, Ethiopia, Gambia, Guinea, Niger, Nigeria, Pakistan, Senegal, Sierra Leone, and South Sudan stand out the most in this regard. Only a small portion of children at age 10-14 has dropped out of school. By age 15-19, the picture is quite different. The percentage of adolescents who have never gone to school is the same as for the earlier age group – usually slightly higher reflecting somewhat lower school entry rates when these adolescents were in the school-entry ages (in all countries, school entry was increasing over time). But the percentages of children still enrolled are considerably smaller compared to the 10-14, as larger groups of adolescents have left school. Many have left school with only primary (green portion of bars) or incomplete secondary (purple portion). The aqua portion of the bars shows adolescents in this age group who have completed the full round of secondary schooling. The few countries were this is a sizeable group at this age are: Bolivia, Egypt, Kyrgyzstan, Nepal, Peru and Tajikistan.

[1] Demographic Household Surveys and Multiple Indicator Cluster Surveys.

As the figures suggest, adolescents, contrary to younger children, face pressure to leave school. As young people progress through their teen years, the probability that they will drop out of school early (before completing secondary) increases rapidly (UNICEF, 2015:105; GPE, 2012:66).

Figure 2 shows the percentage of children who have dropped out of school by age groups. As mentioned, and as shown here, up to age 11, dropout is very uncommon, below 10% in all countries in the figure. By age 12-14 drop out creeps upward; in eight of the countries shown, 10-20 percent of students will leave school. Beyond age 15, the risk of dropout increases multifold as employment opportunities, child marriage and family care make increasing demands on adolescents' time.

As a result of late entry, high repetition rates, and early adolescent dropout, the grades attained by the end of adolescence at age 18-20 can be quite few. Figure 3 shows mean grade attainment for adolescents age 18-20 who had gone to school, in 47 developing countries with a recent DHS survey. In the group of countries on the left side of the figure, the mean grade of leaving school is *only just equal to completed primary school*[2].

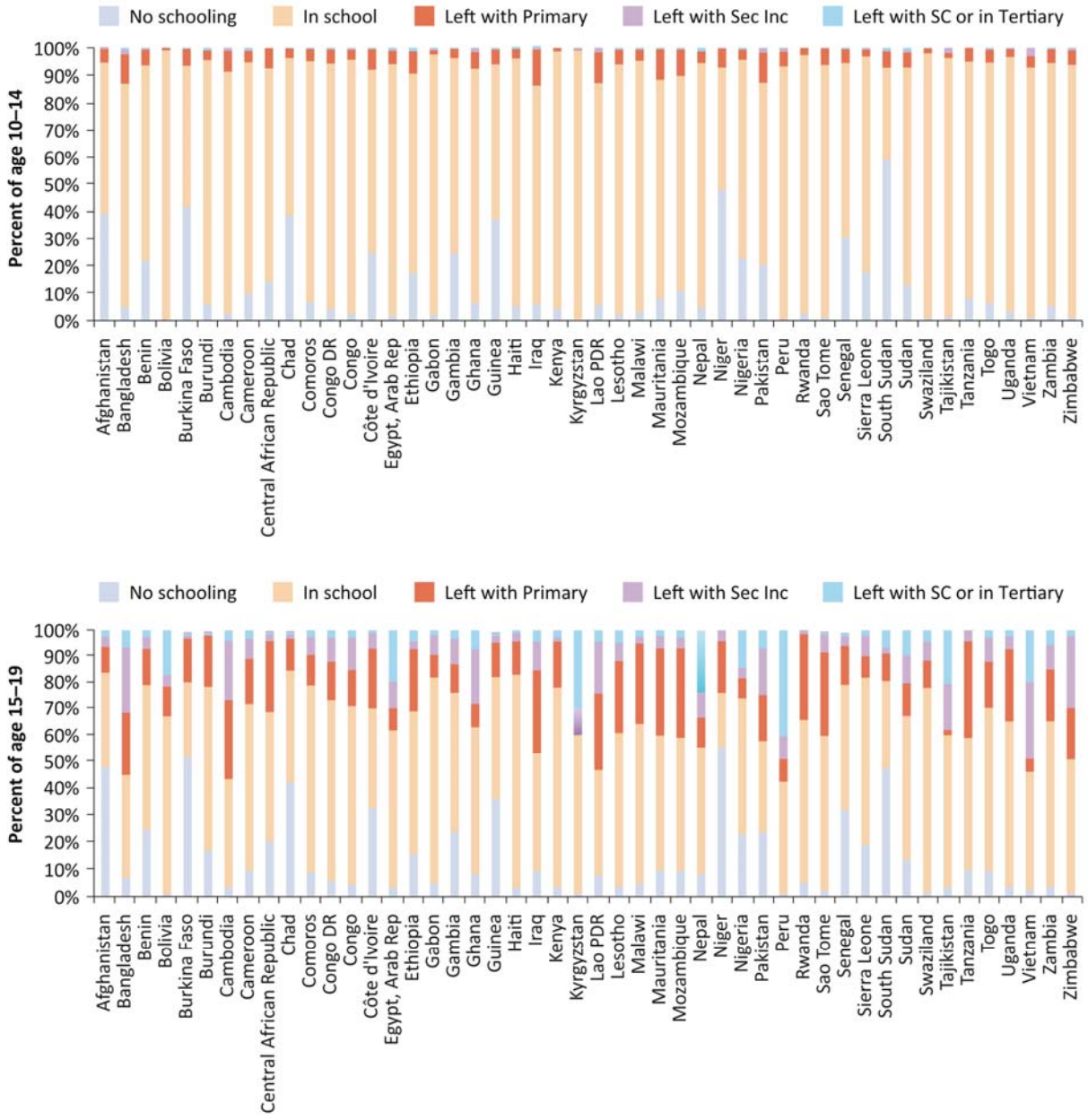
Lifetime prospects of adolescents who leave school early are greatly compromised. Girls are at risk of early marriage and child bearing. Both sexes are more likely live in poverty as adults, and in general to have lower incomes; and their health and that of their children is likely to be worse as a result of low education levels.

In addition to risks of dropout, many adolescents (and younger children) in developing countries acquire far fewer skills and less knowledge compared to their peers in OECD and wealthy East Asian countries. International assessments of learning achievement have shown this. There are three global assessment series, TIMSS, PIRLS, and PISA, which each cover some low- and middle- income countries, and there are regional assessment series covering additional low- and middle-income countries, LLECE (in Latin America), SACMEQ (in Southern Africa), and PASEC (in Francophone Africa) [3]. Altogether, between 2005 and 2015, about half of the world's countries participated in at least one of these six assessment series.

[2] Note that mean grade schooling in this figure does not include those who never attended school. It is distinct from the average years of schooling measure used by UNESCO, which includes those who have never attended school.

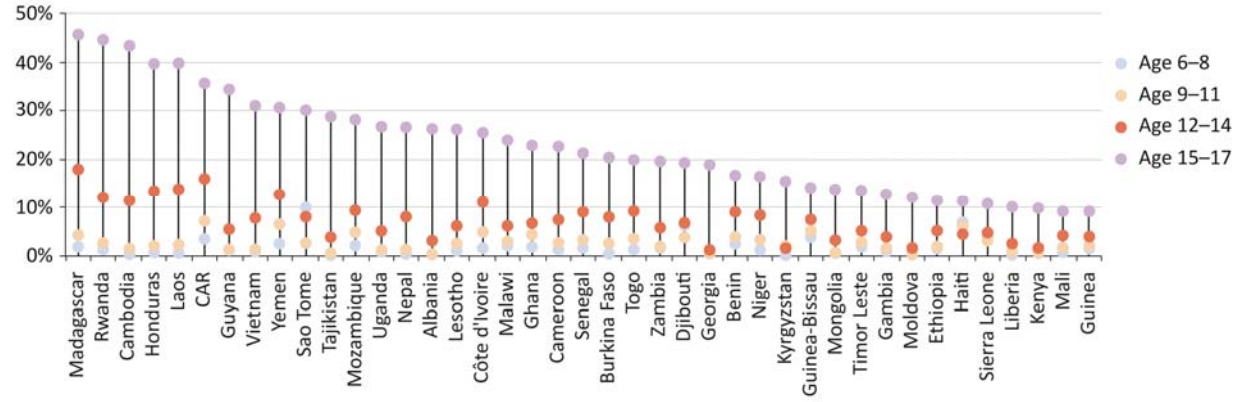
[3] TIMMS = Trends in International Mathematics and Science Study; PIRLS = Progress in International Reading Literacy Study; PISA = Programme for International Student Assessment; SACMEQ = Southern and Eastern Africa Consortium for Monitoring Education Quality; PASEC = Programme on the Analysis of Education Systems; LLECE = Latin American Laboratory for Assessment of the Quality of Education.

Figure 1 Distribution of children age 10-14 and age 15-19 by school status – no schooling, in school, left school with primary, left school with incomplete secondary, attained completed secondary, for Countdown countries



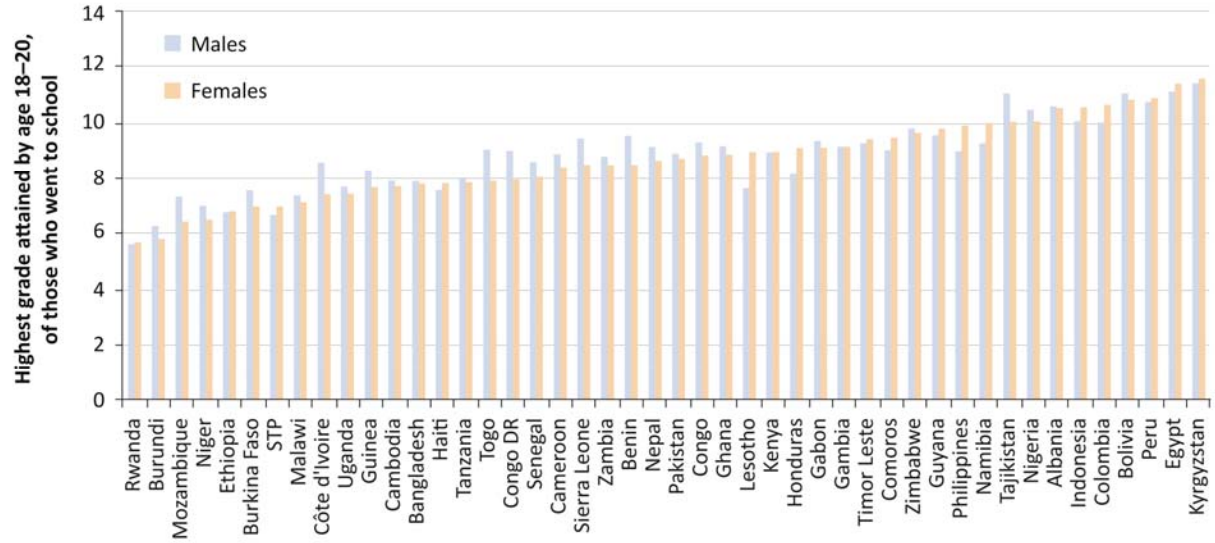
Source: DHS or MICS dataset.

Figure 2 Percentage of children who have dropped out of school by age group, contingent on ever-attending school



Source: GPE (2012).

Figure 3 Mean grade attainment of adolescents age 18-20, who had gone to school



Source: Author's extractions from 47 DHS surveys.

It is known that grades, or years of schooling, by themselves, do not make an educated or skilled population. Hanushek and Woessmann (2010) and Barro and Sala-i-Martin (2004: Ch 12) among others, found that cognitive skills are a very strong predictor of GDP growth – in their models, the observed GDP differences today are (with other factors) the cumulative result of years of cognitive skill differentials, or, the cumulative result of differences in education quantity and quality. These authors also show cognitive skills do not necessarily correspond to educational attainment – because of the enormous quality differences – in some countries, years of schooling amount to little benefit in terms of knowledge.

A growing body of learning assessments has illuminated the very low levels of learning in many developing countries, where even basic skills, such as reading a simple text, or single-digit multiplication are not mastered by large portions of pupils in the upper grades of primary school (e.g. UNESCO, 2004 for an early global overview).

There is no consistent, global education quality indicator – in the way that there are global indicators of quantity such as enrolment rates, completion rates and so forth. Comparable learning measures can found within the series of international learning assessments mentioned above, but each of these includes only a sample of the world's nations.

In order to make global, standardized estimates of learning achievement, a small group of experts has, over the past 15 years, transformed the scores from the different assessments to standardized measures (Hanushek and Kimko, 2000; Hanushek and Woessmann, 2009; Altinok, 2012; Altinok, et al. 2014; Angrist, et al. 2013). While there are differences in these methods, and the methodology has evolved, over time, basic approach is the same: 1) the scores of the three global assessment series (TIMSS, PIRLS, and PISA) are standardized using the US scores as anchor (the US has participated in all the global assessments since the 1970s); 2) the scores from the three regional assessment series (SACMEQ, PASEC, and LLECE) are standardized using countries that have participated in one of these tests and a global assessment as anchors; and 3) the scores are standardized over time using the US scores from a US assessment that has been in use since 1971 – the NEAP. The Angrist et al. estimates are available from the World Bank and these includes 110 countries for the years 2000-2010. This is the most comprehensive set of publicly available, comparable learning achievement scores. The World Bank database standardized scores to a median of 50 with a standard deviation of 10. A four-point change in the score is (very) roughly equal to one year of learning[4].

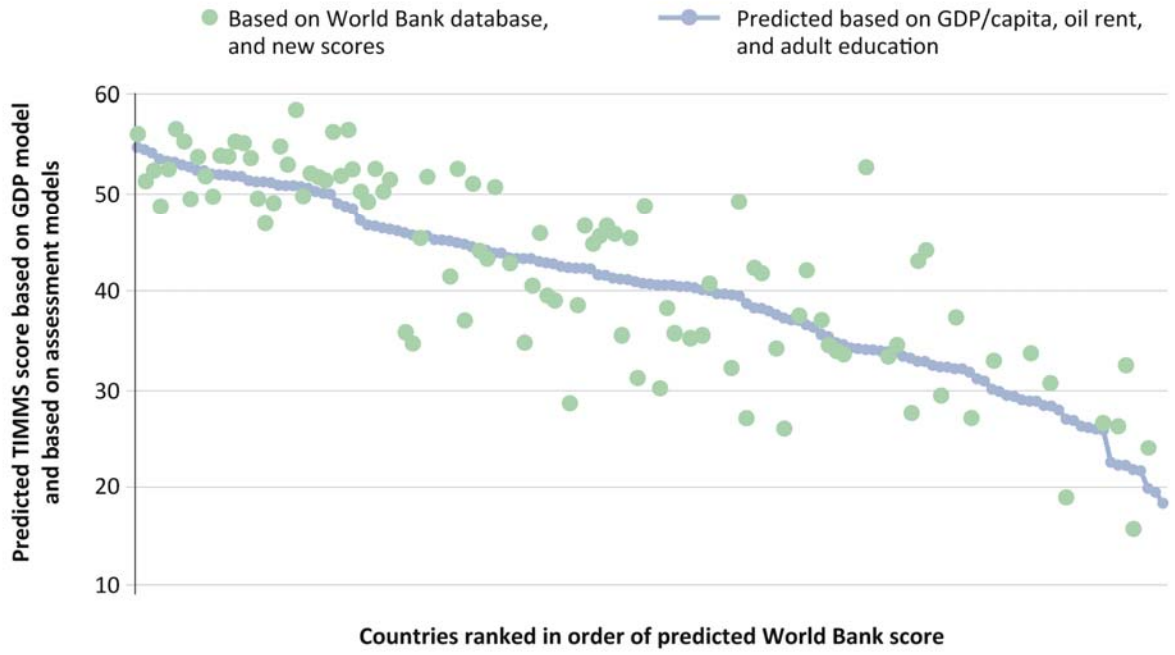
Many developing countries are missing from the World Bank dataset. Some of these missing countries participated in the 2011 rounds of PIRLS and TIMSS, and in the 2012 round of PISA. We can increase the total number of countries with reasonable learning achievement estimates to 118 by including these tests, again using countries that participated in two tests to anchor the transformations.

For the remaining countries, the only options are to remain silent on learning achievement, or to make estimates based on correlations to other, observed variables. This is risky politically because countries presumably will not like to see themselves with an estimated low score in the absence of having had a chance to prove otherwise, but for the sake of the project an attempt is made. As one would expect, for the countries for which we have data, there is a relatively strong correlation with common measures of development such as adult educational attainment (parent effect), and GDP per capita. We obtain an R^2 of .72 with a simple three-variable multivariate OLS regression of adult attainment 25-34 (from Barro and Lee, 2015); the log of GDP per capita in current US$; and extraction rent (both from World Bank Development tables). This very simple model is used to generate a learning achievement estimate for an additional 23 countries without learning observations, bringing the total number of countries with

[4] This is roughly equivalent to 40 points in the PISA test, which is approximately one year of learning (OECD, 2015).

learning achievement estimates to 141. This estimation covers 54 of the 76 countries in the project. The estimated scores are shown in Figure 4.

Figure 4 Estimated learning scores



Source: From the World Bank learning achievement database, updated with estimates based on 2011 PIRLS and TIMSS, and 2012 PISA scores.

3 Marginal effects of risk factors on drop out probability

Adolescent dropout rates are variable, and correlated to a number of prominent risk factors (UNESCO, 2015 and the Out of School Initiative reports). Four important risk factors stand out: poverty, marital status, girl sex, and rural location. For this study, one of our early activities was an analysis of the marginal effects of these four risk factors on dropout – girl sex, early marriage, poverty and rural location. The most important finding from this analysis is that *the adolescent girl-specific risks of secondary school dropout almost completely overlap with adolescent girls' risk of early marriage*. Being married and being in school is almost completely mutually exclusive, that is, if a girl is married, she is almost surely not in school (although not all out-of-school girls are married). The causality of this relationship is not entirely clear and there appear to be complex, reciprocal dynamics (Nguyen and Wodon, 2012a, 2012b). At any point, a girl (or her parents) can choose to go to school or get married; in this sense, marriage does not cause dropout, it is an alternative choice. If the weight of the marriage alternative is reduced in this choice, due to changes in the girls' context that reduce the likelihood of marriage, then it is more likely that she will remain in school.

3.1 Descriptive analysis

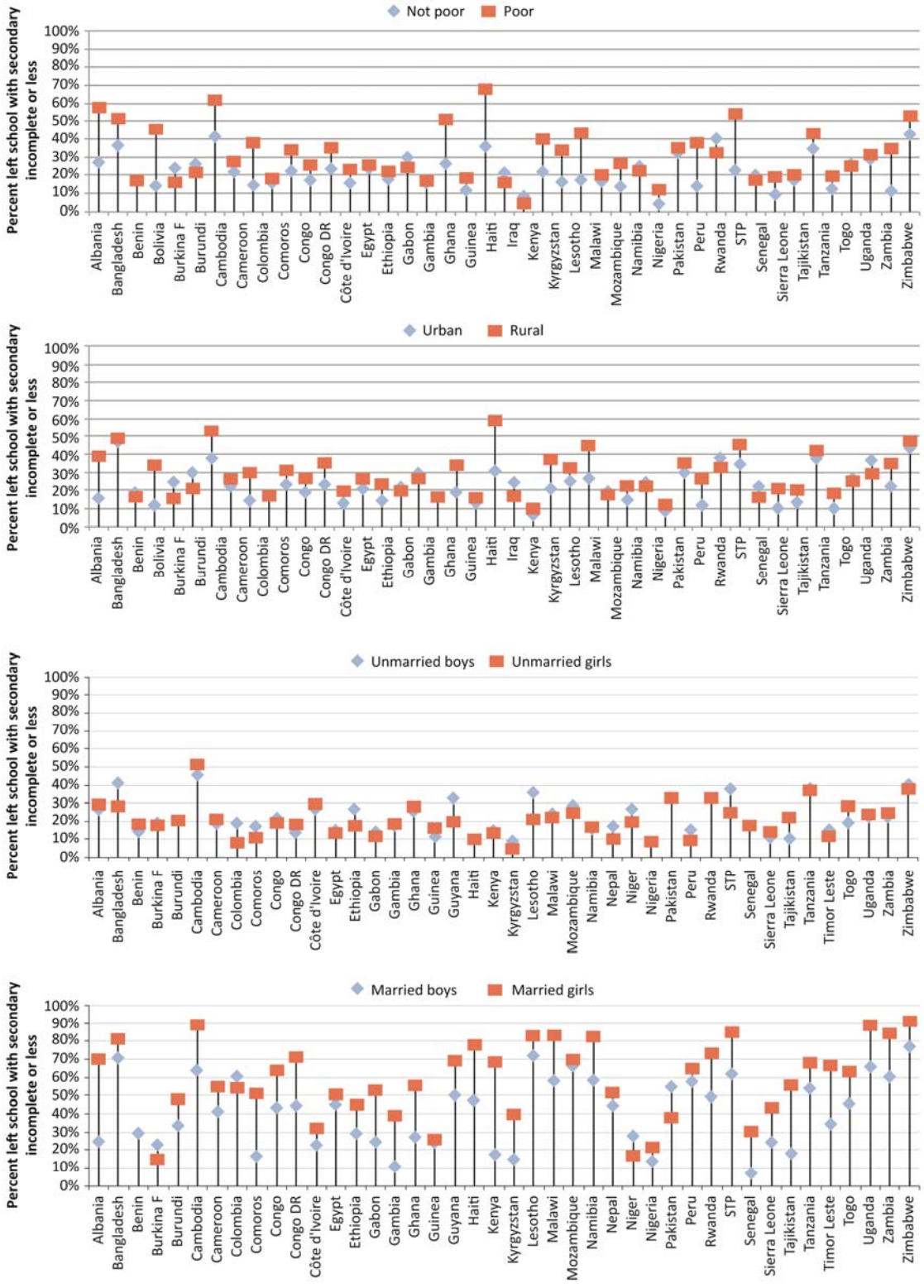
From our reading of the literature a number risk factors stand out for drop out before completing upper secondary: poverty, marital status, girl sex, rural location, disability, living with conflict, certain ethnic groups. Of these, the first four are available easily and consistently in DHS and MICS datasets. The analysis below focuses on these four; not because the other variables are not important, but because at this time, data limitations make it impossible to include them in a multi-country statistical analysis.

As mentioned, early marriage and staying in school are, in some countries, alternate choices for adolescent girls. Figure 5 shows the percentage of adolescents age 15-19 who dropped out of school early with incomplete secondary or less, separated by risk factor for 47 countries with DHS surveys. The top panel shows the percentages of early dropouts who are poor and not poor; the second panel shows the dropped out percentages for rural and urban adolescents; the third for unmarried boys and girls; and the fourth for married boys and girls.

It is clear that poverty is correlated with a higher risk of early dropout. In some countries, poor adolescents are about twice as likely to have dropped out early – Albania, Cambodia, Colombia, Guyana, Honduras, Lesotho, Malawi, Mozambique, Sao Tome and Principe, and Zambia. Rural location is also correlated with higher dropout risks, although overall, the differences between rural and urban dropout are smaller than the differences by wealth.

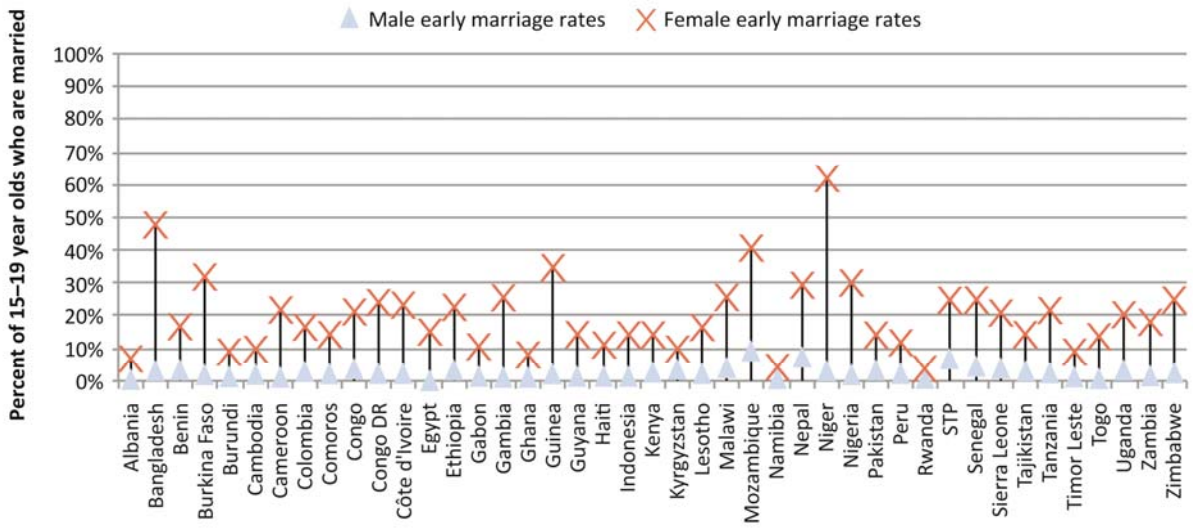
The bottom two panels show an interesting pattern related to sex and marriage, namely that the different *patterns of marriage account for almost all of the dropout differences between boys and girls.* For unmarried male and female adolescents, the dropout percentages *are almost equal.* In some countries, unmarried girls are *more* likely to still be in school at age 15-19 than unmarried girls. On the other hand, for those who are married, first, the likelihood of having dropped out is much higher compared to unmarried peers, and second, the likelihood of having dropped out early is higher for females than for males. Girls are far more likely to be married at age 15-19 (see Figure 6), and the combined risk of female sex and marriage causes girls to have higher dropout rates than boys.

Figure 5 Percentage of adolescent age 15-19, who have dropped out of school before completing secondary, separated for four risk factors: poverty, rural location, sex, and marital status



Source: Author's extractions from DHS surveys.

Figure 6 Percentage of 15-19 year-olds who are married, by sex, in 42 countries with recent DHS surveys



Source: Author's extractions.

3.2 Methodology for dropout risk analysis

The figures above show that poverty, rural location, and a combined effect of marriage and girl sex, correlate with a higher likelihood of dropping out of school before completing upper secondary. The results for poverty and rural location are similar to what has been found for other school-related indicators, such as enrolment rates.

To further understand the impacts of these four risk factors on dropout, and to obtain the independent contribution of each factor to dropout rates, our next step is a regression analysis. Our approach is based on the model developed by Hattori (2014) of the probability of being out of school, contingent on sex, and poverty and rural status. We run a series of regressions for each country separately.

3.2.1 Creation of the dataset

We use household surveys from DHS and MICS, compiling the most recent available micro-datasets for each country from 2008 onward. We combined the micro-datasets into two meta-files, one containing DHS and the second containing all the MICS surveys, and saved only variables related to the regression – age, sex, location, marital status, wealth indices, and responses related to educational status, and created a number of new variables related to dropout, wealth, and marital-education status. This file was used for creating the variables for our analysis.

Creating a drop-out risk variable

For each respondent, the micro-datasets provide the following information: Did the household member ever attend school; Is the household member still in school?; What is the highest grade of schooling

attained or attending this year. From this, we can create a dropout variable – these are the respondents who have attended school, but are no longer doing so. The highest educational attainment tells us at what grade the respondent left school, or, what grade the respondent is attending now. This information is not enough to create a dropout *flow* (there is too much age-specific variability to create an artificial cohort), but it can be used to estimate the risk of having dropped out by age X. We created two binary dropout variables: a) the 0-1 status of having dropped out of school by age 13-15 (an age-aggregated group); and b) the 0-1 status of having dropped out of school before finishing secondary by age 18-20.

Creating a marital-education status variable
The marital status variable is a simple aggregation of marital states – with "never-married" as a zero value, and all other marital states as a value of one. Education attainment was grouped into six aggregated levels: never went to school, still in school, left school with primary only, left school with incomplete secondary, completed secondary not in school, completed secondary and attending tertiary. Combining the two sets of states created a twelve-state marital-education status variable.

Creating an absolute index for poverty with household data
We also created an absolute "poor" measure. Virtually all analyses of wealth impacts with the DHS and MICS surveys use the so-called wealth quintiles as the measure of wealth. For a country analysis, the quintiles are useful because they differentiate within the country. Across countries however, the quintiles are problematic because they measure completely different absolute wealth, depending on the country. It would be more desirable to have a relatively comparable measure of "poor" across the different surveys. That is what our "poor" measure does.

All DHS and MICS surveys have a five-digit wealth index based on materials and capital owned by the household. These indices are not necessarily consistent across the surveys, but they do provide an absolute wealth ranking possibility. Conventionally, these are used to create the wealth quintiles, dividing the household population into five equally sized groups of hierarchical wealth. For our comparable "poor" variable, we used a simple but effective device. The World Bank publishes the percentage of people living below $1.25 per day. This percentage can be used to create a cut-off point in the hierarchical ranking of the five-digit wealth indices for each country. Households below the cut-off are labeled "poor"; and those above are "non-poor".

3.2.2 Regression analysis

These standardized variables are the components of our multi-variate dropout risk models, using the method developed by Hattori. All of the variables in our regression are binary – the status of having dropped out is the binary dependent variable; and female sex, and marriage, poverty status, and rural status are all 0-1 variables. Both of these series provide consistent micro-datasets, with only minor differences. To run the models, we first run a logit regression in Stata using the command
logit dropoutearlyv sexv poor rural if age19==1 & everschoolv==1 & country=="Country" [pw=weight],
The logit results were transformed into marginal effects using the *mfx2, replace* command.

We focused on two models. Model A computes the risk of dropout before age 19 without completing secondary, dependent on: girl sex, poor status, rural location status. Model B adds being married as an independent risk, but only for countries with a DHS survey because the MICS surveys only had marital status for limited populations.

We consider the results for a country valid if: a) the regression converged; and b) the p-values for the model overall were very small relative to the Chi values (often the Prob > chi2 values were 0.0000). We consider variables to be valid predictors if the p-value of the variable <.1. Most of the variables were significant with p-values <.001. If the p-value was greater than .1, the coefficients were not used in the model. Although colinearity is a concern, given that poverty and rural location, as well as marital status and girl sex are correlated, the regression results are generally stable, with significant values for all four indicators. The marginal effects, standard errors and levels of significance are shown in a table in the Appendix.

The transformed logit results provide only the marginal effects of the risk variables. To create a model that would predict dropout overall, we added the dropout out rate at age 19 for the reference group – urban, non-poor, (unmarried), males. This is the base, or constant in our model.

The resulting theoretical risk model for dropout is then a linear equation based on the base dropout risk of the reference group, and marginal effects of the risk factors, and prevalence of the risk factors:

$$d_n = c_n + \beta_n^m p_n^m + \beta_n^g p_n^g + \beta_n^p p_n^p + \beta_n^r p_n^r \qquad (1)$$

where d is the risk of dropout before age 19 without completing secondary; n denotes the country; c is the dropout risk of the reference group, the β's are the marginal effects of the risk factors, the p's are the prevalence rates of the risk factors; and *m, g, p,* and *r*, refer to marriage, girl sex, poor status, and rural location respectively. Model A omits the parameters for marriage.

The predictions of dropout using the model parameters were compared to the observed dropout levels in each country and found to be a good fit.

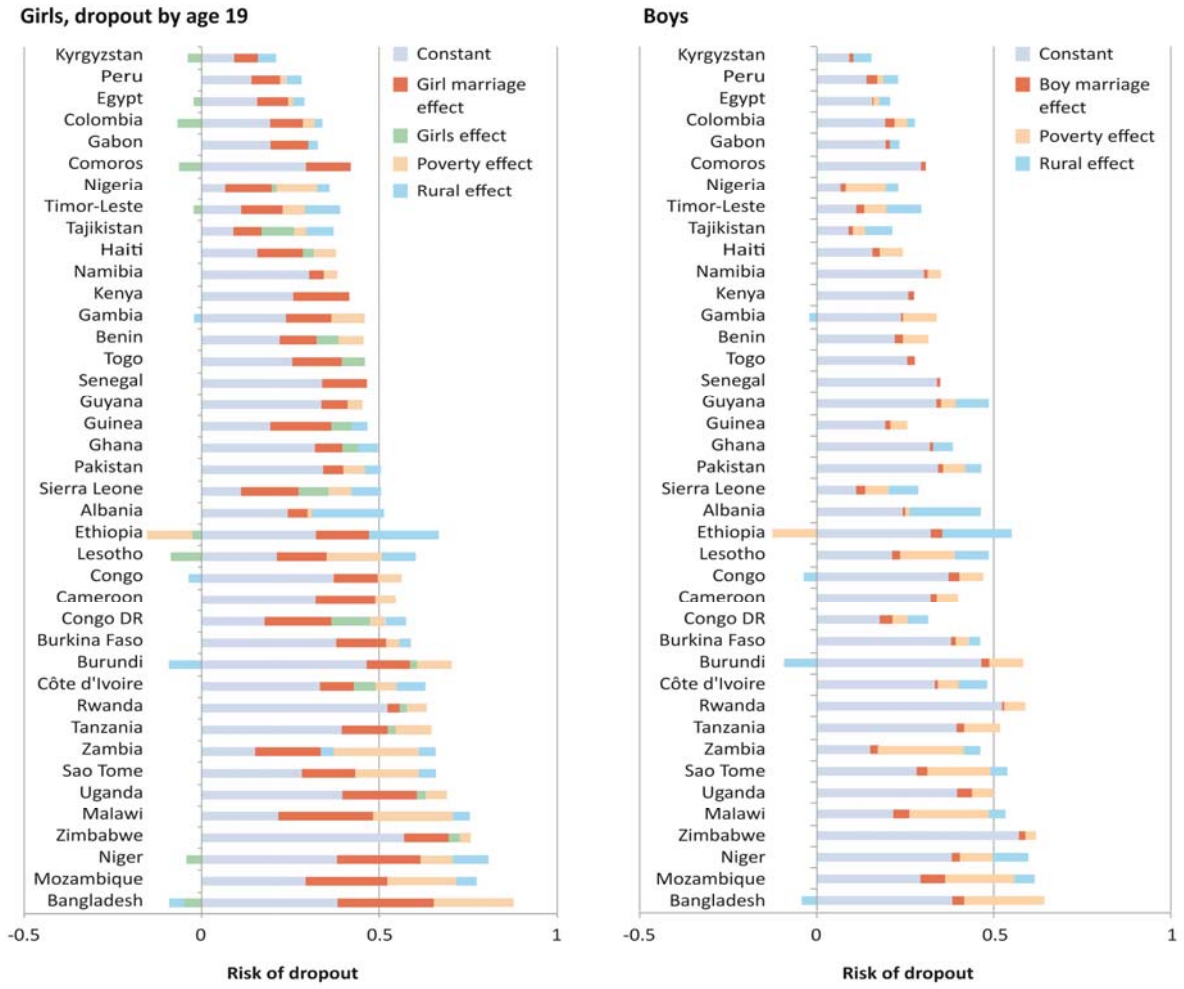
3.2.3 Results: poverty, rural location, and marriage or girl sex as dropout risks for adolescents

The results of this analysis confirm that poverty stands out as a strong risk factor, and rural location, in most countries as a weaker, but still substantial risk. This mirrors earlier findings by others (e.g. UNESCO, 2015; data in the UNESCO-WIDE database).

More interestingly, the analysis highlights the dynamic between girl sex and early marriage.
Figure 7 shows the factors of dropout risk – with the reference group level, and marginal effects of early marriage, girl sex, poor status, rural location – in 41 countries with DHS surveys, for which we could run Model B with marriage. On the left is the model for girls; and on the right, the model for boys.
Obviously, the "girl sex" marginal effect does not exist for boys, but the marriage effect is also small –

even though the marginal effect parameter is the same for boys, male early marriage is so rare that the overall impact of boy marriage on dropout is small – leading to lower dropout risks for boys.

Figure 7 Constant, and marginal effects of four risk-factors on the probability of leaving school before the age of 19 and before completing upper secondary education, 41 developing countries, female and male adolescents



Note: See Appendix C for table with marginal effects by country.
Source: Author's analysis of DHS surveys.

The blue portion of the bars shows the constant, or, the probability of dropping out for those with none of the included risks: unmarried, urban, non-poor, boys. The constant ranges from quite low values of less than 10 percent in Nigeria, to almost 60 percent in Zimbabwe. As a comparison, in the United States, approximately one quarter of adolescents does not finish all of secondary school on time (US government source here), so the lower constant values in this chart are at least comparable to those of some very wealthy nations.

The red portion of the bars shows the additional dropout risk from being married. In a number of countries, early marriage poses a small risk for early dropout in girls, but in most countries the additional

dropout risk associated with early marriage is high (recall that the risk is the combined effect of the marriage coefficient and early marriage prevalence). Comparatively, early marriage is a very small risk in all countries for boys, because of the very low early marriage prevalence for boys.

The green portion of the bars shows the additional dropout risk from being a girl – having netted out the effects of early marriage. We see that, after controlling for marriage, being a girl does not pose a large risk for dropout, and in some cases, the sign turns negative (that is, after controlling for marriage, a girl is more likely to stay in school).

The orange and turquoise portions of the bars show the poverty and rural location effects. Both have independent and large effects, although in practice, they often overlap, making those children doubly disadvantaged. The cumulative impact of all four risk factors – that is, being a poor, rural, married girl – seriously erodes the probability of finishing upper secondary, reflecting what has been found on education attainment and enrolment rates by risk groups (see e.g. UNESCO's World Inequality Database on Education – WIDE).

These results suggest that interventions to reduce early marriage, may, in their education effect, be equivalent to an intervention to increase girls' school attendance. In the education model below, we therefore include interventions to reduce early marriage as a factor to reduce girls dropout rates. Because boys' early marriage is so rare, reducing their early marriage will do little to increase adolescent schooling.

4 What can be done? Summary of interventions for adolescents to reduce dropout and increase learning

The answer of what can be done to reduce early drop out of adolescents and to provide second-chance education is not a simple one, and it may differ from country to country. Policies are needed to improve school systems overall, as well as interventions to help support adolescents from particular marginalized groups. Overviews of what interventions work to enable children to access school and improve learning have been summarized, e.g. in UNESCO (2004), UNICEF (2015), UIS and UNICEF (2015). As mentioned in the introduction, a number of recent meta analyses and "meta-meta" analyses have also made efforts to summarize what it known about programs that work to improve education. Most research has focused on primary school and early years, but some results can be found for adolescents and secondary school students.

This section reviews evidence, compiled from several hundred research studies, about what works to improve education in lower income countries. Although much of the research focuses on primary schooling (pre-adolescence), there is also research on secondary schooling, and some of the results on primary are plausibly transferable to adolescents in secondary school, namely: having schools within reach (nearby); teacher quality; well-developed (possibly scripted) learning methods including those using electronic support materials; remedial teaching; financial support; and some health interventions. In addition, there are interventions that are particular to adolescents. In conservative societies, female

teachers are important for adolescent girls; in all societies adequate sanitary facilities may be critical for adolescent girls. Also, interventions related to early marriage and sexuality (comprehensive sexual education), influence education outcomes.

Despite all the effort to study interventions that improve school outcomes, the literature contains a number of striking gaps. For example, adequate sanitary facilities (water and toilets) reduced absenteeism rates, particularly of adolescent girls, by up to one half (Blanton, et al. 2010; O'Reily, et al. 2007; Bowen, et al. 2007), but the studies remain silent on dropout and learning impacts. In Pakistan, secondary schools with no corporal punishment had 10 percent lower dropout rates (Naz, et al. 2011), but no other studies from outside the United States were found. More research is needed into both of these areas.

More tellingly, given the substantial effects of early marriage on adolescent girls dropout rates, *none of the education intervention meta-analyses included programs to reduce early girl marriage as a potential intervention to increase schooling.* Neither have programs of comprehensive sexual education to reduce extra-marital pregnancy and STD's and promote healthy sexual relationships have not been studied for their impacts on education outcomes per se.

In what follows the paper discusses interventions to reduce dropout, improve learning, and then turns to the possible effects of marriage and comprehensive sexual education programs. This review is largely based on a database of interventions compiled for the UNICEF and World Bank Simulations for Equity in Education (SEE) project, and in addition, information from other Supporting Papers for the study on Investment in Improving Health, Education and other Outcomes for Adolescents.

4.1 Discussion on the development of a common measure for effect sizes of interventions for education

Most of the studies used for the estimation of effect sizes here come from the SEE Interventions Effectiveness database. The SEE database has been described elsewhere (UNICEF and World Bank, unpublished) in greater detail. It includes data from over 200 studies and reports focused on education interventions *in developing countries.* Most of the studies are randomized trials and econometric research, for example from country case studies by Pole de Dakar and the World Bank[5]. The database also includes some pre-post as well as transversal studies. Although the latter two groups are generally considered to be less robust, some of those studies are included if they a) were carefully executed and b) provided information on an intervention and outcome combination that had little coverage through other studies.

The literature on education interventions does not, in general, follow a common standard for publishing results, such as the standards proposed by CONSORT (2015, http://www.consort-statement.org/). CONSORT, which provides guidance for medical studies, recommends that for binary outcomes (such as

[5] These reports often include treatment impact analysis but would not necessarily turn up in a search for interventions literature because the subject tags would be broader policy issues.

entry, enrolment, dropout, repetition, promotion), studies present, baseline values, relative risks or odd ratios, absolute effect sizes, and confidence intervals. The SEE database compilation follows this partially, extracting from studies the baseline values, absolute values, and the relative risks.

In the SEE database, the *effect sizes* presented for any of the education outcomes are *relative risk reductions or: how much of the gap between the benchmark value and intended goal (100 percent for these outcomes) is reduced as a result of the intervention*. Most education studies do not present effect sizes in this way. Usually, they are recorded as absolute value change, as standard deviations, or as coefficients in a regression. Part of the work of putting the database together was transforming the results into standard measures of the reduction of risks through the treatment. The transformation assumes a target value, such as entry, enrolment, or survival rates of 100, or a particular target learning level that was identified in the study (e.g. score 500 on an analysis, read a story, read 60 words a minute). The absolute impact is the difference in the percent of children who do not reach the target with and without the treatment; and the standardized risk reduction is the ratio of the difference and the original learning gap.

As an example of such a transformation, a study in Burundi (World Bank, 2007), found that if a school was more than 45 minutes away, only 53 percent of girls entered school, leaving an entry gap of 47 percent. According to the econometric model based on household survey data from a survey, when school is less than 30 minutes away, 64 percent of the girls enter school, reducing the entry gap by 11 points, or reducing the relative risk by 23 percent (11/47).

Relative risk reduction is a common metric for medical interventions. For example, one might say that bed nets reduce the incidence of malaria by 30 percent. In the medical case, the incidence of malaria is the risk. In the education case the risks are: non-entry, late entry, dropout, repetition, absenteeism, and failing learning metrics. Although it is less common in education to think in this way, it is quite useful to do so. From the policy perspective, talking about risks is a *more effective way to communicate what still remains to be done*, in the same way that counting out-of-school children is a more effective way to focus on needs still to be addressed, than talking about enrolment rates. Moreover, from a practical perspective, it also turns out that the impact of interventions is more or less proportional to the *risk.* In general, interventions have a greater impact when implemented in contexts where the education risks are larger. By measuring impacts in terms of relative risk reductions, we get more consistent effect size across studies for the same intervention-outcome combinations[6].

[6] Although this is generally true, there are some cases where it is not. First, if the intervention does not address an existent barrier, it will have no effect. For example, a food program in an area where there are no schools nearby and there is no food scarcity, will not address enrolment. Second, in cases where the gaps are extremely large, say more than 80 percent, the rule of proportionality doesn't always apply – for example in an early literacy program in India (He et al. 2009), the percentage of children who could read a story increased from 1.9 to 5.2 percent, an impressive gain, but only 3 percent of the not-reading gap that was closed by the intervention – a reduction that was far from proportional to the size of the gap. One reason that the rule of proportionality weakens when gaps are very large is probably because in these situations there are multiple strong barriers, and any one intervention can only address a small portion of them.

The SEE database includes two measures related to dropout: enrolment and survival rates[7]. Table 1 shows the number of studies and types of interventions in the database for these access measures. Fourteen interventions were studied for effects on enrolment rates, and nineteen interventions studied for effects on survival rates are included in the database. The majority of studies included are either randomized trials or econometric analyses, with a smaller number of studies analyzing situations pre- and post-interventions or comparing matched groups in the field.

Before discussing the studies and the results, it is important to note the biases and the limitations of the research reviewed. The research overall, and certainly our selection of what has been published, is limited in scope, and misses a number of effective interventions as already mentioned. Second, the effectiveness of interventions varies considerably by context and by mode of implementation. It would be practically impossible to cover all contexts; in practice the research includes only a few different situations. Often, research is focused on marginalized groups, which could lead to an erroneous conclusion that the intervention is effective *only* for those groups. Another form of bias is that positive results are more likely to be published.

In the coming years, improvements in knowledge may reduce these limitations. The results here are presented in full awareness of these limitations, but with some confidence that these findings are a reasonable representation and synthesis of what is known about these interventions, *at this time*.

Table 1 Description of the number of studies and interventions in the SEE database for each of three access indicators – entry, enrolment rate, and survival/ retention – a list of the interventions included and the types of studies in the group

	Enrolment	Survival
Studies	40	32
Interventions	14	19
Names of interventions	Cash transfers, CCT, Fee abolition, Free uniforms, Scholarships, School feeding, Health training, Supplements, Providing aids and appliances to children with disabilities, School proximity, Preschool, PTA financial support, Community Incentives, Decentralization	Reduce repetition, Cash transfers, Fee abolition, Free school uniforms, School feeding, Mother-tongue instruction, Preschool, Latrines, Materials and buildings, Single vs. multi-grade, PTA financial support, Textbooks, Water source in school, School proximity, School with all primary grades, Female teachers, Pupil teacher ratio, Teacher qualified, Teachers, volunteer
Types of studies*	RCT – 15 Econometric – 15 Pre-post – 8 Matching – 2	RCT – 7 Econometric – 14 Pre-post – 5 Matching – 6

Notes: *RCT includes all randomized control trials; Econometric includes regression discontinuity design, fixed effects models, instrumental variable models, multivariate regression analyses; Pre-post includes difference-in-difference and difference-in-difference-in-difference, and natural experiments with location-specific trend analysis; Matching is propensity score matching.

[7] Entry is counted as the percentage of children who enter school by a particular age or gross or net intake rates; enrolment is generally gross enrolment, although some studies use net enrolment or attendance or age-specific attendance rates; survival is often measured as the survival to a particular grade X, but sometimes it is the transition from one grade to the next.

4.2 Reducing adolescent school dropout rates

Figure 8 shows the relative risk reductions of being out of school and of drop out, for the interventions in the SEE database for which such numbers could be obtained, and which were applicable to secondary schooling. The figure shows the points for single effect sizes as found in each of the studies, and the pooled average size of the effects. McEwan (2013) and Conn (2013), two meta-studies on learning outcome interventions that are discussed in the next section, also pool effect sizes in a similar way and discuss pooling in greater detail.

In terms of both non-enrolment and dropout, two types of interventions with the highest effect sizes are:

1) School proximity.

2) Financial supports – be it in the form of scholarships, (conditional) cash transfers, fee abolition or free uniforms.

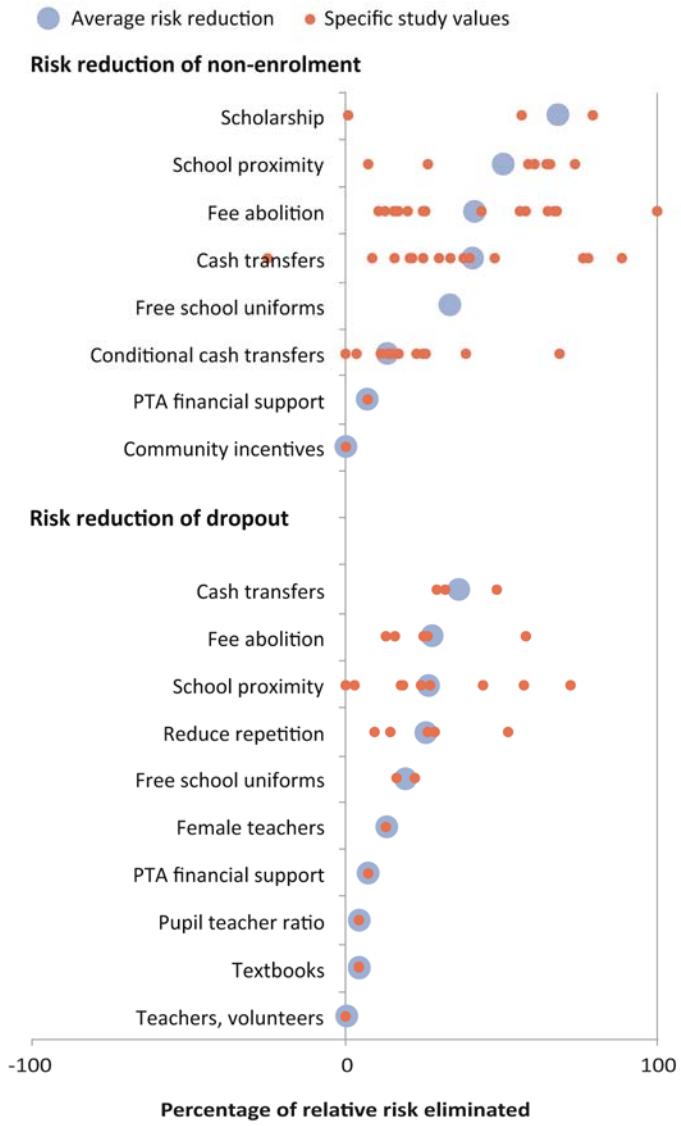
In addition, 3) female teachers had an impact on dropout rates (of girls).

These are discussed below.

School proximity is an important determinant of school access, in particular for rural children. Having a school within reach is a critical determinant of enrolment and attendance. On average, taking studies from the SEE database together, not having school nearby decreases the risk of not being enrolled by about half. For primary school children, a common measure was having a school within a 30-minute walk. One study looked at the effects of secondary school proximity in Ghana and Cote d'Ivoire (Tansel, 1997). The measure was having a school "within the community". In this study the attendance those who did *not* have a school in the community (net of parental and income effects) was approximately 40 percent lower for boys and approximately 70 percent lower for girls, compared to adolescents with a secondary school in the community[8]. In most cases, the children who do not have schools nearby are rural, so intervention to increase school proximity is linked to the rural location barrier.

[8] See UNICEF database for computations based on Tansel's data.

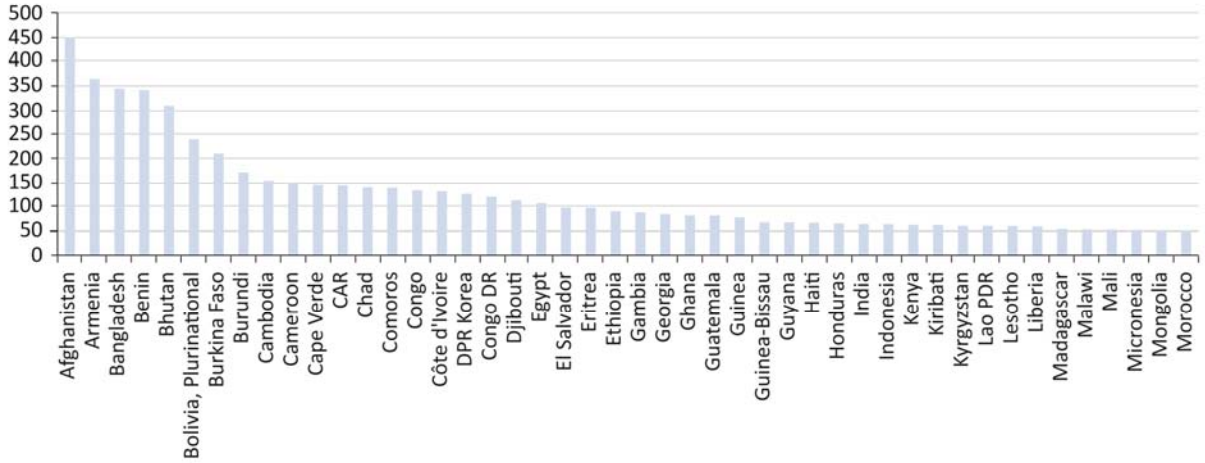
Figure 8 Risk reduction of non-enrolment and dropout, from interventions in the SEE database



If governments or other actors are going to supply secondary schools in rural areas, in many cases, these schools will supply a catchment area with only a small number of potential students. This requires rethinking the typical secondary school, which is large, and has specialized subject teachers. As an adjustment, a growing number of countries are building very small secondary schools, with as few as three teachers, supported by a televised, radio, or internet curriculum. These make secondary school accessible for adolescents in rural communities (e.g. the *Telesecundaria* model pioneered in Mexico). The *telesecundaria* per pupil costs are a little less than 16 percent above the base per pupil costs (Castro, 2000, see EdComm database reference). In the UNFPA model, a 10 percent cost premium is assumed for increasing accessibility through small, rural secondary schools, assuming that economies of scale will allow for the costs to come down.

Building smaller, more rural secondary schools will also address national school shortage, which is still a reality. Many countries (still) need to build more schools and hire more teachers to make up for a shortage of secondary schools (and some lack even primary schools) for all school-age children. Figure 9 shows 48 low-and middle-income countries where the ratio of secondary school age children to the number of public secondary school teachers (as a proxy for basic resources) is greater than 50 adolescents per teacher, indicating supply shortages.

Figure 9 Ratio of secondary school age population to number of secondary school teachers in low- and lower-middle income countries



Transfers and cost reductions are a very important means of increasing access. Education is not a cost-free enterprise for households. In most cases there are at least some direct costs – fees, parent-teacher association dues, uniforms. In 2006, the World Bank found that of 93 developing countries surveyed, only 16 did not levy some kind of school fee (Bentaouett, 2006). In addition, there are indirect costs, such as the loss of a child's labor. In India, for example, of the children age 6 to 11 who were not in school 19 percent were required for work or family care[9]. An additional 16 percent were not in school because of direct costs. Costs are a major barrier cited by parents, and poverty is one of the largest (if not *the* largest) barrier to schooling (UNICEF, 2015a). Transfers and cost reductions help poor- and semi-poor[10] children access school, on average reducing non-enrolment by 33 percent. Transfers are relatively *costly per unit of benefit* compared to other treatments (PAL, 2014), and those costs need to be weighed against choices that are less expensive (per unit of improvement) as well as against the non-education benefits of transfers such as improved health and immediate income support for the poorest households. The cash value of transfers can vary considerably between interventions – for example,

[9] Data extracted from 2006 DHS survey, with SPSS, weighted sample children age 6-11, and excluding invalid responses.

[10] The terms poor and semi-poor are not used with a specific definition in mind here, because the studies use different definitions. Rather they signify generally, those children in households that are relatively most resource constrained and households that are in the middle of income ranges in the lower income countries where these studies take place.

providing free uniforms in Kenya cost $6 per student (0.6 percent of GDP per capita at the time) (Holla and Kremer, 2009); on the upper end, a $15.64 scholarship in Bangladesh was equal to 4.5 percent of GDP per capita at the time (Khandker, 2003). In the UNFPA model, we assumed that cash transfers were equal to 10 percent of the per student base costs.

Cost-reducing measures eliminate only a portion of out-of-school rates among the poor- on average 33 percent, possibly because they reduce out-of-pocket expenses, and (if they transfer exceeds the costs of schooling) they may offset short-term income losses from prolonged schooling. However, even with transfers, more than half of the "poverty effect" remains; this suggests that poor children experience other barriers correlated with poverty, but not related to costs of school. These factors could include disability (disability rates are higher among the poor finds the WHO, 2011), safety, in particular for girls, poor preparation for schooling and inadequate understanding of the returns to education among parents.

There are indications that *improving school safety, in particular for girls,* may be important – for example by providing *female teachers, appropriate and separate latrine facilities, and reducing corporal and sexual violence in schools and around schools*. Unfortunately, at this time, the evidence on the possible effect sizes of these interventions is not strong, and so it is not possible to include them in the costing model.

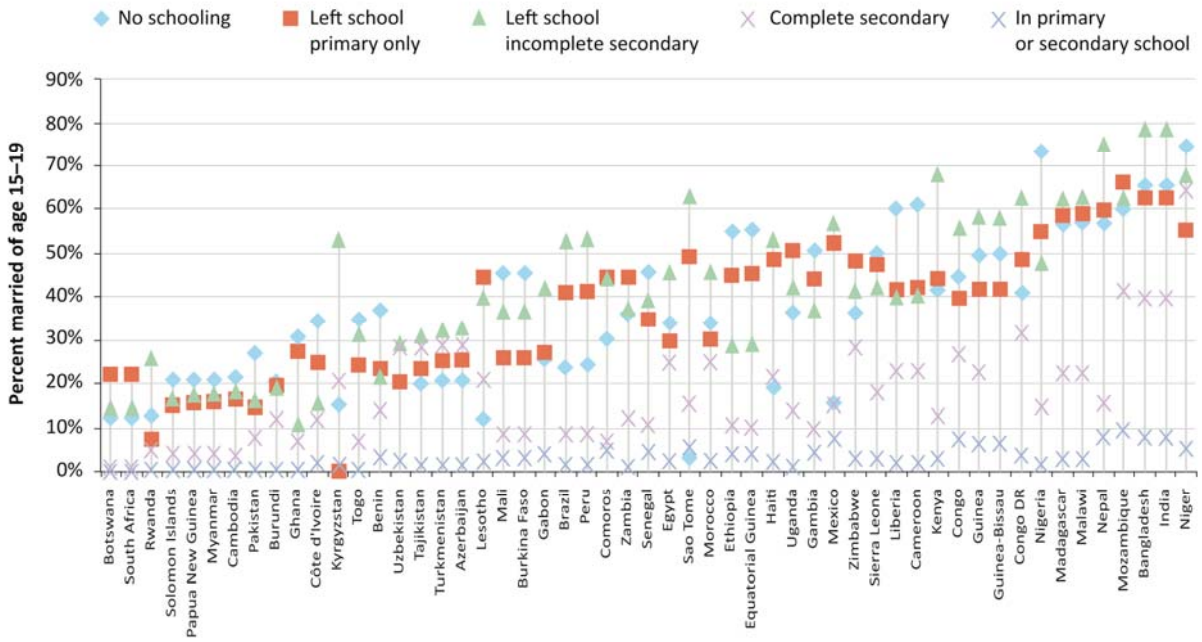
4.2.1 Reducing early marriage as an intervention to improve girls' progression through secondary school

As discussed in the Supporting Paper on Child Marriage, early marriage is considered a substantial risk factor for school dropout:

> Nguyen and Wodon summarise the results of several studies and suggest that for girls aged 15 to 24, child marriage and pregnancies count, depending on the country, for between 5% and 33% of dropouts (Lloyd and Mensch 2008). Their own work in Nigeria found that child marriage and to a much lesser extent pregnancies account for 15% to 20% of drop outs (Nguyen and Wodon 2012a). Similarly delayed marriage leads to higher skill levels (Field and Ambrose 2009; Nguyen and Wodon 2012c, 2012d). (VISES, 2015)

Our own country-specific regression model described earlier, confirms the Nguyen and Wodon estimate. The relationship between marriage and dropout is reciprocal. On the one hand, a reduced preference for early marriage (through social change or programs) can reduce girls' dropout rates. The lower dropout rates in turn, reduce early marriage further, because out-of-school girls with higher education levels are less likely to be married early (see Figure 10).

Figure 10 Likelihood of being married, by education status, girls, age 15-19, 53 countries



Source: Author's extractions from DHS surveys.

Interventions to mitigate that impact could take two approaches: one, to reduce the *prevalence* of early marriage, and a second, to reduce the *effects* of early marriage (i.e. if a girl is married, to improve the possibility that she continues her schooling). All of the studies in the Supporting Paper on Child Marriage (Rasmussen and Maharaj, 2015) focused on the former approach. In consultation with the project team, two interventions were selected for inclusion in the education-marriage model:

1. Community programs for the creation of safe spaces and life skills training for poor girls (Abriendo Oportunidades, Berhane Hewan, Prachar, Ishraq, Life skills programme in Maharashtra, reviewed in Bruce, et al. 2012, Brady, et al. 2007 and Pande, et al. 2006)
2. Provision of goat/pregnant ewe for rural girls (Berhane Hewan, reviewed in Erulkar and Muthengi, 2009).

The approximate effects of each of these interventions is to reduce early girl marriage by 15 percent, and the cost, per girl is estimated at $31.50 per year for the community programs, and $53.00 per girl for the goat/pregnant ewe program respectively. Furthermore, the creation of safe spaces was linked to all girls; while the provision of animals was linked to rural girls only (in the model this means that if the intervention coverage is increased to 100 percent, this is for rural girls only).

The reduction of marriage among adolescent girls is affects the prevalence parameter in the dropout equation (1), which in turn, reduces dropout rates. Note that the change mechanism is entirely through the reduction of marriage prevalence, rather than through a reduction of the marginal impact of being married on being in school.

4.2.2 Comprehensive sexual education

Comprehensive sexual education programs can be effective deterrents for pregnancy and STI's but can also reduce pregnancy-related school dropout. In the review of comprehensive sexual education programs, Sweeny (2015) finds on average impact CSE programs reduce pregnancy rates by 40 percent, with a range of 20-80 percent.

In many countries, pregnancy leads to school dropout. In some countries, girls who are visibly pregnant are legally obliged to leave school. In their study of 20 African countries, Lloyd and Mensch (2006) find that pregnancy is cited as the reason for school departure by 1% of girls in Niger to 31% in South Africa (the data is from the late 1990s and may no longer be relevant). Using more recent data, in a study of South Africa, Grant and Hallman (2006) found that of girls who were pregnant 74 percent left school in the following year, but 29 percent returned. The net effect of pregnancy in this study was a 45 percent likelihood of permanent school departure. In a study of Malawi, 17 percent of the 15-19 adolescent girls who were not in school cited pregnancy as the reason for departure (Chalasani, et al. 2012). In a recent study South Africa, Rosenberg et al. (2015) found that the odds of getting pregnant for girls who were in school were 0.57 in South Africa. In Latin America the effects of pregnancy on school dropout are also considerable – Azevedo et al. (2012) found that teen pregnancy reduced the expected years of schooling by about one year in Mexico and Chile. In low- and middle-income countries in other parts of the world – Asia, and Eastern Europe teen pregnancy rates are much lower and hence also its effects on dropout rates (UNFPA, 2015).

The effect of CSE on dropout would depend on: a) the impact of the program in reducing pregnancy; b) the rate of pregnancy for enrolled girls; and c) the likelihood that pregnancy leads to dropout; or, in the absence of those numbers, one can also assume the effect of the program would be the product of a) the reduction of pregnancy rates and b) the percent of dropouts due to pregnancy.

As seen from the above, the percentage of dropouts due to pregnancy, while high in some contexts, is quite variable. The expected impact of the CSE on dropout rates, if it reduced pregnancy by 40 percent, would potentially be quite substantial in those contexts where teen pregnancy is a major contributor to overall dropout rates. From the brief literature review above, countries where teen pregnancy is a major contributor to dropout rates are: Mexico, Chile (Azevedo, et al. 2012), Malawi (Chalasani, et al. 2012), South Africa (Rosenberg, et al. 2015) and countries where teen pregnancy was a major contributor in the late 1990s (and may still be) are: Central African Republic, Mozambique, Cameroon, Zambia, and Kenya (Lloyd and Mensch, 2006). In these countries, CSE may be cost-effective purely on the merits of its dropout-reducing effects (which will be compounded by the health benefits). In other countries, pregnancy was a smaller factor of school dropout (<10 percent): Burkina Faso, Niger, Mali, Guinea, Chad, Benin, Cote d'Ivoire, Togo, Comoros, Nigeria, Madagascar, Tanzania, Zimbabwe (Lloyd and Mensch, 2006).

4.3 Improving learning achievement for adolescents

As seen in the view of learning achievement, most low- and middle-income countries are far behind high-income OECD countries. In the standardized World Bank metric shown in Figure 4, most OECD countries are at a score around 50 or higher; many middle-income countries are in the range of 35-45; while many low-income countries score 20-35. With a standard deviation of 10, this suggests the middle-income countries are approximately one standard deviation behind the OECD, and low-income countries approximately 2 standard deviations. What does this mean, in terms of something concrete, like years of schooling?

These World Bank scores are *roughly* 1/10 of the values of the international assessments, PISA, TIMSS, and PIRLS, where the OECD countries and high income East Asian countries score around 500 and higher; many middle-income countries 350-450; and low-income countries 350 or less. In those tests, the standard deviation is always set to 100, and students in high-performing countries advance approximately 40 points per year, or by 0.40 standard deviations (Pritchett, 2004: 188; OECD 2009, 2012) By this measure, countries scoring 400 are 2.5 or more years behind the high-income countries, and the lower income countries are as much as five years behind. Or, more accurately, a country with a score of 300 would be five years behind *if learning were as fast as in high-performing countries*. In reality, the annual learning gains in low-performing are slower, so it would take the average student there much longer than five years to catch up to an OECD student in the same grade. And, most research suggests that students who get behind are not able to catch up later.

Such numbers are daunting. Fortunately, much can be done to raise learning, provided the systems and politics to enable change are in place. Below, we cite some research of interventions and changes that have been shown to be very effective, and these are included in the UNFPA model.

4.3.1 Improving teacher quality through selective hiring, in-service support, and incentives

Better teachers can cause impressive accelerations in learning. Bruns and Luque (2014) in their book "Great teachers" cite findings from the United States on widely varying teacher effectiveness, even within the same school and same grade. "*Students with a weak teacher may master 50 percent or less of the curriculum for that grade; students with a good teacher get an average gain of one year; and students with great teachers advance 1.5 grade levels or more (Hanushek and Rivkin 2010; Rockoff 2004).*" (author's italics). Even a single highly effective teacher has long-term effects on a person's further education and income (Chetty, Friedman and Rockoff, 2011). Using another approach, Hanushek (2010) estimated that eliminating the bottom 5 percent of teachers could raise learning scores by .28 standard deviations.

Countries with exceptionally high learning achievement in international assessments, such as Finland and Singapore, differentiate themselves by the high quality of their teachers. But acquiring a world-class teaching force is not a simple task and defining the exact characteristics of a good or great teacher is difficult, but evaluations exist of policies that have improved learning outcomes by selecting teachers

based on measurable metrics of content and pedagogical knowledge, classroom observations, and pay raises. Bruns and Luque (2014) propose a three-pronged approach: 1) recruiting better teachers though more critical selection; 2) grooming teachers through in-service evaluation and training; and 3) motivating teachers, e.g. with bonus pay and promotions to raise societal respect for teachers (see also Friedman, 2012).

In a set of mostly industrialized countries, analyses from PISA found the following positive influences on 15-year old learning achievement: inclusive schools and school systems that provide all students equitable chances to learn; school autonomy in designing curricula, possibly combined with standards-based external examinations; prioritizing quality of teachers (through higher salaries, selectivity, and other factors) over smaller classes; preschool attendance; safe and well-disciplined environments (OECD, 2009, 2012).

Estrada (2013) studied the effects of a change to more critical recruitment in the poorer, rural areas f a middle-income country, Mexico. He looked at the effects of changing hiring practices for teachers in *Telesecundaria* schools, comparing matched schools where one group switched to hiring based on clearly defined quality metrics, and the control group continued to use a discretionary approach. In communities that instituted this change, the learning improvements were huge and rapid – an average increase of .43 standard deviation in math and Spanish in the year following the change in hiring practices. Such impressive results may not be transferrable to contexts where there is a dearth of good teacher *candidates*. To take account of such contexts, we assume that a metrics- and evaluation-based policy to improve teacher quality will increase learning by a more modest .25 SD. As an approximation, we assume the premium for the policy – costs of evaluations and some salary raises – is 10 percent of the base per pupil costs.

4.3.2 Remedial teaching

Once a student falls behind, it is difficult to catch up when incoming, new material builds on the pieces that the student does not comprehend. In this case, remedial teaching can help. In India, two well-known number of random control trials investigated the impacts of after-school support, and of a summer reading camp (Banerjee, et al. 2004; Banerjee, et al. 2010). As mentioned above, the OECD found that high-quality systems make sure that all student have equitable chances to learn. McEwan found impacts of approximately .10 SD improvement. There is no precise information on what remedial teachers would cost for secondary school pupils, but we assume here that it would be 5 percent of the average per pupil cost.

4.3.3 Use of electronics – computers, TV and radio – in conjunction with teacher support

Computers and television broadcasts have been used in various contexts to increase the quality of learning. McEwan (2012) reviewed studies on the use of computers in classrooms and found that if the introduction of computers is accompanied by teacher training (to use the new tools), learning is improved by 0.15 standard deviations.

The more successful implementations have been where these technologies are combined with teacher support, and where teachers know how to build on them. Telesecundaria – the use of TV in small secondary schools so that a few teachers can cover all subjects – was started in Mexico in 1968 and is increasingly popular. More than a million students attend telesecundaria schools in Mexico. Other programs using radio or television are in use in Asia and Africa. The main benefit of telesecundaria is that makes secondary schools in small villages a possibility; but there is also evidence that students learn more. Patrinos et al. (2005) found that the introduction of telesecundaria in Mexico reduced the learning gaps between average students and the disadvantaged students served by telesecundaria by 30 percent. The costs of telesecundaria are 16 percent higher per pupil than the costs of "regular" secondary schooling; to be conservative, we assume the costs of this intervention group adds 10 percent to the base per pupil costs.

4.3.4 Summary of review of interventions

This review provides but a small selection of all the options that are available to improve secondary schools for adolescents. These are summarized in Table 2. The table is organized as follows: column 1 shows the interventions; columns 2-4 show how much the intervention reduces the risk of dropout, repetition, or learning gaps; column 5 shows the costs per child per year; and columns 6-9 show which risk group the intervention is most effective for. For example, rural school supply (having a school nearby) reduces the risk of dropout by 50 percent; it adds 10 percent to the base costs of schooling; and is effective for the group of rural children. The effect sizes are the averages discussed above. We have some confidence in the external validity of the findings of those studies, and we also account for context in part, by measuring effects as risk reduction rather than absolute change, and in another by linking each intervention to a particular sub-group; however, these numbers should be taken as indicative at the present time.

The interventions shown in this table are also the ones that are included in the intervention scenario discussed in the model section next.

Table 2 Interventions reviewed as effective for improving adolescent education outcomes, based on literature review. The interventions for which reliable studies exist are a small selection of possible options.

School Interventions for adolescents	Intervention effectiveness at reducing gaps			Cost per child per year*	Targeted risk factor – select only ONE			
	Dropout	Repetition	Learning gaps		Girls	Poverty	Rural location	ALL
Rural school supply***	50%			10% of base secondary costs			X	
Transfers (stipends, scholarships)	33%			0.6% of GDP per capita		X		
Free school uniforms for girls	19%			10% of base secondary costs		X		
Female teachers	Precise effects not found							
Reduce violence in schools	Precise effects not found							
Appropriate sanitary facilities for girls	Precise effects not found							
Reduce early marriage: community programs	15%			$31.50		X		
Reduce early marriage: goat/ewe programs	15%			$53			X	
Comprehensive sexual education (reduce early pregnancy)	Effects variable by country							X
Better teachers, through selection, support and compensation	10%		20%	10% of base secondary costs				X
Computer, TV, or radio aided learning	6%		12%	10% of base secondary costs				X
Remedial teachers for students falling behind	4%		8%	5% of base secondary costs		X		

Notes: * Costs are expressed in % of GDP per capita. These values are for Bangladesh.
Target coverage = scale, percent of target risk population to receive intervention; Target year = year in which full implementation is reached; Intervention effectiveness = for those receiving the intervention, percent reduction in failed school progress (dropout, repetition, learning gaps) – usually average from multiple studies; Cost per child per year = dollar cost computed relative to GDP per capita, Bangladesh values shown; Targeted risk factor = the sub-population who can benefit from the intervention.
Source for costs and effectiveness: UNICEF intervention database.

5 Education model for adolescents – intervention scenarios for education progress and reduced early marriage

This section describes how progress in education, driven by interventions, is modeled. We start a brief background review of education modeling; an overview of the placement of the education model within the larger context of the VISES approach; and an overview of the education model itself[11]. It is hoped that this section will provide the reader with a basic understanding of how the education results, described in the next section, are obtained. *A more detailed mathematical description of the model is provided in Appendix B.*

5.1 A brief overview of related models from education and health

The education model developed for the UNFPA builds on decades of work to simulate education change and also borrows from health sector modeling. On the education side, it is common to project education with so-called cohort models (UNESCO, 2005, 2012, 2015b; EPDC, 2009). These models open with the distribution of (male and female) pupils across grades, and observed rates of gross intake (percentage of children who enter primary school relative to the school entry age population), repetition rates, as well as promotion and transition rates between school levels. The models project a matrix of pupils by grade over time, dependent on the intake at the top of the matrix in grade 1; flows to a next grade based on promotion or transition; and flows to the same grade in the next year based on repetition rates. The costs of providing education for the pupils are based on assumed per-pupil values for inputs such as teachers, materials, and construction, and the unit costs of these inputs. These models are typically driven by assumptions about target levels for percentage of children who will enter or complete schools; and international target levels for inputs such as pupil teacher ratios, and salaries relative to GDP per capita. A disadvantage of this approach is that top-down assumptions of education output drive the scenarios, rather than change being driven from the bottom up by improvements of inputs. For example, a typical scenario would assume that primary school completion reaches 100 percent by the year *T*; and that with a pupil teacher ratio of 40 by *T*, *X* number of teachers will be needed; instead of the other way around, namely that an increase in the teacher and school supply influences how many children go to school.

This approach contrasts to what one that was developed in health, with the Marginal Budgeting for Bottlenecks (e.g. Soucat, et al. 2001) and OneHealth tools (e.g. WHO, 2015). In those models, change in health outcomes is driven by bottom-up changes to: the coverage of health service provision; changes to public uptake of those services; and the effectiveness of those services at reducing various health risks. This approach in health has been an important tool for advocating for the expansion of health services, and for guiding what allocations of health services is most cost-effective.

Attracted by the approach of the health models, in 2011, UNICEF and the World Bank teamed up to develop a tool that would apply this bottom-up, or intervention-led approach to education, the

[11] A description of the most important calculations can be obtained by request to VISES.

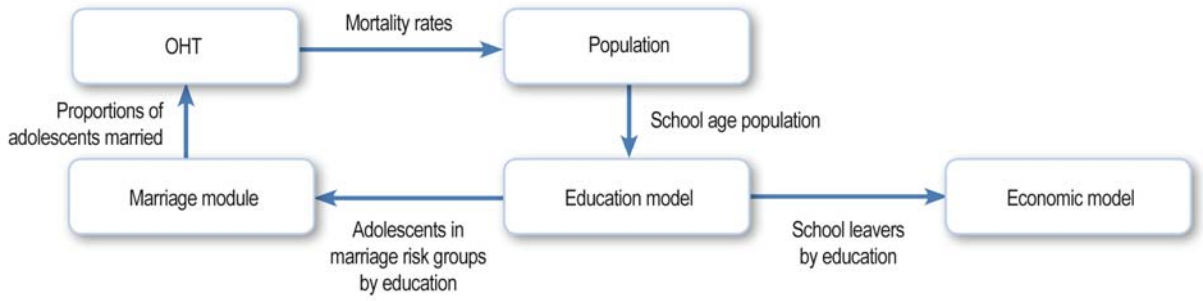
Simulations for Equity in Education model (UNICEF, 2015b) and commissioned the author of this report to develop the tool. The core of the SEE model is the same cohort matrix as in the traditional education simulation models. It is distinct from the traditional models in two important ways. First, changes to education outcomes are driven from the bottom up by assumptions about intervention coverage and intervention effectiveness, via the intermediate drivers of education progress – intake, progression, and repetition. Second, the SEE model adds equity considerations, by allowing for up to four separate risk groups, and including barriers, such as poverty, girl sex, language minority status within each risk group. This model has been piloted in Ghana, Burkina Faso, Bolivia, and Pakistan. Some of the insights from those applications have been summarized in, e.g. UNICEF (2014), and UIS and UNICEF (2015:98-99).

The VISES research team desired to use a bottom-up, intervention led approach in order to evaluate the *cost-effectiveness of education interventions to improve adolescent welfare.* The present form of SEE does not allow for an analysis involving a large number of countries, such as the one in this UNFPA project. Therefore for this project, a new tool was developed, which uses some of the aspects of SEE. It is described further below.

The new education model is one of a suite of inter-linked models being used by VISES to capture adolescent welfare. On overview of these links is shown in Figure 11. It is linked to:

1. The OHT – In the ideal case, OHT scenarios were to output provide mortality rates that affect the growth rate of the school-age population. In practice, it was not feasible to link up the two models. Instead, for the population, the United Nations medium projections are used.
2. The economic model – the education model provides school leavers by age and grade over time, which are used to make estimates of income growth, one of the returns to education investments.
3. The marriage module – the education model provides the adolescent population by education attainment (no schooling, in school, left school by education attained), which is linked to differing risks of early marriage. If more adolescents are in school, or those who have left are more educated, the aggregate risk of early marriage is lower. The marriage module provides the proportions of married adolescents, which feeds into the OHT.
4. The economic module – The education attainment and learning achievement index of school-leavers provides the basis for change in the productivity and composition of the labor force in the economic model. This is where the returns to education, and the benefit-cost-ratios are computed.

Figure 11 Overview of the links from other models in the VISES approach to the education model



Note: Not all of the components of the VISES approach are included here.

5.2 Description of the education model for UNFPA

This section provides a non-technical description of the education model for the UNFPA. A more detailed mathematical description of the model is provided in Appendix B.

In 2015, the author of this report developed the education model for UNESCO that was used to estimate the costs of achieving the education Sustainable Development Goals at the Oslo Summit (UNESCO, 2015b). This model is a traditional cohort projection model (described above), but it is set up to make series of education projections for scores of countries. It contains: a database of indicators needed for all countries to be projected; the actual projection model itself; macros that automate the projection for the whole series of countries included; and a results database with selected projection output.

The UNESCO costing model (which is in the public domain) was taken as the primary building block for the new education model – in this way, it was possible to utilize the detailed database that had already been compiled, as well as the computations for basic unit costs for teachers, salaries, classroom construction and materials. Second, basic ideas of the SEE model (also in the public domain) – with its intervention-led change – were incorporated in the new model. Even using these two models as a base, all of the computations for the projections of pupils over time, progression through grades, and school departure needed to be developed from scratch in order to achieve the following features:

1. Change in education outputs driven by intervention coverage, effectiveness, and costs, with the possibility of assuming multiple interventions operating in parallel.
2. Using the interventions to make projections for a large number of countries.
3. Risk factors included in the model, with (usually higher) education risks for adolescents who are poor, girls, and who are married.
4. Marriage is explicitly included in the model.
5. Includes age-specific school progression in order to project age-specific school leaving patterns as input into the economic model.
6. Tracks the education attainment of adolescents and young adults who have left school as input into the economic model.

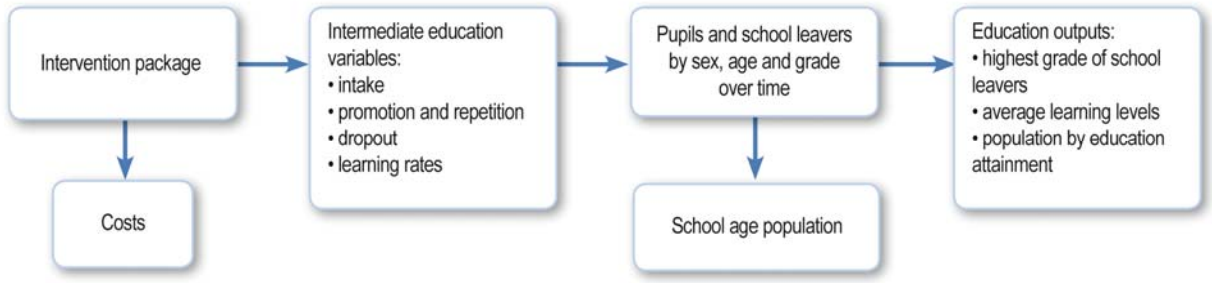
7. Includes education achievement in a quality measure.

Figure 12 gives an overview of the new education model, with the direction of influence illustrated from the top left to the right. First, the set of interventions is defined by the analyst (we use a package derived from the interventions listed in Table 2. One output from the intervention package is costs.

Second, the intervention package determines changes to the intermediate education variables – school intake, repetition rates, dropout rates, and learning rates. If there is just one intervention, then the education impact is the product of: the coverage rate and effectiveness. Examples of effectiveness are shown in columns 2-4 of Table 2. For example, say that programs to recruit and develop better teachers is implemented to 100 percent. According to the table, this will reduce learning gaps by 20 percent; and will reduce dropout rates by 10 percent (because better learning itself reduces dropout rates). Or, say that community programs to reduce early marriage are implemented to reach 50 percent of poor girls, this would reduce the dropout rates of poor girls by .50 x 15% - 7.5 percent (the overall dropout effect would depend on the prevalence of poverty). If there are multiple interventions the model takes account of possible substitution effects, and the impact of each individual intervention is slightly lowered by the presence and impact of other interventions.

Dropout and repetition determine how adolescents progress through secondary school. The model tracks pupils by sex, age, and grade over time based on those variables. The dropout rates determine the grades at which pupils leave school, and repetition slows down progress through school (and adds to costs). In parallel, the model computes improvements to learning achievement rates. To keep the data and model manageable within the constraints of the project, the learning rates are assumed equal for all school grades.

Figure 12 Flow diagram of the education model



One of the features of this model is that it allows for a selection of interventions focused on specific risk groups. As discussed in Section 3.2 on the risk analysis, there are large differences in the likelihood that adolescents will leave school early depending on their background. From a human rights perspective, this means that much of our effort will need to be focused on particular groups with higher risks of education failure (so that they may enjoy their education right fully), and from an efficiency perspective this is also where the greatest returns are likely to be found. Country-specific research with the SEE

model showed that an equity focus on marginalized groups could lead to greater returns than a business as usual approach (UNICEF, 2014)[12].

The model also tracks the adolescents who leave school, by age and the grade of school departure (these flows are used directly in the economic model). The school-leavers flow into the stocks of post-school education groups, namely, the population who left school with primary education only; the population who left school with incomplete secondary; and the population who achieved full secondary education (a portion of this group may still be pursuing tertiary education, but this is not included in the model).

Finally, the model includes early marriage, where education is a factor that can reduce this risk. As we saw in Figure 10 above, the risk of being in an early marriage differs substantially by education status with the highest risks for those who have never been to school or left school early; intermediate risk for adolescents who have completed secondary; and almost nil for adolescents still in school. The initial prevalence of early marriage is the weighted average of marriage prevalence within each of those education groups. The model tracks how this prevalence of early marriage changes over time through two mechanisms:

1) Indirect via schooling. Keeping the marriage risks within each education group constant, the average prevalence of early marriage changes over time as the distribution of education shifts. If there were an intervention that results in lower dropout rates for adolescent girls, then, even if with no changes to the risks of marriage *within* the education groups, such a shift would reduce the overall probability of early marriage. The interventions to consider for this pathway would be those that keep girls in school longer, such as rural school access, transfers, free uniforms and interventions that improve the quality of schools.

2) Directly by reducing the probability that a girl will marry. Another mechanism to reduce early marriage is by lowering the marriage risk *within* the education groups – particularly if those interventions affected girls who had never gone to school, or those who had left school early. Some interventions along this pathway are for example, community interventions to affect norms on the desirable marriage age, or those that offer alternative livelihood activities for unmarried girls (e.g. a program to distribute pregnant ewes to unmarried girls, Erukhar and Muthengi, 2009).

Besides these features, the model includes some adjustment computations if there is discrepancy between data from different sources.

[12] A more detailed technical explanation of the education model, including the most important equations, can be requested from VISES.

5.3 Data for education and marriage model

The model has a lot of data detail for every country – pupils, repetition, promotion and dropout rates by grade for a number of historical years; pupil distribution by age; inputs such as teachers, salaries, classrooms, materials; percentage of private pupils; prevalence of risk groups and marginal effects of risk factors on adolescent dropout rates; education attainment and marital status by age; GDP per capita levels; fertility rates overall and for adolescents 15-19; population by age, and distribution in rural and urban areas. All of the data was compiled from multiple international databases, from household surveys, from national sources, or estimated based on the data from other countries.

As mentioned a large core of the data was already in the UNESCO costing model. The data on school entry age, duration of different school levels, pupils by grade, repetition, promotion and dropout rates, teachers, non-salary expenditure, and the percentage of private pupils were largely compiled from the UNESCO Institute of Statistics (UIS) database. In a few cases with missing data, information from online country sources, such as government websites or reports, was used. Information on salaries was obtained from a variety of sources, including UIS, UNESCO, the OECD, and country reports. The population projections and fertility rates by age are taken from the United Nations POPIN division online database. The GDP per capita and poverty rates are from the World Bank Development Indicators database. For the UNFPA model, these data were updated and new countries added.

For the UNFPA model all of the additional indicators come from household surveys, namely marginal risk effects, age-specific grade attendance, and educational attainment. As discussed in Section 3, the marginal effects and prevalence rates of risk factors were obtained from a regression and descriptive analyses of DHS and MICS survey micro-datasets. From the same surveys, we obtained the distribution of pupils by age within each grade so that we could make age-grade specific projections of pupils and school-leavers. Finally, again from the same surveys, we obtained the initial distribution of marriage and five education status groups.

The DHS and MICS household surveys did not include all of the Countdown countries. To obtain a more complete set of estimates, the marginal effects and education/marriage distributions from other, similar countries, were used for 25 countries.

It is important that all of the data from these different sources match well with each other. For example, information on pupils (UIS source) should match with data on population (United Nations POPIN source). Similarly, data on pupils from UIS, should match up with estimates of pupils based on the household surveys, and data on pupil progression and dropout should match up with household survey data on education outcomes.

One can estimate pupils from household surveys by multiplying the proportion of the (weighted) survey population in grade X with the population size from the United Nations. In general, the resulting numbers match well with pupil values from UIS. Where they did not, we used the household survey data because not doing so led to discontinuities in the projections of educational attainment. The

discrepancies between UIS and household survey data are well known and some experts prefer to use survey data in general (see UIS, 2005 and Stukel and Feroz-Zada, 2010 for discussions of the issues).

Table 3 Countries covered by DHS and MICS surveys, and countries for which estimates of the survey-based indicators were made using surveys from other countries

Source	Countries
DHS surveys	Albania, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Cameroon, Colombia, Comoros, Republic of Congo, Democratic Republic of Congo, Cote d'Ivoire, Egypt, Ethiopia, Gabon, the Gambia, Ghana, Guinea, Guyana, Haiti, Honduras, Kenya, Kyrgyzstan, Lesotho, Malawi, Mozambique, Namibia, Nepal, Niger, Nigeria, Pakistan, Peru, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Tajikistan, Tanzania, Timor-Leste, Togo, Uganda, Zambia, Zimbabwe
MICS surveys	Afghanistan, Belarus, Belize, Bhutan, Bosnia and Herzegovina, Central African Republic, Chad, Iraq, Kazakhstan, Laos, Mauritania, Mongolia, South Sudan, Sudan, Swaziland, Tunisia, Vietnam
Estimates (countries used for estimates in parentheses)	Angola (Ethiopia), Azerbaijan (Kyrgyzstan), Bolivia (Peru), Botswana (Namibia), Brazil (Peru), Djibouti (Burkina Faso), Equatorial Guinea (Ethiopia), Eritrea (Chad), Guatemala (Honduras), India (Bangladesh), Indonesia (Vietnam), Liberia (Cameroon), Madagascar (Malawi), Mali (Burkina Faso), Mexico (Colombia), Morocco (Egypt), Myanmar (Cambodia), Papua New Guinea (Cambodia), Philippines (Vietnam), Solomon Islands (Cambodia), Somalia (South Sudan), South Africa (Namibia), Turkmenistan (Tajikistan), Uzbekistan (Tajikistan), Yemen (Sudan)

One more substantive inconsistency did emerge, concerning the probability of finishing upper secondary school. One can estimate the probability of completing upper secondary based on UIS data using so-called survival ratios. These are basically a synthetic survival curve based on promotion and repetition (UIS data). A second option is to use observed ratios of education attainment from household surveys. In this case, the estimated survival to the end of secondary for a given cohort (say age 20-24) is the proportion of those who have completed secondary, out of those who ever been to school. It turns out that the probability of completing secondary school based on the household survey data is often considerably higher than the survival probability to the last grade of secondary school based on the UIS data. To a certain extent these discrepancies are plausible – the UIS data may under-estimate older adolescents and young adults in upper secondary school if they are participating part-time, or in a stop-and-go fashion, or go to private schools that don't report or are abroad. For our projections, the survival rates based on the household surveys were used. While this decision shifts the projection of secondary school completion upwards, it does not affect the cost-effectiveness and benefit-cost ratios because the unit costs of completing those years of school are the same regardless of which estimate for completion is used.

5.4 Results of the education projections

This section describes a selection of the results from projections with the education model. Clearly, many scenarios could be run and an analysis could focus on a large set of outcomes, but here, we focus the discussion on the three variables that are used in the economic model:

1) Years of schooling at the time of leaving school.
2) The proportion of young adults, age 20-24 who have completed secondary schooling.
3) The education quality index of the school leavers.

The discussion focuses on two main scenarios:

1) A baseline case of education outcomes with no interventions.
2) An intervention scenario, with a full implementation of the programs listed below.

The intervention scenario includes nine education programs for secondary schools and adolescents. These are:

1) Construction of rural secondary schools with 100 percent coverage of rural adolescents reached by 2020. The early year is likely unrealistic, but was chosen so that the long-term impacts of education improvements would be evident. Rural schools near adolescents can reduce dropout rates by 50 percent.
2) Transfer programs with 100 percent coverage of poor adolescents by 2020. These programs can cover a range of transfers from conditional support, scholarships, fee removal, feeding or other.
3) Free uniforms with 100 percent coverage of poor adolescents by 2020. The effectiveness of transfer programs is quite variable; we have taken an average of 33 percent.
4) Policies to improve the quality of teachers with full coverage of all rural adolescents in school by 2030. As discussed above, these can include a range of specific programs including more selective hiring, incentives for better teachers, and in-service supports. Rural adolescents are chosen for this intervention because without intervention, the better teachers tend to concentrate in urban areas. The effectiveness of free uniforms was tested in Kenya, and reduced dropout rates by 19 percent.
5) Use of electronic materials to support teaching with full coverage of rural adolescents' schools by 2030. Computers, TV and radio can be particularly important in rural areas where schools may be small with fewer specialized teachers. It is important that such interventions are accompanied by training and teacher support; computers alone do not appear to improve learning outcomes. McEwan (2013) did an extensive review of these interventions and found that the average improvement in learning was .15 standard deviations. As one expects the improved learning to lead to higher retention, there is also a smaller effect on dropout rates.
6) Remedial teaching with full coverage of all poor adolescents (as a proxy for those who need remedial support) by 2030. All countries have high variation in learning outcomes; one way to improve average learning achievement is to raise the floor of lowest learners.
7) Comprehensive sexual education for all girls by 2030.
8) Community centers with full coverage of all poor girls by 2030. These Centers are safe places that reduce the risks of marriage among other benefits.
9) Provision of a goat or ewe for girls who stay in school for an additional two years, all rural girls by 2030.

The effects of the CSE and marriage interventions are discussed in the supporting papers on marriage (Rasmussen and Maharaj, 2015) and on adolescent sexual health (Sweeny, 2015).

This specific intervention package is not meant as a prescription of how countries should invest, even if, as is shown in the economic returns paper, the package generates high positive returns. It will be up to

each country – through civil, policy and government dialogue – to decide on the programs that are best suited to that country's needs. The results here may be used input into that discussion, but at this point serve more broadly to make the case for education investments in at-risk adolescents.

Note that although all of the target coverage of all the interventions is set to 100 percent this does *not* mean 100 percent of all adolescents. First, the interventions are limited to the number of adolescents *in school.* Second, all of the interventions, this refers to the sub-group of adolescents who are poor, rural, or girls.

Another important note is that all of the interventions are for secondary school only. Other interventions could have significant impact by increasing school entry rates and reducing very early dropout from primary school.

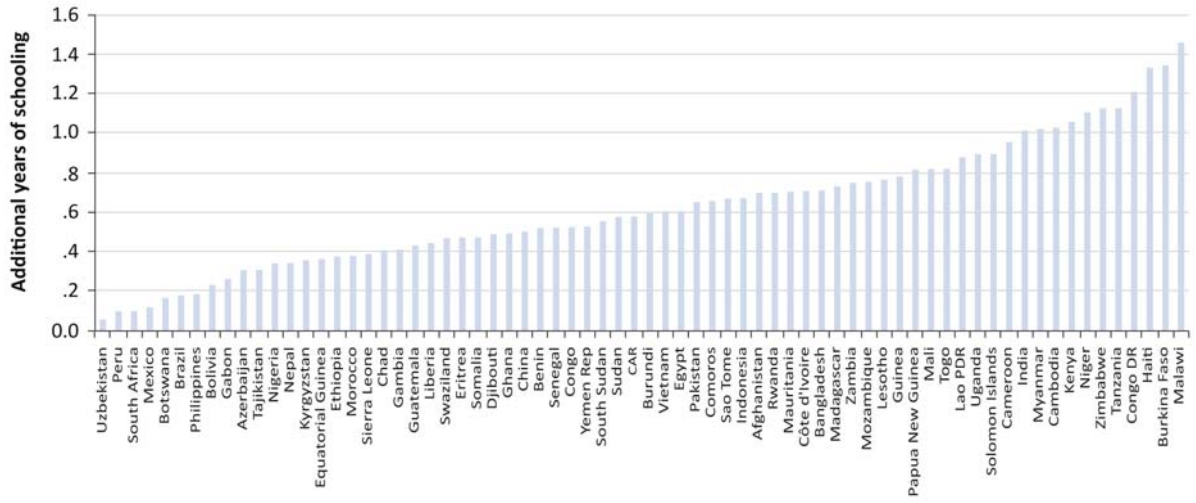
5.4.1 Changes to average years of schooling attained

In many of the Countdown countries, the average level of grades attained when adolescents leave school is low – in some countries the average is barely above primary school completion. Figure 13 shows the added years of schooling as a result of the full intervention package. In some countries, the gains are small: less than 1/10 of a year in Uzbekistan, Peru, South Africa and Mexico. These are countries, where the retention in secondary school is already high, and there is little scope for further increases. On the other end of the figure, are countries, where the interventions add more than a full additional year, or roughly 1/6 of the period of secondary school. These are Cambodia, Kenya, Niger, Zimbabwe, Tanzania, Democratic Republic of Congo, Haiti, Burkina Faso, and Malawi.

It is clear that these types of interventions alone are not enough to allow all children to complete primary and secondary. Other actions focused on younger children (school entry at an appropriate age, school readiness, timely acquisition of literacy and numeracy skills) will be necessary to fill some of the gaps. In addition, more system-wide change to make secondary school an expected and available part of adolescent training for adulthood will be needed.

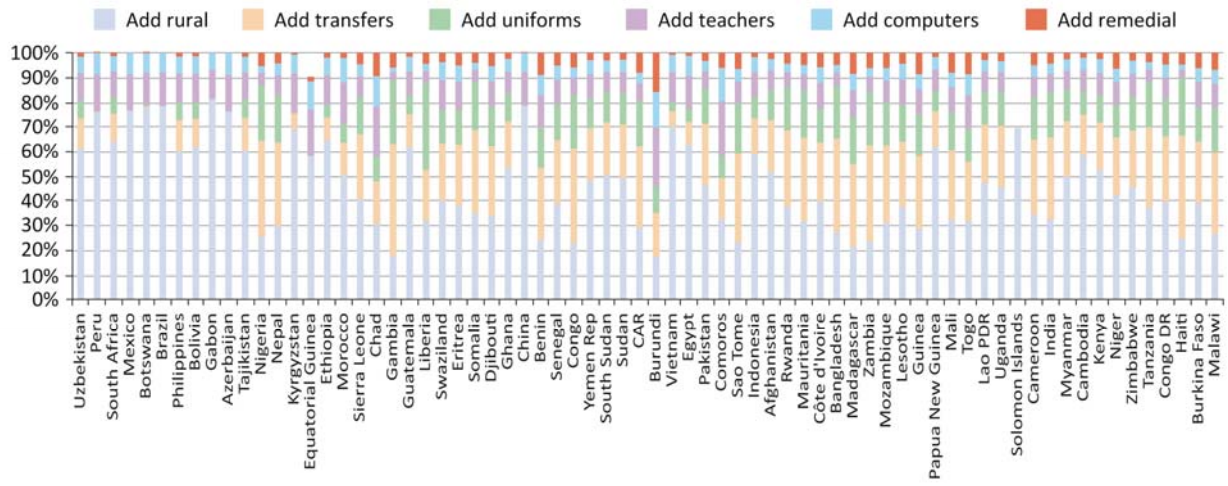
Nevertheless, in many countries, the gains from these interventions would provide a significant measure of additional learning time.

Figure 13 Average years of schooling attained by school leavers in 2030, base case and intervention case in 70 Countdown countries



The contribution *from each intervention* to those improvements depends on the country context. The impacts of the programs that are targeted to adolescents in poverty – transfers, uniforms, and remedial teaching – will be higher in countries where increased dropout risk attributable to poverty is higher (through higher marginal impacts of poverty and/or higher poverty prevalence rates). Similarly, the program of rural schools will have the greatest impacts where the dropout risk attributable to rural location is highest. As Figure 14 shows, the distribution of how much each intervention contributed to dropout reductions varies quite widely by country, even though the scenario settings were the same for all countries. Countries are arranged in the same order as Figure 13. For example, in Mexico, Botswana, and Brazil, most of the (small) increases in additional years of school came from improving rural access. ON the other end of the spectrum, in Haiti, Burkina Faso, and Malawi, programs to stimulate demand and reduce poverty effects contributed a large portion of the schooling increases. The reason is that the risk attributable to the barriers that the interventions are designed to address, vary from one country to the next.

Figure 14 Proportion of the increase in average years of schooling attributable to each intervention

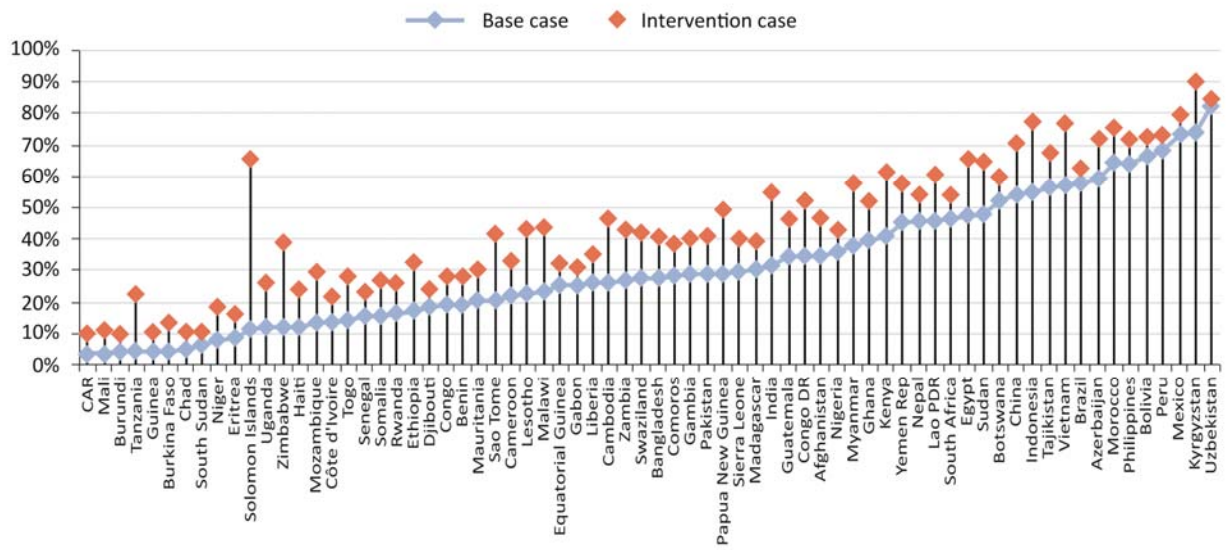


5.4.2 Changes to the proportion of young adults with completed secondary schooling by 2030 – base case and intervention case

One particular measure of the increased levels of schooling is the proportion of young adults who will attain completed secondary schooling by 2030 – the target year to reach the education SDG 4.1 "By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes." (United Nations, 2015). Figure 15 shows the proportions of young adults 20-24 who will have complete secondary schooling by 2030 in the base scenario and in the intervention scenario.

In a number of countries starting from a very low base case, the interventions would double the proportion of young adults with complete secondary. In many countries the gains are 15-20 percentage points or greater (the Solomon Island stands out with a 50 point gain).

Figure 15 Proportion of young adults 20-24 who will have attained full secondary schooling 2030 in the base and in the intervention case



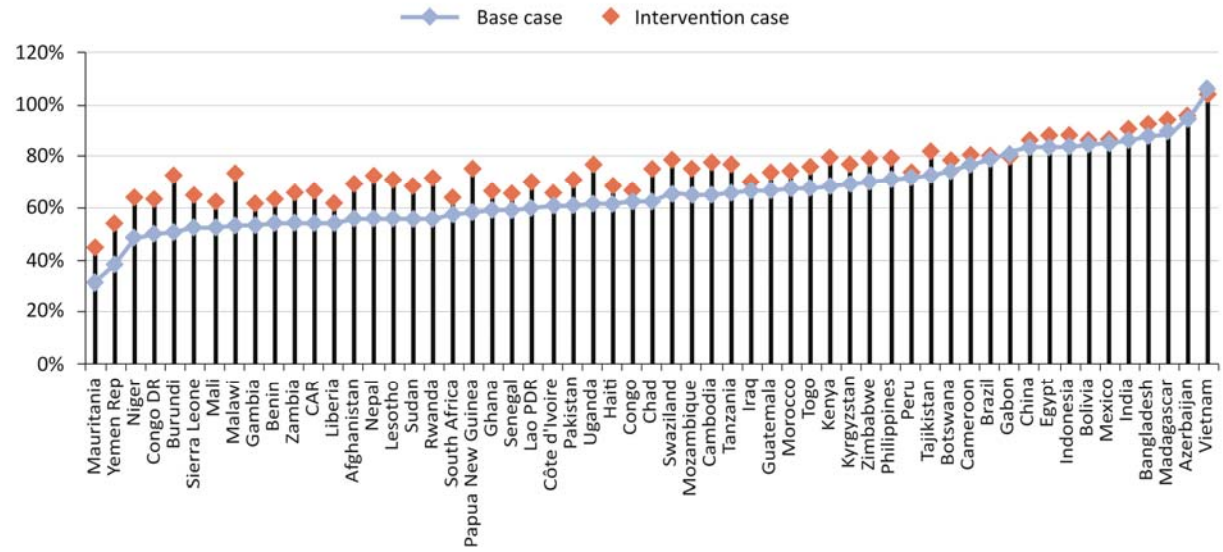
5.4.3 *Improved learning achievement – measured through the quality index*

The interventions also improve learning achievement. For learning achievement we created and index based on the World Bank-based learning scores discussed in Section 2. Rather than use an absolute score value, we transformed those into an index related to a target score. For the target score a value of 50 in the World Bank was chosen, this is roughly equivalent to a score of 500 on the TIMSS, PISA, or PIRLS assessments, which is within the range of scores achieved in the OECD. With this level of learning, adolescents in the Countdown countries would be global peers of adolescents in wealth countries. Without any changes to how adolescents learn in schools, many Countdown countries are at an index level of 60 percent or less, which is equivalent to being 5 or so years behind OECD adolescents in learning achievement (in our index, 8 percentage points are approximately equivalent to one year of secondary school learning in an advanced country[13]).

As a result of the three quality interventions, the learning indices in all countries rise, with larger improvements in those countries starting from a lower base (as expected). At the lower end of the distribution, the countries pick up 10 to 20-plus percentage points in the index, which is roughly equal to moving up one to two and a half grades of learning. Again, while this does not solve the learning crisis in many lower income countries, it is a significant step in the right direction. It also has a positive returns ratio economically, as shown in the economics paper (Sheehan, 2015).

13 As mentioned in Section 2, one year of learning in an advanced country is roughly equivalent to a four-point change in the World Bank scores with a mean of 50.

Figure 16 Changes to the learning index score as a result of a package with three interventions to improve learning achievement of poor and/or rural adolescents in secondary school



6 Conclusion

In education development circles secondary schooling and the education of adolescents is often the poor, ignored cousin of greater concerns with early education, preschool and primary. This is reflected for example in the literature on interventions to improve education outcomes – almost all of them focus on primary school. This paper shows that adolescents face considerable education risks, most of which relate to early dropout and to lack of learning. For girls in particular, marriage increases their risk of early dropout, and is the main factor contributing to the overall higher dropout risk of girls in developing countries. Interventions to reduce this risk are important.

Given the paucity of robust evidence on interventions specifically to improve adolescent education outcomes, this paper focuses on only a small set of investments. These have been shown to generate relatively consistent positive effects in terms of longer retention in school and improved learning outcomes. The possible impact of those interventions was tested in a model developed specifically for the purpose of this project. The results show that the effects of the interventions vary quite widely between countries, reflecting a wide variation in risk factors between countries. The interventions are shown to potentially be able to reduce dropout and low levels of learning by meaningful amounts, but cannot eliminate education gaps between the low- and middle-income countries and wealthy industrialized nations. Nevertheless, they are shown, in other papers in the VISES study to have important and cost-effective impacts on marriage and future income levels. It is hoped that these results will lead to a stronger case to invest in the education of teens.

This study was not able to include some important challenges, such as teen education in emergencies; the importance of second-chance learning for teens, who have never gone to school or left at a very

early stage; and employment training programs. In part this was driven by the fact that in many ways, our analysis of adolescent schooling had to piece together many pieces that had not been used for work on teens before.

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APPENDIX A: Technical description of computations for initial conditions

General initial conditions of education

The model is set up with initial conditions for each country. These include data taken from the UNESCO (2015) report and additional data compiled for the adolescent study. The initial conditions provide a comprehensive starting point for each country including the existing student population and its education outputs (progress through school and dropout rates), risk factors for dropout in the adolescent years, and the initial learning levels.

Basic data on the pupil distribution by sex and grade, number of teachers, teacher salary, annual expenditures on materials, and estimates on classrooms, and projections of the school age population are taken from the UNESCO (2015) model. The UNESCO (2015) model used as its sources: the UNESCO Institute of Statistics for school related indicators; the UN Population Division medium projection from 2012 for population by sex, rural/urban location, and age 5-24; and World Bank and IMF for GDP and poverty data. Where there were gaps, national level data from official sources are used, and in rare cases, gray online sources. The UNESCO (2015) model also provides initial values of intake rates to grade 1.

Repetition and dropout rates by grade were obtained from UIS data in the UNESCO (2015) model. Because we wanted to include the known effects of age on dropout rates, the grade-specific dropout divided into three groups (5-9, 10-14, and 15+), such that older students each grade are more likely to drop out (given probabilities of having dropped out by age from household surveys). The age adjustments maintain the UNESCO (2015) grade-specific dropout values in the aggregate.

DHS and MICS household surveys were accessed for initial age-distribution within grades, and for the age- and sex-wise initial distribution of the population over education and marital status groups – those with no schooling, those in school, those post-school with primary, post school with incomplete secondary, and post-school with secondary completed, all for never-married or ever-married.

Initial marginal effects of risk factors on dropout rates.

The adolescent education model delves more deeply into the initial conditions that add to the risk of dropout, namely, the age-distribution of students – because higher age is correlated with higher drop out risk – and the background variables female sex, poverty, and rural location. Based on earlier work, it was known that age, female sex, poverty, and rural location could reliably be obtained from household surveys. Other risk factors, such as disability, ethnic minority status, and living in conflict zones are known to have large negative impacts on education, but the surveys do not reliably provide information on these. DHS and MICS household surveys were accessed for information. Conceptually, the model for dropout rates is:

$$d_a = c + \sum_k \beta_k p_k,$$

or, the dropout probability at age a is equal to a constant – which could be said to reflect general country-specific context, plus the sum of risk impacts, each of which is the product of the prevalence of the risk factor (subscript k) and a coefficient of the marginal impact of the risk factor on dropout.

To obtain the values for this model, DHS and MICS household surveys were analyzed following an approach used by Hattori (2013) to look at socio-economic determinants of primary school attendance. Two meta-files were created from 47 DHS household surveys and XX MICS surveys for the analysis. The meta-files preserved a set of relevant variables – school attendance by grade and level, education attainment by highest grade[14], sex, age, wealth[15], location, country, marital status, as well as sampling information (psu's, strata, and weights).

The age-distribution of students by grade was taken from a sample-weighted table for each country and sex. Columns provide the proportions of students in grade X by single-year age 5-24, with rows for grades one to the end of upper secondary. In school systems with on-time entry and little repetition, close to 100 percent of students in each grade are of the official age for that grade; but many of the countries in our set of 74 have widely distributed age-ranges within grades due to over-age entry and/or high repetition rates.

The *estimations for the contribution of the risk factors sex, poverty, and rural location* to dropout rates required a more extensive analysis. We separated pupils into three adolescent age groups – age 10, age 14 and age 19[16] and created a set of drop out related variables – "left school" (conditional on having attended), and "left school before completing secondary" (conditional on having left school). We then ran a logit regression for each country and for each of the three age groups with "left school before completing secondary" as the dependent variable and the risk factors – being a girl, being poor, and living in a rural area – as the dependent variables. The odds ratios from the logit regression were transformed into marginal effects of the risk factors on dropout using the Stata "mfx2 compute" function. Ultimately, the dropout results for the younger age-groups were not utilized. Only output from on dropout for age 19 for each country was used in the education model as it captured all of the dropout risk through adolescence. The final model for the probability of having dropped out of school looks like:

$$d = c + \beta_f p_f + \beta_p p_p + \beta_u p_u,$$

or, the probability of having left school before age 19 and before completing upper secondary is equal to a constant, plus the marginal effects of being a girl times the prevalence of girls (subscript f), plus the marginal effects of poverty times the prevalence of poverty (subscript p), plus the marginal effects of living in a rural area times the prevalence of the rural population (subscript u). Any values with significance levels below 0.1 were discarded as zero.

[14] We created a continuous grade variable from first to the last grade of upper secondary from the survey data on grade within school level, the school level, and data on the school system from UIS.

[15] The wealth indices in the surveys, which are available by household member, were used to create a poverty dummy variable for each country in the following manner. First, a Stata protocol arranges all household members in the dataset (for each country) in order of the wealth index. Second, the percent of population living on less than $2 per day was obtained from the World Bank. This percentage was coded into Stata as the cut-off point for the arranged household members. The X percent of household members with the lower wealth indices (X being the percent living on less than $2 per day) are given the value "poor"; the remainder is "not poor". This measure is distinct from the usual wealth quintiles (household members divided into five groups of relative wealth) used in a poverty analysis of household data, and has the advantage of approximating an absolute value of poverty deprivation rather than a relative one.

[16] To increase the sample size within each group, we added those who were one year older and one year younger – so age 10 is actually comprised of household members age 9-11; age 14 includes those age 13-15; and age 19 includes those age 18-20. For communication, in the rest of the paper these are referred to as age 10, age 14, and age 19.

APPENDIX B: Technical description of the education model

Projections – the demographic universe of the education model

The demographic universe in which these scenarios and projections occur is the population from age 3-24. For the pre-adolescent years 3-9 the numbers are simply taken as the medium UN population projection (version 2012). Theoretically, there should be some changes to the pre-adolescent population as a result of education – because education will affect the fertility levels of future women of child-bearing age – but in practice with the 15-year time horizon of the model, the effects will be too small to notice and would require a large amount of additional programming.

For the ages 10-24, the population is projected using mortality rates from the OHT model. The population in each sex, age group, in year t is equal to the previous year's population, previous age reduced by the mortality. In the absence of input from the OHT model, the medium UN population projection for these ages is used.

Intervention-led reductions in dropout rates, repetition and learning failure.

The intent education interventions is to improve outcomes through improvements that will help all students, and through policies that reduce the *marginal effects* of risk factors on dropout (see more on computations of marginal effects in Appendix C). Other interventions, not considered in this model, could reduce the prevalence of those risk factors. Intervention impact is the combined effect of the scale at which it is operating – what percent of the population is covered – and its effect on those people who receive it (see e.g. WHO, 2013 for explanation from the health sector, which works in a similar way). One group of interventions has a global benefit; these can be scaled up to reach the entire population. But another group is meant to alleviate barriers for particular risk groups, and the scale of those is limited to the size of the risk group they affect. For example, a reform to attract more talented teachers with higher salaries and better working conditions can be scaled up to the entire school system because teachers affect all students. On the other hand, the scale of an income support project for the poor is maximized when all poor children are reached. With this in mind, a general formulation for the impact of a given intervention is:

$$i_{i,k} = c_{i,k} p_k e_i$$

or, the impact of the intervention i in risk group k, is equal to the product of the scale or the coverage of the intended risk group (c), the prevalence of the risk group in the population (p), and the effectiveness of the intervention for those who receive it.

Multiple interventions are often combined in a package. If they are not complimentary, the effect is multiplicative, with each intervention's effect eroded slightly by the impact of other interventions. In the MBB model this effect is formulated as a chain:

$$\hat{\imath} = (1 - i_1) * (1 - i_2) * \ldots * (1 - i_n)$$

where $\hat{\imath}$ is the cumulative effect of all the interventions together. The value of $\hat{\imath}$ can change over time, depending on the assumed path of scaling up the interventions (effectiveness is assumed to remain constant).

The education model maintains a separate $\hat{\imath}$ for each of the three risk groups and for the constant in the dropout equation (above). The combined effect of all four $\hat{\imath}$ values determines the future paths of dropout, repetition and learning.

Reductions in the dropout rate, equal the sum of the î effects on the initial marginal risk-factor effects and the projected prevalence of the risk factors:

$$\Delta d_t = (\hat{\imath}_{c,d,t}c + \hat{\imath}_{f,d,t}\beta_f p_{f,t} + \hat{\imath}_{p,d,t}\beta_p p_{p,t} + \hat{\imath}_{u,d,t}\beta_u p_{u,t})$$

Note that both the î effects and the prevalence rates are time-dependent, as they change in the course of the simulation. The d in the subscripts denotes the relation to dropout.

For repetition and learning we did not consider the marginal effects of risk factors, but the scale of interventions is still limited by the prevalence of the risk factors. The equation for repetition, with r subscripts for repetition, is:

$$\Delta r_t = \hat{\imath}_c \left(1 - p_{f,t}\left(1 - \hat{\imath}_{f,r,t}\right)\right) * \left(1 - p_{p,t}\left(1 - \hat{\imath}_{p,r,t}\right)\right) * \left(1 - p_{r,t}\left(1 - \hat{\imath}_{r,r,t}\right)\right),$$

which takes account of the fact that the overall impact of some interventions is limited by the prevalence of the risk groups. The equation for reducing learning failure is the same, but with the impacts related to learning.

The actual dropout, repetition, and learning rates are equal to the initial values multiplied by the relative change. For learning, this means simply: $l_t = l_0 * \Delta l_t$. Repetition is disaggregated by grade - $r_{g,t} = r_{g,0} * \Delta l_t$ - and dropout is disaggregated by grade and age-in-grade - $d_{a,g,t} = d_{a,g,0} * \Delta l_t$.

Finally, all of the above applies only to repetition and learning of the adolescent students; for younger students, age 5-9, there are simply target-led, user-set assumptions about changes (generally a target for lower values to be reached by a specified target year).

Projections of the prevalence of the risk factors are taken exogenously from international sources. The percentage of girls and the percentage rural are from the UN medium population projections. The percentage poor is from the UNESCO (2015) model which projects an estimate of poverty – percentage of population living on <$2 per day – based on initial conditions, the IMF projected GDP per capita, and a coefficient of GDP per capita and poverty change based on a cross-sectional analysis of poverty and GDP per capita.

Projections of students, school-leavers, educational attainment, adjusted by quality

With the projected dropout, repetition and learning rates, we can project students, school leavers and quality-adjusted education. The students (S) are comprised in a three-dimensional matrix of grade, age, and time. All three dimensions are important – grade because it determines educational attainment; age because it is related to the rate of dropout and the start of post-school probabilities or work or marriage; and time as the simulation dimension. As mentioned, the initial student body by grade comes from UIS data in the UNESCO (2015) model and the age-distribution within each grade from DHS and MICS household surveys.

In each projected year, t+1, the number of students (S) by age and grade are the sum of the repeaters from the same grade in the previous year and previous age; plus the promotes, from the grade earlier in the previous year and the previous age:

$$S_{a,g,t} = S_{a-1,g,t-1}r_{g,t-1} + S_{a-1,g-1,t-1}pr_{a-1,g-1,t-1},$$

with the promotion rates, pr, being simply the residual of 1-repetition-dropout. In addition (not shown), there is an annual attrition of students due to age-specific mortality. Through mortality the OHT output directly affects costs and throughput of education.

The projection of grade 1 students is moderated to consider intake rather than promotion. Intake into grade 1 is projected as the gross intake rate (an exogenously assumed variable) times the population in the official entry age, distributed over age with a consideration of initial over-age entry and an exogenous assumption about the reduction of over-age entry.

From the projected students, the computation of school-leavers is straightforward as the product of students and the dropout rate:

$$L_{a,g,t} = S_{a,g,t} d_{a,g,t}$$

This is the education output used in the economic model.

The school-leavers are an annual flow, which enter into the stock of the population post-school. The post-school population is also a three-dimensional matrix of age, grade attained, and time, and each sub-group is equal to:

$$P_{a,g,t} = P_{a-1,g,t-1}(1 - m_a) + L_{a,g,t}(1 - m_a).$$

In addition to this post-education population group, the *total population* includes the students (S) and the never-schooled population. Up to age 5, the entire population is considered never-schooled. After that, flows into school (the intake to grade 1) diminish this group as age goes up. The never-schooled population is:

$$P_{a,0,t} = P_{a-1,0,t-1}(1 - m_a) - I_{a,t}.$$

Intake is considered possible up to age 12 in the model.

The population by educational attainment can be used as input to the OHT scenarios.

The sum of the education-specific population groups is equal to the total population.

APPENDIX C: Output of the regression for marginal effects of risk factors on early dropout probability before age 19, for 44 DHS surveys

VARIABLES	Married	s.d.	Girl sex	s.d.	Poor	s.d.	Rural location	s.d.	Observations
Albania	0.325***	(0.0574)	0.0166	(0.0354)	0.145**	(0.0607)	0.349***	(0.0302)	1,457
Bangladesh	0.398***	(0.0162)	-0.0808***	(0.0183)	0.295***	(0.0230)	-0.0585***	(0.0186)	4,940
Burkina Faso	0.426***	(0.0300)	-0.0262	(0.0323)	0.0710*	(0.0404)	0.0733*	(0.0404)	1,769
Burundi	0.578***	(0.0168)	0.0446*	(0.0263)	0.109**	(0.0473)	-0.110***	(0.0407)	2,226
Cambodia	0.311***	(0.0126)	0.0455***	(0.0157)	0.200***	(0.0162)	0.108***	(0.0200)	4,752
Cameroon	0.531***	(0.0180)	0.0206	(0.0215)	0.177***	(0.0277)	0.0214	(0.0274)	3,891
Colombia	0.357***	(0.0162)	-0.130***	(0.0108)	0.263***	(0.0201)	0.0939***	(0.0148)	11,209
Comoros	0.577***	(0.0414)	-0.123***	(0.0364)	0.0544	(0.0336)	0.0289	(0.0350)	1,368
Congo	0.396***	(0.0360)	0.0288	(0.0361)	0.283***	(0.0455)	-0.139***	(0.0480)	2,258
Congo DR	0.494***	(0.0242)	0.208***	(0.0239)	0.0619*	(0.0371)	0.0994***	(0.0336)	4,736
Cote d'Ivoire	0.383***	(0.0353)	0.137***	(0.0339)	0.169***	(0.0477)	0.252***	(0.0434)	1,647
Ethiopia	0.470***	(0.0246)	-0.0518*	(0.0278)	-0.168***	(0.0543)	0.283***	(0.0501)	3,982
Gabon	0.459***	(0.0527)	0.0503	(0.0370)			0.253***	(0.0363)	1,879
Gambia	0.507***	(0.0301)	0.00183	(0.0296)	0.157***	(0.0368)	-0.0634*	(0.0352)	2,413
Ghana	0.454***	(0.0273)	0.0934***	(0.0237)	0.0145	(0.0306)	0.110***	(0.0284)	2,407
Guinea	0.470***	(0.0397)	0.128***	(0.0356)	0.111*	(0.0625)	0.0800	(0.0632)	1,526
Guyana	0.256***	(0.0510)	-0.138***	(0.0431)	0.337***	(0.0523)	0.129***	(0.0438)	1,038
Haiti	0.603***	(0.0266)	0.0620***	(0.0212)	0.137***	(0.0291)	0.0196	(0.0293)	3,664
Kenya	0.556***	(0.0337)	0.0468	(0.0345)	-0.00265	(0.0395)	-0.0220	(0.0515)	2,072
Kyrgystan	0.232***	(0.0404)	-0.0707***	(0.0230)			0.0826***	(0.0195)	1,551
Lesotho	0.466***	(0.0193)	-0.172***	(0.0246)	0.252***	(0.0279)	0.127***	(0.0357)	2,971
Malawi	0.521***	(0.0158)	0.0245	(0.0219)	0.277***	(0.0342)	0.0598*	(0.0361)	5,515
Mozambique	0.385***	(0.0220)	0.0202	(0.0257)	0.258***	(0.0305)	0.100***	(0.0285)	2,977
Nepal	0.450***	(0.0244)	-0.0445*	(0.0263)	0.219***	(0.0263)	-0.00935	(0.0306)	2,673
Niger	0.384***	(0.0306)	-0.0919**	(0.0368)	0.143***	(0.0404)	0.183***	(0.0403)	1,188
Nigeria	0.434***	(0.0221)	0.0298**	(0.0123)	0.148***	(0.0116)	0.0702***	(0.0117)	7,180
Pakistan	0.279***	(0.0279)	0.0113	(0.0214)	0.169***	(0.0242)	0.0737***	(0.0235)	5,055
Peru	0.372***	(0.0257)	-0.0437***	(0.0139)	0.203***	(0.0279)	0.160***	(0.0179)	5,566
Rwanda	0.363***	(0.0197)	0.0411**	(0.0182)	0.0671**	(0.0309)	0.00779	(0.0292)	3,088
Senegal	0.533***	(0.0359)	-0.00174	(0.0457)	0.0485	(0.0416)	-0.000372	(0.0425)	1,484
Sierra Leone	0.530***	(0.0254)	0.161***	(0.0239)	0.0866***	(0.0332)	0.166***	(0.0271)	3,363
STP	0.392***	(0.0430)	-0.0736	(0.0549)	0.337***	(0.0467)	0.0945*	(0.0508)	731
Tajikistan	0.194***	(0.0298)	0.177***	(0.0238)	0.0905***	(0.0265)	0.103***	(0.0233)	2,230
Tanzania	0.388***	(0.0165)	0.0466**	(0.0228)	0.147***	(0.0325)	-0.00897	(0.0311)	2,683
Timor Leste	0.627***	(0.0247)	-0.0450**	(0.0190)	0.131***	(0.0199)	0.142***	(0.0206)	3,316
Togo	0.534***	(0.0222)	0.143***	(0.0275)	0.0561	(0.0430)	0.0359	(0.0399)	2,132

Uganda	0.465***	(0.0187)	0.0487*	(0.0255)	0.0945***	(0.0314)	-0.0302	(0.0312)	2,353
Zambia	0.558***	(0.0159)	0.0719***	(0.0218)	0.324***	(0.0277)	0.0904***	(0.0239)	4,597
Zimbabwe	0.287***	(0.0163)	0.0611***	(0.0186)	0.0944***	(0.0197)	0.0164	(0.0201)	2,457