

WORKING P A P E R

Prioritizing Educational Investments in Children in the Developing World

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LABOR AND POPULATION

Prioritizing Educational Investments in Children in the Developing World

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Abstract: We bring together 40 randomized and non-randomized evaluations of education programs to compare cost-effectiveness, seeking to facilitate prioritization of different candidate interventions by policymakers. We examine cost-effectiveness across three outcomes (enrollment, attendance, and test scores) and find distinct “best interventions” for each outcome. For increasing enrollment, urban fellowships, school consolidation, and extra teachers have proven most cost effective. For school attendance, school-based deworming stands out as most cost effective. And for improving test scores, several interventions seem similarly cost effective, including providing blackboards, workbooks, training teachers, and others. We discuss some of the challenges inherent to comparing interventions.

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Introduction

In recent years, both critics and advocates of foreign aid have increased their demand for evidence on what works in development. A recent Center for Global Development report states, “After decades in which development agencies have disbursed billions of dollars for social programs...it is deeply disappointing to recognize that we know relatively little about the net impact of most of these social programs.” Bill Gates put it succinctly: “Success depends on knowing what works” (Center for Global Development 2006).

Rising simultaneously has been the quality of a significant proportion of program impact evaluations. Randomized trials of development interventions are becoming more common. Consider, for example, a randomized trial that showed major impacts of a cash transfer program to poor families in Mexico (Behrman et al. 2005) or another that showed striking impacts of providing deworming medication on school attendance in Kenya (Miguel and Kremer 2004). A multitude of other studies use quasi-experimental methods to imitate randomized trials.

Many project evaluations simply estimate whether a program has had a significant impact on the outcome of interest, such as whether children’s test scores have risen. However, a positive answer to that query only provides a third of the answer as to whether the intervention is a good policy choice. The second third concerns the cost: programs with a positive impact are only worth implementing if the benefit exceeds the cost of the intervention. Some papers perform such a cost-benefit analysis, making assumptions about the value of the benefits gained from the intervention. As a policymaker, this information is helpful but still insufficient. The final third of the answer comes in the comparison with other interventions: faced by dozens of candidate interventions that have been proven cost effective, the policymaker must determine which intervention will be the *most* cost effective; in other words, which program will provide the largest benefit per dollar (or bang for buck)?

In this paper, we bring together evidence on the effectiveness of various interventions to improve educational outcomes of children in developing countries, together with available cost estimates of such interventions to arrive at specific results and recommendations on prioritizing educational investments in the less developed world.¹ Glennerster (2005)

¹ The World Health Organization performed this exercise for health interventions through its CHOICE program (CHOosing Interventions that are Cost Effective): see, for example, Tan-Torres Edejer et al. (2005) for

conducts such an analysis looking at children's education, but examines fewer outcomes and includes only randomized trials. Further, in the few years since her study, a number of other studies have yielded results. We discuss some of the problems inherent to including both randomized and non-randomized trials in the methods section; and in our results, we distinguish between randomized and non-randomized evaluations. We also discuss some of the challenges inherent to comparing these kinds of interventions.

We find that distinct interventions prove to be most cost effective across the different outcomes: enrollment, attendance, and test scores. For increasing enrollment, urban fellowships, school consolidation, and extra teachers have proven most cost effective. For school attendance, school-based deworming stands out as most effective. And for improving test scores, several interventions seem similarly cost-effective, including providing blackboards, workbooks, training teachers, and others. The appropriate choice of intervention will depend on the specific educational goal to be achieved.

Methods

This section offers a detailed description of the methods used to arrive at cost-effectiveness estimates for various interventions. Briefly, we followed four steps to derive the estimates: first, we identified papers that evaluate one or more educational interventions – either in a randomized or a non-randomized framework; second, we reviewed the papers for the exact methods used, and the particular interventions and outcomes studied; third, we obtained cost estimates for the evaluated interventions – either from the paper or through direct contact with the authors – and thereby narrowed the sample to papers for which reliable cost information was available; finally, we made the calculations to arrive at cost-effectiveness estimates for each intervention.

(a) Selecting papers: randomized versus non-randomized interventions

We reviewed the existing literature on evaluation of educational interventions in developing countries to make an initial selection of papers for this study. While Glennerster (2005) and Kremer (2003) offer excellent reviews of randomized interventions (at the time), our study

prioritization of investments in children's health, and Adam et al. (2005) for the same analysis concerning maternal and neonatal health.

seeks to add evidence from new papers, on more outcomes, and to include evidence provided by quasi-experimental evaluations. While this should create concerns about the internal validity of the estimates from some of the included studies, we offer a transparent discussion of the methods used in these papers so that readers can discern. Such an approach demands caution in interpreting the results from the cost effectiveness analysis, but it also makes this study more comprehensive in its scope and final results.

All papers that were initially selected for this study are listed in Table 1. While most of these papers are from the development economics literature, we found some useful evaluations in the public health and education literatures as well. Evaluations based on randomized experiments are listed in panel A, while all other papers are in panel B. The papers reviewed in Glennerster (2005) and Kremer (2003) are also identified in the table, and are identified by the entries in columns 5 and 6. As can be seen from Table 1, of the 40 papers initially selected for this study, about half (21) are based on evaluations from randomized interventions. Among the remaining 20, most papers seek to identify causal estimates of program impacts using methods like instrumental variables (IV), difference-in-differences, or the inclusion of a large number of control variables.²

The use of such non-experimental methods leaves concerns about biases arising from endogeneity of treatment, from selection, or generally speaking, from omitted variables. We discuss some of these concerns in the discussion section. We differentiate between results obtained from randomized and non-randomized evaluations in our subsequent cost effectiveness analysis.

(b) Interventions & Outcomes

A broad range of interventions were evaluated by these studies, e.g., cash transfers (Schultz 2004; Behrman et al. 2005), provision of school inputs (Banerjee et al. 2004, 2005; Bedi & Marshall 1999, 2002; Bedi et al. 2004; Case & Deaton 1999; Chin 2005; Dreze & Kingdon 2000; Evans et al. 2008; Glewwe & Jacoby 1994; Glewwe et al. 2004, 2007; Glick & Sahn 2006; Kremer et al. 2003; Tan et al. 1997; Duflo et al. 2006, 2007a), teacher incentives (Duflo et al. 2006, 2007b; Glewwe et al. 2003), vouchers (Angrist et al. 2002; Mizala &

² Of course, this means we have excluded a host of non-experimental observational studies. This paper can be seen as an overview survey: the citations of these papers (and the papers where they are cited) are a logical place to continue the work.

Romaguera 2000), scholarships (Alderman et al. 2003; Kim et al. 1999; Kremer et al. 2004), micro-credit programs (Pitt & Khandker 1998; Wydick 1999), as well as health interventions with educational impacts such as family planning programs (Sinha 2005), school-based deworming (Miguel & Kremer 2004), and school-based deworming coupled with iron supplementation (Bobonis et al. 2004). Despite the broad array of interventions, educational outcomes studied in these papers generally fit into three categories: enrollment, school participation or attendance,³ and test scores or performance. In our cost-effectiveness analysis, therefore, we present separate results for each of these three outcomes. (Many of the papers also have other outcomes: for example, Duflo et al. 2006 also examine adolescent pregnancies, and Duflo et al. 2007a and 2007b examine teacher absenteeism. For this review, we focus on the most common outcomes across papers).

We present cost-effectiveness estimates for several interventions for each of the outcomes. The various interventions and outcomes studied in these papers are listed in Table 1. In quite a few of these papers, the same intervention was evaluated with respect to different outcomes (such as both participation and test scores). This makes a cost-effectiveness analysis even more worthwhile, as an intervention that fails in raising school attendance might still prove to be highly cost-effective in increasing test scores. Similarly, our review of a large number of similar interventions helps us to identify those that were ineffective in a particular setting, but successful in another place.

(c) Cost of interventions

As can be seen in Table 1, most of these studies provide the costs of implementing specific interventions. When cost information was not available for a particular intervention, we contacted the authors and requested them to provide us with any available cost estimates. For one such intervention – early childhood programs in Jamaica (Walker et al. 2005) – the authors were able to give us cost information. Unfortunately, no cost information was available for the following six studies by Sinha (2005), Bedi & Marshall (2002), Case and Deaton (1999), Dreze and Kingdon (2000), Lloyd et al. (2005), and Zimmerman (2003) – either from authors or from other sources recommended by the authors. Therefore, these

³ Student participation is a combination of enrollment and attendance: it measures the percentage of unannounced enumerator school visits at which a student is present. Thus, if a student has dropped out of school, student participation will be zero.

studies were dropped from the subsequent cost-effectiveness analysis, even though (for completeness) we mention the findings from these papers in the next section.

A distinction needs to be made between studies that provide the total cost of carrying out an intervention versus those that provide the value of services only (e.g., the amount of the microcredit loan provided). There are five interventions for which we have the value of services only, as opposed to the total cost, and these are – the capitation grant program in Uganda (Bjorkman et al. 2006), student subsidy program in Chile (Mizala and Romaguera 2000), micro-credit program in Bangladesh (Pitt and Khandker 1998), food-for-education program in Bangladesh (Ravallion and Wodon 2000), and a micro enterprise lending program in Guatemala (Wydick 1999). For these studies, the total cost of an intervention is likely to be understated and we mark these studies separately while interpreting the results from our cost-effectiveness analysis.⁴

We converted costs to 1997 US Dollars so that the amounts were comparable across interventions. We used the “all urban consumers” consumer price index to deflate prices across years, and we used historical exchange rates in the year of the expenditure to convert to US dollars.⁵ For interventions that incurred costs over multiple years, we were able to use the information provided in the papers to arrive at annual costs or the discounted total cost. Also, in almost all cases, we were able to arrive at a per-child (or per-household) cost estimate for a specific intervention. Wherever necessary, further details of our cost calculations are presented in the next section on a paper-by-paper basis, along with the results.

We considered whether to use dollars adjusted by simple exchange rates or by purchasing power parity (PPP). Exchange rate conversions tend to overprice the cost of labor-based interventions (when comparing labor-intense projects in poorer countries to other projects in less poor countries), as labor is much cheaper in low-income countries. However, they give the best indication of what an international donor may expect in outcomes when choosing both where to invest and what kind of program to invest in. For local policymakers determining how to allocate their budgets in local currency, PPP is superior as it more

⁴ Assuming that micro credit programs were self-sustaining, the average value of services (or credit) offered by these programs might be an accurate representation of the average cost, but even then the start-up costs of such programs are being ignored.

⁵ Foreign exchange rates were obtained from <http://www.oanda.com/convert/fxhistory>.

accurately captures what the government or non-profit might expect in exchange for a certain investment in local currency. Most studies report costs in dollars and do not mention using PPP (probably because many of the interventions evaluated were funded by donors). We therefore assume that most are using exchange rate conversions.

(d) Calculating the cost-effectiveness of interventions

As mentioned before, the various interventions have been studied with respect to three main educational outcomes: enrollment, participation or attendance, and test scores. We carried out separate cost-effectiveness calculations for each category of outcomes. We believe that such an approach not only helps to present the results in a clean and methodical fashion, but would also be helpful to policymakers in addressing specific problems, e.g., raising the test scores of children in Uganda or Kenya, or increasing enrollment in India and Pakistan. Cost effectiveness ratios are constructed by dividing the program costs per pupil by the gain in test scores, or enrollment, or school participation per pupil. Following Kremer's (2003) approach, we also present the "education budget cost-effectiveness" of interventions, which accounts for the deadweight loss associated with raising the necessary funds. This calculation is based on the assumption that it costs 1.4 dollars to raise one dollar through taxation, and hence, the program cost effectiveness ratios are multiplied by 1.4 to arrive at the education budget cost effectiveness ratios, which would be particularly relevant for policymakers operating with a given budget. The particular procedures used to arrive at cost-effectiveness estimates for each of the three broad analyses are as follows:

(i) Enrollment: To assess the cost-effectiveness of alternative interventions in improving school enrollment, we used the impact estimates in percentage terms (not percentage points, in order to make some adjustment for baseline values) along with the reported cost of the intervention per child or per household. This cost figure was divided by the percentage increase in enrollment, to arrive at the per child cost of increasing enrollment by 1 percent. For one such intervention – the fellowship program in Pakistan (Kim et al. 1999; Alderman et al. 2003) – we assumed that girls stayed in primary schools for at least four years, and using the information on monthly fellowship amounts and the start-up costs of the program, we arrived at yearly costs per student. Dividing this figure by the percentage increase in

enrollment brought about by this program, we derived the cost-effectiveness ratio of this intervention.

(ii) School participation: We followed a similar strategy for evaluating interventions with respect to increased school participation or years of schooling. The intervention cost was divided by the gain in school participation or attendance as estimated in the paper to arrive at the cost of inducing an additional year of schooling. For example, Duflo (2001) studies a school construction program in Indonesia and provides the total program cost (discounted over several years) per constructed school. Using her estimate of increased schooling along with information on cost, we were able to arrive at the cost per child for an additional year of schooling. In this same outcome category, we also include a paper by Chin (2005), where the author evaluates the teacher component of Operation Blackboard (OB) in India with respect to school completion of boys and girls. For two of the interventions – food-for-education program in Bangladesh (Ravallion & Wodon 2000), and microenterprise lending in Guatemala (Wydick 1999), we used the value of services delivered – dollar values of the average quantity of rice received by households or average amount of loans taken by households – to get at the per household cost of these programs. These are certainly lower bound estimates of the costs of such interventions, and as such, need to be interpreted with caution. We have marked them separately in our results.

(iii) Test scores: From studies that look at the effect of specific interventions on test scores, we utilized the impact estimates for improvements in total test scores (combined across subjects such as math, reading, etc.) along with reported costs, in order to arrive at comparable cost estimates across interventions. In cases where effects on total test scores were not available, we used the impact estimates for improvements in math scores from various interventions. Further, to obtain comparable estimates of improvements in test scores, we measured test score increases (due to an intervention) in standard deviation units, which were either available in the papers, or were calculated by hand using impact estimates and summary statistics from the papers. Finally, dividing the per pupil cost of each intervention by the gain in test scores in standard deviation units, we arrived at the per pupil cost of improving test scores by 0.1 standard deviation across interventions. As with enrollment and school participation, these cost effectiveness ratios were multiplied by 1.4 to arrive at the education budget cost-effectiveness of alternative interventions.

Results

The results from our cost effectiveness analysis are presented separately for each of the three outcome categories. As mentioned before, we present both the program cost effectiveness estimates and the education budget cost effectiveness estimates for each intervention, and use the latter to compare the efficacy of various interventions.

(i) Enrollment

Results from the cost effectiveness analysis of interventions that seek to improve enrollment of children in developing countries are summarized visually in Figure 1 and quantitatively in Table 2. Results from randomized evaluations are in Panel A of Table 2, while those for non-randomized evaluations are in panel B. Among randomized interventions, Duflo et al. (2006) evaluate the impact of distributing school uniforms to girls in Grade 6 in western Kenya and show significant improvements in school enrollment (actually preventing drop-outs), with a 20% effect for girls and a 25% effect for boys. That comes to about \$17 and \$13.50 per percent increase for girls and for boys. An urban fellowship program evaluated by Kim et al. (1999), and also by Alderman et al. (2003), proved to be quite cost effective with an annual cost of about 2.50 dollars per child for one percent increase in enrollment. This program was implemented in the city of Quetta in Baluchistan province of Pakistan, and it provided a public subsidy for establishing private schools and encouraging girls' enrollment in such schools. The government paid the subsidies directly to these schools – based on the number of girls enrolled in such schools – for three years. The authors find that this program led to at least a 25 percent increase in girls' enrollment, with the effect possibly being as large as 43 percent in the second year of the program, and it also had a significant positive impact on boys' enrollment. A similar rural fellowship program, however, failed to be as successful in raising enrollment rates among boys, which the authors attribute to the lack of pre-existing constraints on boys' enrollment in rural areas, and the higher price of enrolling boys in the fellowship schools.

In another randomized evaluation, Schultz (2004) evaluates the PROGRESA program in Mexico that provided cash grants to families, conditional on their children attending school regularly. Utilizing the randomized phase-in of the program in different areas for his

assessment, Schultz finds that it led to a 3.4 percent increase in enrollment of students in grades 1 through 8, with the largest impact of 14.8 percent for girls who had completed grade 6 and were in junior secondary school. The cash transfer program, however, is quite costly with per pupil program costs of around 270 dollars (at the junior secondary level), and rising up to more than 1600 dollars (at the primary level) for one percent gain in enrollment. (The obvious reason for this is that the cash transfer program is seeking to affect many other outcomes than just education.)

Among non-randomized evaluations, micro credit programs in Bangladesh (Pitt and Khandker 1998) yield the lowest cost-effectiveness ratio, but the total costs of the program are clearly underestimated in this case, since we are using the average amounts of loans taken by women, i.e., the value of services received as an approximate measure of cost. This excludes administrative and other program costs from our calculations in arriving at the budget cost effectiveness of the program, based on the conventional deadweight loss assumptions alluded to earlier. In the absence of an experimental design, the authors evaluated the group-based micro-credit program by using a quasi-experimental survey design and a limited-information maximum-likelihood estimation framework, along with village fixed effects. The cost effectiveness estimates reported here are for the Grameen Bank program, considered one of the most successful credit programs for the poor around the world.

Bedi et al. (2004) analyze the effects of reduction in school costs and increase in the number of skilled teachers on school enrollment in Kenya. Using household survey data combined with district level information for multiple years, they perform cross-sectional, pooled, and also a pseudo-panel (at the district level) estimation of enrollment probit equations, controlling for school and family characteristics. They find that reduction in school fees and increase in skilled teachers through teacher training have a positive effect on enrollment (elasticity estimates of 0.04 and 0.4 percent respectively), and the associated per pupil costs are about 7 and 13 dollars respectively for such measures, for a one percent increase in enrollment. Glick and Sahn (2006) estimate a discrete choice model of primary schooling and simulate policy alternatives for rural Madagascar using data from a nationwide household survey. They implement a nested logit model of school choice controlling for household, community, and school characteristics. Their policy simulations suggest that

hiring an additional teacher to reduce multigrade classes by 50%, and school consolidation (closing small schools to improve the quality of other neighboring schools through teacher transfer) with multigrade elimination would lead to 10 and 7 percent increases in enrollment respectively, while per pupil costs of these policies would be between three and four dollars for every percentage gain in enrollment.

While most of the evaluated interventions have looked at the effects of reducing schooling costs and improving educational inputs, a study by Handa (2002) looks at the effect of a two interventions that affect household consumption and adult literacy on children's school enrollment in Mozambique. He uses household survey data along with detailed information on school characteristics from administrative sources, and performs a difference-in-difference estimation with controls for child, household, and school characteristics. Results from the policy simulations suggest that increasing household per capita consumption to the 25th percentile, or ensuring literacy of household heads in the bottom quartile of the per capita expenditure would increase enrollment rates by 2 and 8 percent, at per pupil costs of around 20 and 5 dollars respectively.

(ii) School participation

Results from the cost effectiveness analysis of interventions that seek to improve attendance or school participation of children in developing countries are summarized in Figure 2 and Table 3, with results of randomized evaluations in Table 3 Panel A, and those for non-randomized evaluations in Table 3 Panel B. Among randomized interventions, Angrist et al. (2002) evaluate a Colombian vouchers program that provided scholarships to poor students for attending private secondary schools. This program targeted low-income families, and vouchers were allocated through lotteries, in case demand exceeded supply. The vouchers covered more than half the cost of private secondary school and were renewable as long as students maintained satisfactory academic performance. The authors find that participants in this program benefited from higher educational attainment as well as higher test scores. However, per pupil cost for inducing an additional year of schooling was somewhat high at nearly 750 dollars. The conditional cash transfer program (PROGRESA) in Mexico was similarly expensive at about 860 dollars per child for an additional year of secondary education (Behrman et al. 2005).

In contrast, a school-based deworming program in Kenya was remarkably cost effective at less than five dollars per child for an additional year of schooling (Miguel and Kremer 2004). In this program 75 schools were randomly phased in from the southern Busia region of Kenya, and inexpensive deworming drugs were used in mass school-based treatments twice a year. The deworming program led to improved health and school participation for treated students, and also created positive health and school participation externalities for untreated students through reduced disease transmission. A similar program in India was evaluated by Bobonis et al. (2006), where iron supplementation and deworming drugs were distributed to preschool children aged 2 to 6 through a randomized health intervention. The authors find that this program also led to a healthy increase in weight among the treated children and led to increased school participation. Moreover, similar to the Kenyan deworming project, this program was also relatively cost effective at about 37 dollars per child for an additional year of schooling.

Banerjee et al. (2005a) examine the cost of increasing attendance at non-formal schools in a tribal area of Rajasthan in India. This area had low school attendance, particularly among girls. They evaluate a program which provided a supplementary teacher, where possible female, to a randomly selected sample of 21 out of 42 non-formal schools operated by an NGO, and find that the program increased average daily attendance of girls by 50% from a base of about four, but had no significant effect on the attendance of boys. The program cost was about 81 dollars per child for an additional year of schooling. Duflo et al. (2007a) also hire an additional community teacher in schools in western Kenya and find a cost of about \$323 per additional year of schooling.

Duflo et al. (2007b) evaluate another program in rural Rajasthan that provided financial incentives to teachers based on their regular attendance at school. Cameras with tamper-proof time and date function were given to teachers in 60 randomly chosen informal schools, along with instructions to have one of the children photograph the teacher and other students at the beginning and end of every school day. A teacher's salary was directly based on her attendance, which was tracked using the time and date stamps on the photographs. The authors find that this monitoring-based incentives program led to an immediate decline in teacher absence and also boosted children's school attendance and test scores. The

program was reasonably cost effective in increasing school attendance at about 73 dollars per child for an additional year of schooling.

Kremer et al. (2003) perform a randomized evaluation of a program operated by a non-profit organization that sought to reduce the cost of attending school and increase the supply of non-teacher inputs by providing uniforms, textbooks, and classroom construction to seven treatment schools out of a pool of 14 poorly performing schools. This program led to an increase of 0.5 years in school participation at a cost of about 142 dollars per child (for uniforms) for an additional year of schooling. Later, Evans et al. (2008) examine a randomized trial distributing uniforms to children in primary school in a similar area and find a similar cost of \$104 per child for an additional year of schooling. Vermeersch and Kremer (2005) evaluate a school meals program in Kenya that provided subsidized breakfast on every school day, and this led to a 30% increase in school participation of children at a cost of about 47 dollars per child for every additional year of schooling.

Among non-randomized interventions, Chin (2005) evaluates the teacher component of Operation Blackboard (OB) in India. Under OB, the government of India sought to provide all primary schools with a teaching-learning equipment packet, including basic inputs such as blackboards, books, charts, etc. In her paper, Chin evaluates the teacher component of this program under which all primary schools that had only one teacher were provided with a second teacher. She uses data from the National Sample Survey and the All-India Educational Survey, and implements a difference-in-difference estimation strategy with state and cohort fixed effects, controlling for family and child characteristics. She finds that the teacher component of OB had a significant positive effect on the schooling of children in India, and it increased school completion of boys and girls by about three and nine percent respectively. The program incurred significant costs in hiring more than 140,000 additional teachers – it cost 300 million dollars between 1987 and 1994). However, given the large number of children affected by this program, per pupil costs were very low at around three dollars per child for an additional year of schooling.

A microenterprise lending program in Guatemala (Wydick 1999) turns out to be more costly in inducing greater school participation – at nearly 1,800 dollars per household for an additional year of schooling. The author uses instrumental variables for the amount of loans or credit received by households to estimate the impact of the micro enterprise lending

program on children's schooling, and finds that for an average household the probability that a child is withdrawn from school to work in a household enterprise is reduced by 30% by this program.

A school construction program in Indonesia (INPRES) is much more cost effective in increasing children's schooling at a per pupil cost of around 90 dollars for an additional year of school participation (Duflo 2001). Using detailed survey data along with district-level census data, the author exploits the differences across regions in the number of schools constructed along with differences across cohorts induced by the timing of the program to derive the causal impact of the school construction program. She finds that the program led to an average increase of 0.12 - 0.19 years of education for every primary school constructed per 1000 children.

Ravalion and Wodon (2000) evaluate a food-for-education (FFE) program in Bangladesh, under which participating households received monthly food rations as long as they sent their children to school. This program, which operated in low-income areas, was in effect a targeted enrollment subsidy. The authors use an instrumental variables technique in which village participation in the program is used as an instrument for household participation, and they find that the FFE subsidy led to 18-19 percent gain in school attendance of children. Using the average value of the subsidy received by households as a measure of cost (or, the value of services), the program was quite cost effective at a per pupil cost of about 67 dollars for boys and 70 dollars for girls for ensuring full school attendance for a year. Again, this excludes administrative costs and so is likely an underestimate.

(iii) Test scores

Figure 3 and Table 4 summarize the results from the cost effectiveness analysis of interventions that seek to improve test scores of children in developing countries. As before, the results from randomized evaluations are in Table 4 Panel A, while those for non-randomized evaluations are in Panel B. Among randomized interventions, a remedial education program in India stands out as being the most cost effective, with a cost of only about one dollar per child for 0.1 standard deviation improvement in total test scores. This program, evaluated by Banerjee et al. (2005b) recruited young women ("balsakhi") from the community to teach basic literacy and numeracy skills to children lagging behind in

government schools, and it led to a 0.28 standard deviation improvement in test scores in its second year. The same paper reports results from another remedial education program in India, where each child in the fourth grade was provided with two hours of shared computer time per week to reinforce mathematical skills. This also led to a 0.25 standard deviation improvement in test scores at a cost of about eight dollars per child for every 0.1 standard deviation improvement.

Duflo et al.'s program discussed in the previous section, hiring additional teachers in Kenya and – in some schools – tracking students by ability, saw a 0.1 standard deviation increase in test scores for just \$2.61.

Duflo et al.'s (2007b) evaluation of the teacher incentive program in India (discussed in the previous section) that was based on the teachers' regular attendance at school suggest that it raised test scores of affected children by 0.17 standard deviation at a relatively low cost of about four dollars per child for every 0.1 standard deviation improvement. In contrast, the Colombian vouchers program (Angrist et al. 2002) that provided scholarships to students for attending private secondary schools turns out to be more expensive at a per pupil cost of about 45 dollars per 0.1 standard deviation improvement.

Evaluations of several randomized interventions in Kenya (Duflo et al. 2007a, Glewwe et al. 2003, 2007; Kremer et al. 2004) indicate that providing an extra teacher (especially when coupled with tracking students by initial achievement), extra textbooks or scholarships to students from poor families, and giving incentives to teachers can be quite effective in improving student achievement, while also being relatively low cost at about three to six dollars per child for every 0.1 standard deviation improvement. A prospective evaluation of another intervention that provided flipcharts to students (Glewwe et al. 2004) suggests no significant improvement in test scores, even though a retrospective analysis did show significant increase.⁶

Next, we summarize the results from non-randomized interventions that have been evaluated with respect to improvements in student achievement. Bedi and Marshall (1999) use data collected from 33 randomly selected schools in rural Honduras to assess the effect of school and teacher characteristics on student achievement and attendance. For student

⁶ Most of these interventions have earlier been reviewed in Kremer (2003), and Glennerster (2005). Cost effectiveness results from most of the Kenyan programs have also been summarized by Kremer et al. (2004).

achievement, they estimate educational production functions that are selection corrected and have instrumented school inputs, along with controls for family, child, school, and teacher characteristics. They find that reducing class size by about 7 students and increasing teacher training through seminars lead to significant improvement in test scores – by about 0.57 and 0.37 standard deviations respectively. While class size reduction is slightly more costly at around \$22 per child for every 0.1 standard deviation improvement in test scores, the corresponding per pupil cost for providing increased training to teachers is less than a dollar, assuming there were three seminars with twenty five teachers, and could increase to only about four dollars if there was just one seminar with ten teachers.

Tan et al. (1997) also evaluate the effect of various school inputs on test performance of students in the Philippines, and find that providing workbooks to students or spending on classroom furniture were both quite cost effective in raising test scores at less than a dollar per child for 0.1 standard deviation improvement. However, preschool programs were relatively more expensive at a corresponding cost of nearly \$18 per student. For this study, the authors use data on 110 randomly chosen schools from a household and school matching survey conducted in the Philippines, and estimate student achievement equations using a generalized least squares model that allows for within group correlations. They also test for selection bias in their estimates, and address the problem of errors in variables for some of the inputs by using instrumental variable techniques.

Glewwe and Jacoby (1994) use data from the Ghana Living Standards Survey (GLSS), and estimate achievement regressions in a two-stage least squares framework, after accounting for selection bias by predicting school attainment and delayed enrolment in ordered probit specifications, and also choice of middle school in a multinomial logit model. They find that providing blackboards and repairing classrooms were highly cost effective in improving test scores, with per pupil costs of around ten cents and two dollars respectively for 0.1 standard deviation improvement in test scores.

Bjorkman (2006) evaluates a capitation grant program in Uganda that was bolstered by a simultaneous newspaper campaign to prevent the capture of public funds, and thereby increase the actual amount of grants reaching schools. Utilizing the inter district variation in newspaper circulation, she implements a difference-in-difference estimation strategy to estimate the effect of the grant program on student achievement in the primary leaving exam.

She finds that availability of public funds – when they actually reached their intended recipients – had a considerable positive impact on student performance, and led to a 0.40 standard deviation increase in test scores. Also, assuming that school received the full amount of the grant money for every student (8,100 Ugandan Shillings for a student in grade 7), the per pupil cost of this grant program was quite low at about US\$1.50 per 0.1 standard deviation increase in test scores.⁷

Discussion

Based on the results above, we find that for increasing school enrollment in developing countries, a broad range of interventions might prove to be both useful as well as cost effective. These include supply-side interventions targeting improvements in school inputs and provision of public subsidies (“fellowships”) to encourage enrollment in private schools, as well as demand-side interventions that provide credit or loans to households or seek to improve household consumption and adult literacy levels. In contrast, the conditional cash transfer program in Mexico (PROGRESA) is an expensive way of increasing enrollment. Interpretation of these results requires care, as a conditional cash transfer program might have large benefits in terms of poverty reduction even though it proves to be costly in increasing enrollment. However, for a policymaker concerned with both poverty and low levels of school enrollment, micro credit programs may be more cost effective in increasing enrollment.

Inducing school participation or ensuring that children attend school turns out to be much more challenging (in terms of effectiveness per dollar) than increasing enrollment. This is certainly a reflection of the high absenteeism in developing countries, even among children who are enrolled in school. It is interesting to note that interventions that stand out as being most cost effective in improving participation are those that seek to improve children’s health (deworming in Kenya, or deworming and iron supplementation in India). Other reasonably cost effective interventions are those that target improvements in school

⁷ We are ignoring the cost of the newspaper campaign in this cost calculation because of the following reason. The annual cost of publishing newspaper advertisements was about 30,000 dollars. Assuming that at least 30,000 students in Uganda were affected by both the grant program and the information campaign, the per student cost of this newspaper advertisements is less than a dollar, and less than 25 cents for 0.1 standard deviation increase in test score. Since the actual number of students affected by the campaign are likely to be much more (there were more than 7000 students per district in grade 7 alone in 2002 (Bjorkman 2006)), the cost of the information campaign per student is therefore negligible.

quality, provide non-pecuniary incentives such as food or uniforms, or ensure an adequate supply of schools in itself. These include, but are not limited to policies such as hiring additional teachers, providing school uniforms, ensuring teacher attendance, and food-for-education programs. In contrast, providing direct cash grants (PROGRESA in Mexico), loans (microenterprise lending in Guatemala), or subsidies (educational vouchers in Colombia) to households turn out to be expensive policies for inducing school participation, in spite of their relatively large impacts. Overall, a program that combines improvements in health and nutrition of children along with improvements in school quality – for example, through hiring additional teachers and ensuring teacher attendance – could prove to be highly effective and possibly economical in keeping children in school.

A range of interventions seem to work quite well for improving test scores at a low cost in developing countries. Most of the low-cost and effective interventions (that have been tested) target improvements in school inputs or instructional quality, e.g., remedial education programs, class-size reductions, providing incentives or training to teachers, and provision of blackboards, better classrooms, workbooks and textbooks. Evidence on the cost-effectiveness of scholarship or subsidy programs are mixed – while the girls’ scholarship program in Kenya was highly cost-effective in improving student achievement, providing vouchers in Colombia turn out to be moderately cost effective, and a student subsidy program in Chile was relatively expensive. Among preschool interventions, a program in the Philippines was quite cost-effective, while the early childhood program in Jamaica turn out as being moderately so, perhaps due to the fact that it targeted stunted children who needed additional resources and care for improving their performance. It is interesting to note that among interventions that provided direct grants or subsidies to students, the capitation grant program in Uganda was the most cost-effective in raising test scores, and this can possibly be attributed to the successful newspaper campaign accompanying the grant program, which ensured that there was little or no leakage, and the money reached its intended recipients.

Challenges with comparing randomized and non-randomized trials

Randomized and non-randomized trials have differing strengths.⁸ Randomized trials tend to score well on internal validity: the causal impact of an intervention on an outcome can be

⁸ For a summary of these relative strengths which is friendly to non-experimental studies, read Rodrik (2008).

identified confidently. Other studies often have debatable internal validity: the researcher can often not rule out other explanations for changes in outcomes, often linked to unobserved characteristics. This varies broadly across studies: the non-experimental Duflo (2001) paper on school construction in Indonesia is quite convincing with a careful difference-in-differences strategy and numerous robustness checks, whereas a paper comparing schools with lots of textbooks to schools with few textbooks and attempting to control for other differences is unlikely to be convincing (as it is impossible to control for all the differences between the schools and thereby isolate the effect of the additional textbooks). Many non-experimental studies unfortunately fall into this latter category.

Glewwe et al. (2004) compare retrospective estimates of providing flip charts in Kenyan schools on test scores to estimates from a randomized evaluation and find that the retrospective estimates overstate the gains from the program. Comparing the non-random evaluations and the random evaluations included in our study, we find non-random evaluations are associated with -0.3 difference in cost-per-benefit in outcome: in other words, non-randomized evaluations look like a cheaper way to improve outcomes. This is consistent with Glewwe et al.'s finding, although we cannot rule out that the difference may stem from the actual cost-effectiveness of the programs.

That said, the non-experimental studies can also have their strengths: they sometimes use data from a broader geographic area and so may have more external validity than an experimental trial carried out in a small area under ideal (or almost ideal) conditions. The research consumer has to decide which strengths are most important to her and how a given piece of research holds up on these fronts.

Challenges with comparing across contexts

The external validity concern mentioned above extends beyond the question of location. Consider, for example, the three papers reviewed which involve the distribution of free school uniforms to children: Duflo et al. (2006), Evans et al. (2008), and Kremer et al. (2003). All three papers examine the distribution of school uniforms and all three come from primary schools in the same geographic area (western Kenya). Yet the interventions vary in a host of other ways. Duflo et al. examine school uniforms given to girls in Grade 6 whereas Evans et al. examine uniforms given to children in Grades 1-4 and the Kremer paper

examines school uniforms given to children in all grades in primary schools. Evans et al. examine school uniforms given as part of a sponsorship program (in which a foreign adult sends funds regularly to sponsor a Kenyan child) whereas Kremer et al. examine school uniforms provided in the context of a program also providing textbooks and classroom construction. The Kremer uniforms were rolled out in 1995 whereas the Evans uniforms were rolled out in 2002-2005 and the Duflo uniforms were rolled out in 2003. Other studies in this survey differ in the educational context much more starkly: Ghana has a 64% primary school completion rate, whereas Kenya has a 90% rate and Indonesia has close to 100% (World Bank 2007⁹). How do these differences in packaging, age of recipients, and timing of the intervention affect our interpretation of the results? Is this of any use to an NGO in Burundi or a Minister of Education in Sierra Leone?

Despite myriad reasons that children in Burundi, in Sierra Leone, and even children in *eastern* Kenya in 2008 may be different from schoolchildren in western Kenya in earlier years, the fact is that school uniforms worked to reduce drop-outs and increase attendance *somewhere*. As a policymaker examines the array of interventions available, she must take into account distinctive factors in her environment: a deworming intervention is unlikely to be effective in a desert region with few worm infections, and distributing school uniforms is unlikely to improve attendance in a country where school uniforms are not the norm. Yet having a menu of interventions that have been tried and tested elsewhere gives the policymaker power to (a) recognize that some other context is in fact similar to her own and that a similar policy may indeed be appropriate (or at least worth trying), (b) identify interventions that have not been tried and that may be uniquely appropriate to her context, and (c) identify policies that have been tried and found ineffective to avoid or adjust with increased hope of success.

What education trials need to report

Reviewing myriad papers revealed many differences and a few commonalities across papers. We identify two factors that authors should keep in mind for their evaluations of educational interventions to yield the greatest usefulness for policy comparisons. First, papers should

⁹ These numbers are from 2004 and 2005, the most recent years available in the on-line World Development Indicators from the World Bank.

carefully gather cost information and seek to report it in a transparent way. Pilots may be more or less expensive than scaled-up interventions: they may be more expensive in that NGOs and academic research institutions may be more efficient in delivery than public institutions charged with scaled-up implementation, and they may be less expensive due to economies of scale. Still, reporting fixed and marginal costs associated with interventions gives a needed benchmark from which policymakers can extrapolate, taking into account the uncertainty inherent to the process.

Second, papers should include consistent measures of outcomes measured in consistent ways. Often a paper with student participation as an outcome is greeted with the question: But what does this do to drop-out rates? Ultimately, a variety of outcomes are of interest (test scores, enrollment / drop-outs, attendance), and papers will be of most value to policymakers if they report at least some results for this basic set of outcomes, facilitating comparison across interventions.

Conclusion

We find that our results are in broad agreement with the themes in Hanushek's (1995) and Kremer's (2003) reviews. In his review of research on schooling in developing countries, Hanushek (1995) emphasized the role of performance incentives and the need for improvement in school quality, while Kremer (2003) found that reducing the cost of schooling to households in developing countries and instituting school-based health and nutrition programs were effective policies for improving educational outcomes. In line with these findings, our analysis also identifies the following key categories of interventions as being both effective and low-cost in improving educational outcomes:

- *Quality improvements* in the school environment and instruction through policies such as classroom construction, provision of blackboards, teacher training, remedial education, etc.
- *Preventing illness and malnutrition* through school-based programs such as deworming, iron supplementation, and school meals.
- *Reduction in school costs* through the provision of indirect fellowships, uniforms, textbooks, etc.

- *Providing incentives* to teachers as well as to students through monitoring, scholarships, food-for-education programs, etc.

Additionally, we find that the following measures can also be effective in improving schooling and student performance:

- *Raising public awareness about government programs* and thereby instituting anti-corruption measures to prevent leakage.
- *Targeting the demand for schooling* through demand side interventions such as micro-credit, adult literacy programs, etc.

The results from this analysis also indicate that direct subsidies or cash transfers to households are expensive policies for improving educational outcomes, although such programs may have large benefits in the form of poverty reduction and health improvements. As such, those kinds of programs only make sense for coalitions of government ministries to consider rather than education ministries per se.

Despite a number of difficulties with comparing across interventions, policymakers are surely better off with clear evidence of what has worked in other contexts, and then adapting to experiment with policies that seem most likely to work in theirs. As researchers and policymakers both continue to explore what works, improved consistency in reporting costs and benefits will lead the value and impact of these studies to improve sharply.

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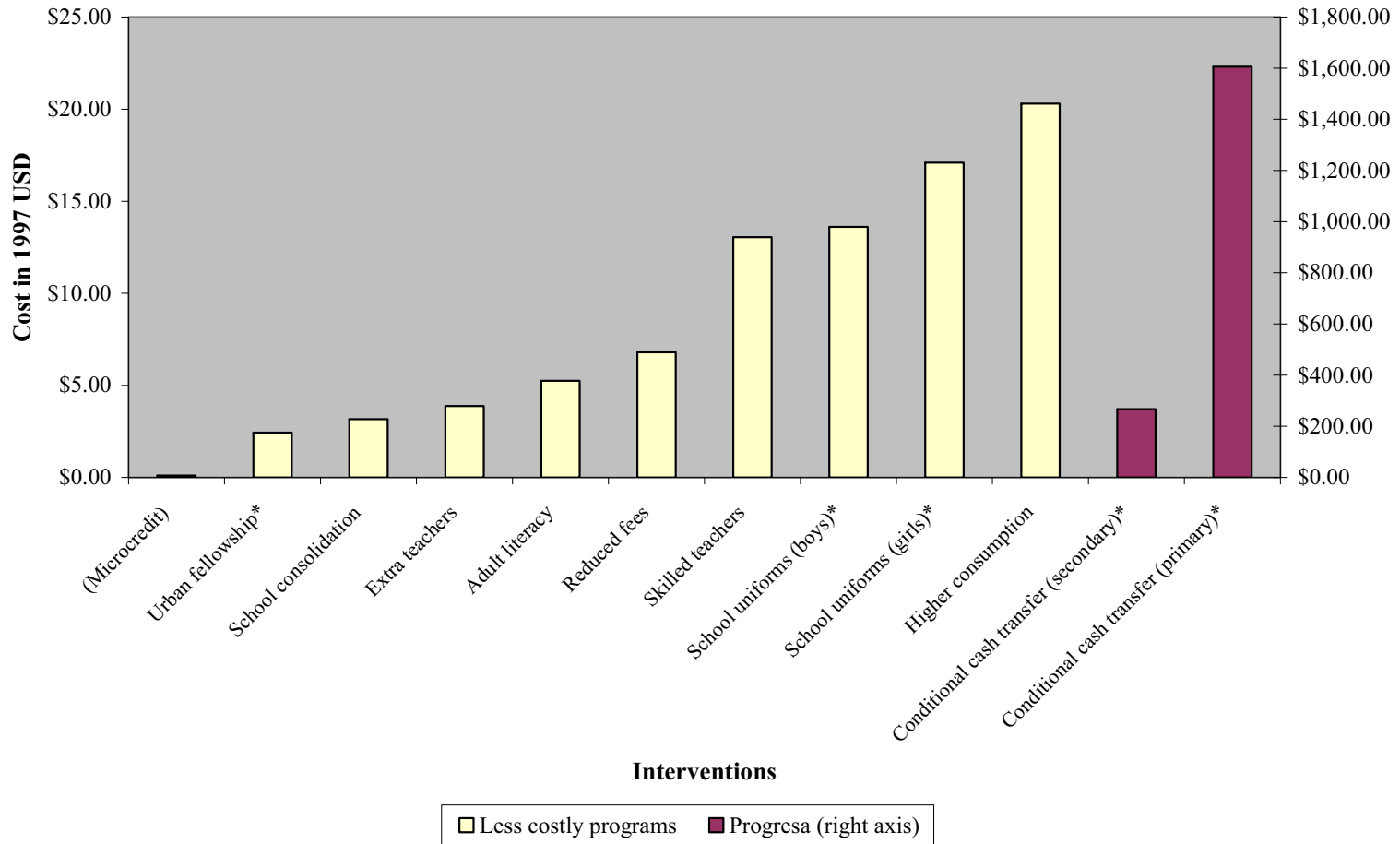
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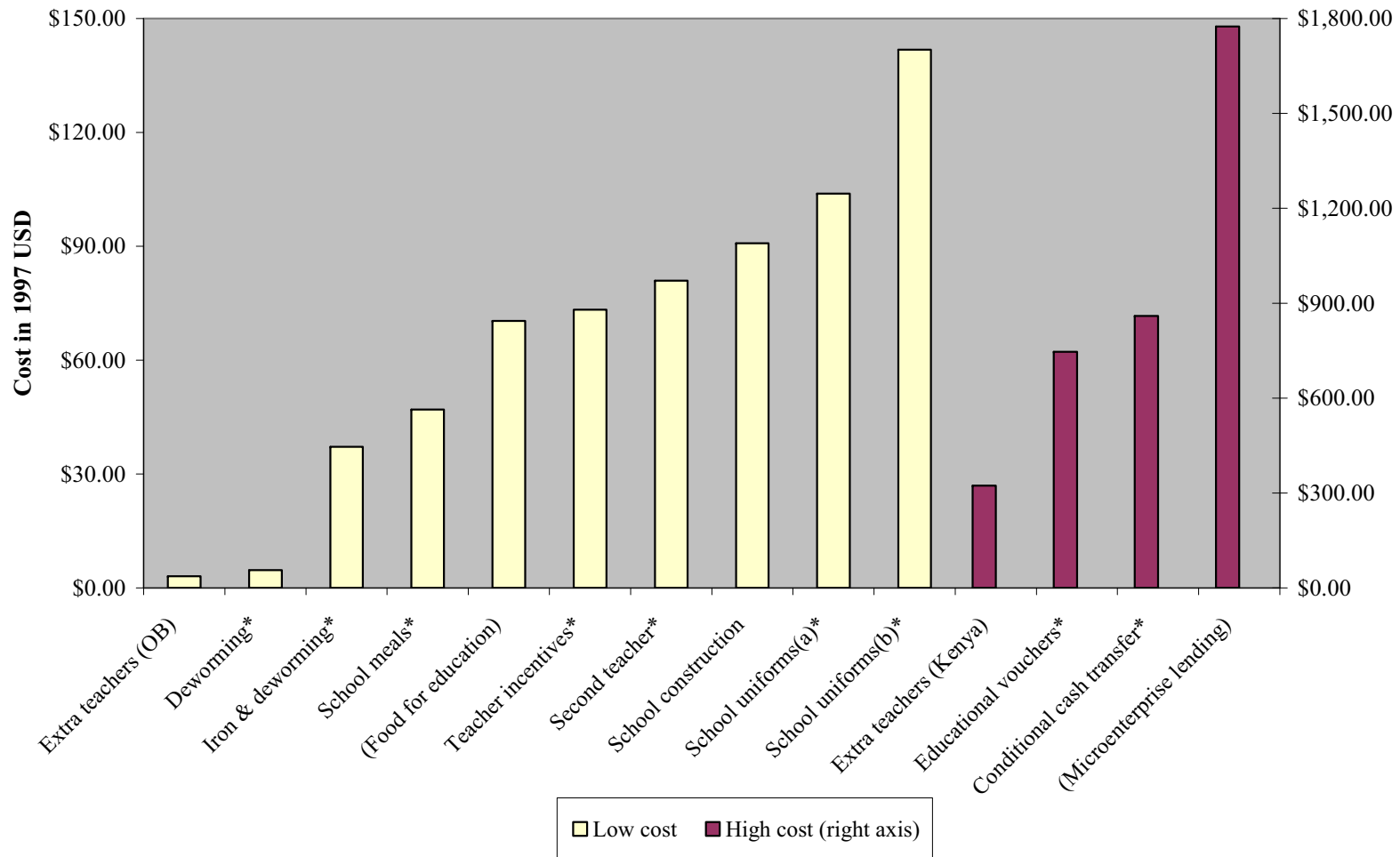
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Figure 1: Program costs for achieving one percent increase in enrollment



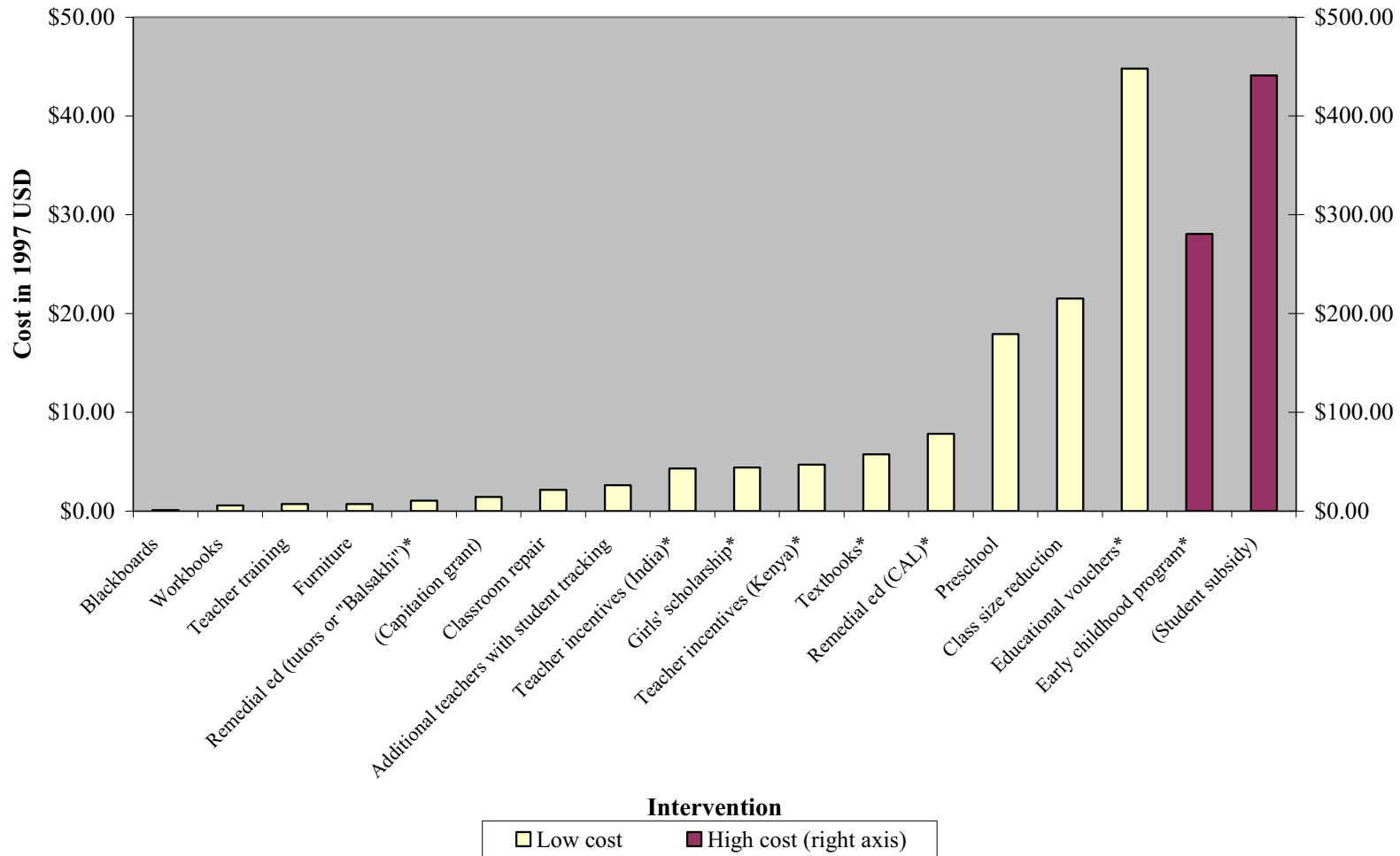
Notes: Interventions in parenthesis indicate that cost information is merely the cost of the service provided (excluding administrative costs) and so may be inappropriately low. Asterisked interventions indicate randomized evaluations. The two programs on the right are much more expensive and so have a separate y-axis (right-hand side).

Figure 2: Program costs for an additional year of school participation



Notes: Interventions in parenthesis indicate that cost information is merely the cost of the service provided (excluding administrative costs) and so may be inappropriately low. Asterisked interventions indicate randomized evaluations. The four programs on the right are much more expensive and so have a separate y-axis (right-hand side).

Figure 3: Program costs per 0.1 s.d. improvement in test scores



Notes: Asterisked interventions indicate randomized evaluations. The two programs on the right are much more expensive and so have a separate y-axis (right-hand side).

Table 1: Initial list of evaluations

| | Paper | Intervention(s) | Method | Outcome | Cost Information | Glenn. 2005 | Kremer 2003 |
|----|---|--|---------------------|--|---------------------------------|--------------------|--------------------|
| | <i>Panel A: Randomized Evaluations</i> | | | | | | |
| 1 | Alderman et al. 2003 | Fellowship program | Experimental design | Enrollment | In paper. Total cost | - | - |
| 2 | Angrist et al. 2002 | Educational vouchers/ scholarships Adding a second teacher | Experimental design | Grade attainment & test scores | In paper. Total cost | - | Yes |
| 3 | Banerjee et al. 2005a | to one-teacher schools | Random assignment | School attendance & test scores | In paper. Total cost | Yes | Yes |
| 4 | Banerjee et al. 2005b | Remedial education | | School participation & test scores | In paper. Total cost | Yes | - |
| 5 | Behrman et al. 2005 | Conditional cash transfer | Random assignment | Years of secondary education | In paper. Budgetary cost | - | - |
| 6 | Bobonis et al. 2004 | Iron supplementation & deworming drugs | Random assignment | School participation | In paper. Total cost | Yes | Yes |
| 7 | Duflo et al. 2006 | Free school uniforms | Random assignment | Enrollment | In paper. Total cost | - | - |
| 8 | Duflo et al. 2007a | Reduced class size, teacher incentives, & student skill tracking | Random assignment | Test scores & Student attendance | In paper. Total cost | - | - |
| 9 | Duflo et al. 2007b | Monitoring & incentives for teachers | Random assignment | Test scores | In paper. Total cost | - | - |
| 10 | Evans et al. 2008 | Free school uniforms | Random assignment | Student participation | In paper. Total cost | - | - |
| 11 | Glewwe et al. 2003 | Incentives for teachers | Random assignment | Test scores | From Kremer et al. (2004) | - | Yes |
| 12 | Glewwe et al. 2004 | Providing flip charts | Random assignment | Test scores | From Kremer et al. (2004) | - | Yes |
| 13 | Glewwe et al. 2007 | Providing textbooks | Random assignment | Test scores | From Kremer et al. (2004) | - | Yes |
| 14 | Kim et al. 1999 | Fellowship program | Experimental design | Enrollment | In paper. Total cost | - | - |
| 15 | Kremer et al. 2003 | Providing school uniforms | Random assignment | School participation | In paper. Total cost | Yes | Yes |
| 16 | Kremer et al. 2004 | Providing scholarship | Random assignment | Test scores & Student attendance | In paper. Total cost | Yes | - |
| 17 | Miguel & Kremer 2004 | Deworming | Random assignment | Student participation | In paper. Total cost | Yes | Yes |
| 18 | Schultz 2004 | Conditional cash transfer | Random assignment | Enrollment | In paper. Total cost | Yes | Yes |
| 19 | Sinha 2005 | Family planning program | Experimental design | Enrollment | Not available Not in paper. | - | - |
| 20 | Vermeersch & Kremer 2005 | School meals | Random assignment | Student participation & test scores | Reported in Kremer (2003) | Yes | Yes |
| 21 | Walker et al. 2005 | Early childhood programs | Random assignment | Test scores | From author. Total cost | - | - |

| Panel B: Non-randomized Evaluations | | | | | | | |
|--|-------------------------|---|---|---|-----------------------------|-----|---|
| 22 | Alderman et al. 2001 | School quality & fees | Nested logit with many controls | Enrollment | Not available | - | - |
| 23 | Bedi & Marshall 1999 | School inputs | IV | Test scores | In paper. Total cost | - | - |
| 24 | Bedi & Marshall 2002 | School inputs | 2-stage estimation with many controls | Student attendance | Not available | - | - |
| 25 | Bedi et al. 2004 | Reduced fees; school inputs | Difference-in-difference | Enrollment | In paper. Total cost | - | - |
| 26 | Bjorkman 2006 | Capitation grant & newspaper campaign | Difference-in-difference | Test scores Enrollment, schooling & test scores | In paper. Value of grant | - | - |
| 27 | Case & Deaton 1999 | School inputs | OLS with controls & 2SLS | School completion | Not available | - | - |
| 28 | Chin 2005 | Teacher component of Operation Blackboard | Difference-in-difference | Enrollment, grade attainment School completion & student participation | In paper. Total cost | - | - |
| 29 | Dreze & Kingdon 2000 | School inputs | Regressions with many controls | Enrollment, grade attainment School completion & student participation | Not available | Yes | - |
| 30 | Duflo 2001 | School construction | Difference-in-difference | Test scores | In paper. Total cost | - | - |
| 31 | Glewwe & Jacoby 1994 | School inputs | 2-stage estimation with many controls | Enrollment | In paper. Total cost | - | - |
| 32 | Glick & Sahn 2006 | School inputs | Nested logit with many controls | Enrollment | In paper. Total cost | - | - |
| 33 | Handa 2002 | Increase household consumption & literacy | Difference-in-difference | Enrollment | In paper. Total cost | - | - |
| 34 | Lloyd et al. 2005 | School access and quality | Nested logit with many controls | Enrollment | Not available | - | - |
| 35 | Mizala & Romaguera 2000 | Voucher-type per student subsidy | OLS with many controls | Test scores | In paper. Value of services | - | - |
| 36 | Pitt & Khandker 1998 | Micro credit program | Quasi-experimental design & fixed effects | Enrollment | In paper. Value of services | - | - |
| 37 | Ravallion & Wodon 2000 | Food-for-education (FFE) program | IV | School participation | In paper. Value of services | - | - |
| 38 | Tan et al. 1997 | School inputs | OLS & IV | Test scores | In paper. Total cost | - | - |
| 39 | Wydict 1999 | Micro enterprise lending program | IV | Student participation | In paper. Value of services | - | - |
| 40 | Zimmerman 2003 | Child fostering | Regressions with many controls & FE | Enrollment | Not available | - | - |

Table 2: Cost effectiveness of interventions for improving enrollment

| Intervention (authors) | Country | Gain in enrollment | Cost/pupil for 1% gain (1997 USD) | Cost/pupil per 1% gain adjusted for deadweight loss (1997 USD) |
|---|------------|-----------------------------|---|--|
| | (1) | (2) | (4) | (5) |
| A. Randomized Evaluations | | | | |
| 1. Providing school uniforms (Duflo et al. 2006) | Kenya | 20% (Girls) | \$12.21 | \$17.09 |
| 2. Urban fellowship program (Kim et al. 1999, Alderman et al. 2003) | | 25% (Boys) | \$9.72 | \$13.61 |
| 3. Conditional cash transfer (Schultz 2004) | Pakistan | 25% | \$1.74 | \$2.44 |
| | | | \$194.12 (secondary) | |
| | Mexico | 3.4% | \$1164.70 (primary) | \$271.77 (secondary) \$1630.58 (primary) |
| B. Non-randomized Evaluations | | | | |
| 4. Reduction in school fees (Bedi et al. 2004) | Kenya | 0.04% (elasticity) | \$4.86 | \$6.80 |
| 5. Increase in skilled teachers through teacher training (Bedi et al. 2004) | Kenya | 0.4% (elasticity) | \$9.32 | \$13.05 |
| 6. Add teachers to reduce multigrade classes by 50% (Glick & Sahn 2006) | Madagascar | 10% | \$2.77 | \$3.88 |
| 7. School consolidation with multigrade elimination (Glick & Sahn 2006) | Madagascar | 7% | \$2.26 | \$3.16 |
| 8. Increase household consumption (Handa 2002) | Mozambique | 2% | \$14.50 (per household) \$3.75 (per household) | \$20.30 |
| 9. Increase adult literacy (Handa 2002) | Mozambique | 8% | \$3.75 (per household) | \$5.25 |
| 10. Micro credit program (Pitt & Khandker 1998) | Bangladesh | 3.5% (girls) 4.3% (boys) | \$0.08 (girls) \$0.07 (boys) | \$0.11 (girls) \$0.10 (boys) |

Table 3: Cost effectiveness of interventions for improving participation

| Intervention (authors) | Country | Gain in participation | Cost/pupil per year gain (1997 USD) | Cost/pupil per year gain adjusted for deadweight loss (1997 USD) |
|---|------------|-------------------------------|-------------------------------------|--|
| <i>A. Randomized Evaluations</i> | (1) | (2) | (3) | (4) |
| 1. Educational vouchers (Angrist et al. 2002) | Colombia | 0.12 - 0.16 years | \$533.36 | \$746.70 |
| 2. Hiring additional teachers (Banerjee et al. 2004) | India | 50% | \$57.84 | \$80.98 |
| 3. Conditional cash transfer (Behrman et al. 2005) | Mexico | 0.68 years | \$614.18 | \$859.85 |
| 4. Iron supplementation & deworming (Bobonis et al. 2004) | India | 20% | \$26.56 | \$37.18 |
| 5. Hiring additional teachers (Duflo et al. 2007a) | Kenya | 3.2% | \$230.94 | \$323.32 |
| 6. Teacher incentives (Duflo et al. 2007b) | India | 0.1 years | \$52.36 | \$73.30 |
| 7. Providing school uniforms (Evans et al. 2008) | Kenya | 0.07 years | \$74.14 | \$103.84 |
| 8. Providing school uniforms (Kremer et al. 2003) | Kenya | 0.5 years | \$101.27 | \$141.78 |
| 9. Deworming (Miguel and Kremer 2004) | Kenya | 0.14 years | \$3.37 | \$4.72 |
| 10. School meals program (Vermeersch and Kremer 2005) | Kenya | 30% | \$33.55 | \$46.97 |
| <i>B. Non-randomized Evaluations</i> | | | | |
| 11. Teacher component of Operation Blackboard (Chin 2005) | India | 8.7 % (girls) 3.1 % (boys) | \$2.17 | \$3.04 |
| 12. School construction program (Duflo 2001) | Indonesia | 0.12 - 0.19 years | \$64.85 | \$90.79 |
| 13. Food for education program (Ravallion and Wodon 2000) | Bangladesh | 19% (boys) 18% (girls) | \$47.61 (boys) \$50.26 (girls) | \$66.65 (boys) \$70.36 (girls) |
| 14. Micro enterprise lending (Wydick 1999) | Guatemala | 30% | \$1,267.90 | \$1,775.06 |

Table 4: Cost effectiveness of interventions for improving test scores

| Intervention (authors) | Country | Gain in test score | Cost/pupil per 0.1 s.d. gain (1997 USD) | Cost/pupil per 0.1 s.d. gain adjusted for deadweight loss (1997 USD) |
|--|----------------|-------------------------------|--|---|
| <i>A. Randomized Evaluations</i> | (1) | (2) | (4) | (5) |
| 1. Educational vouchers (Angirst et al. 1997) | Colombia | 0.20 s.d. | \$32.00 | \$44.80 |
| 2. Remedial education ("balsakhi") (Banerjee et al. 2005b) | India | 0.28 s.d. | \$0.75 | \$1.05 |
| 3. Remedial education (CAL) (Banerjee et al. 2005b) | India | 0.25 s.d. | \$5.59 | \$7.83 |
| 4. Hiring additional teachers (with student tracking by achievement in some schools) (Duflo et al. 2007a) | Kenya | 0.22 s.d. | \$1.87 | \$2.61 |
| 5. Teacher incentives (Duflo et al. 2007b) | India | 0.17 s.d. | \$3.08 | \$4.31 |
| 6. Teacher incentives (Glewwe et al. 2003) | Kenya | 0.07 s.d. | \$3.36 | \$4.70 |
| 7. Flipchart provision (Glewwe et al. 2004) | Kenya | Not significant | - | - |
| 8. Textbook provision (Glewwe et al. 2007) | Kenya | 0.04 s.d. | \$4.10 | \$5.74 |
| 9. Girls' scholarship program (Kremer et al. 2004) | Kenya | 0.12 s.d. | \$3.15 | \$4.41 |
| 10. Early childhood program (Walker et al. 2005) | Jamaica | 0.35 | \$200.36 | \$280.50 |
| <i>B. Non-randomized Evaluations</i> | | | | |
| 11. Class size reduction (Bedi and Marshall 1999) | Honduras | 0.57 s.d. | \$15.36 | \$21.50 |
| 12. Teacher training (Bedi and Marshall 1999) | Honduras | 0.37 s.d. | \$0.51 | \$0.71 |
| 13. Capitation grant program (Bjorkman 2006) | Uganda | 0.40 s.d. | \$1.03 | \$1.44 |
| 14. Blackboard provision (Glewwe and Jacoby 1994) | Ghana | 2.24 s.d. | \$0.07 | \$0.10 |
| 15. Classroom repair (Glewwe and Jacoby 1994) | Ghana | 1.77 s.d. | \$1.54 | \$2.16 |
| 16. Student subsidy program (Mizala and Romaguera 2000) | Chile | 0.14 | \$314.98 | \$440.97 |
| 17. Workbook provision (Tan et al. 1997) | Philippines | 0.19 s.d. | \$0.40 | \$0.56 |
| 18. Furniture in classroom (Tan et al. 1997) | Philippines | 0.32 s.d. | \$0.52 | \$0.73 |
| 19. Preschool program (Tan et al. 1997) | Philippines | 0.08 s.d. | \$12.80 | \$17.92 |