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# Benefits and Costs of Public Schooling in Ghana

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## Abstract

This paper examines the monetary benefits and costs of the quantity of public schooling (that is, years of schooling completed) in Ghana. The paper also examines the monetary benefits and costs of some aspects of the quality of public schooling, measured by the gains in achievement produced by selected interventions in public schools. The analysis uses estimates of (i) labor-earnings returns to schooling and private spending on public schooling, based on the latest national household sample survey data; (ii) government spending on public schooling, based on administrative information; (iii) impacts on test scores, and costs, of education interventions in public schools, drawn from experimental studies; and (iv) conversions of impacts on test scores produced by education interventions to (future) labor earnings, all for Ghana. The results are a set of benefit-cost ratios in the style of the Copenhagen Consensus.

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## 1 Introduction

This study estimates the monetary benefits and costs of public schooling in Ghana. We conduct this analysis for the quantity of schooling, or years of schooling completed, and for the gain in the quality of schooling (in terms of measured achievement) produced by specific education interventions. Our motivation is twofold: to understand the extent to which public spending on schooling provides good value for money; and to provide benefit-cost ratios that can be compared to similar estimates for other public spending in the style of the Copenhagen Consensus. Regarding the latter, our work is complementary to the recent Ghana Priorities project conducted by the National Development Planning Commission in partnership with the Copenhagen Consensus Center.[1]

Our estimates of monetary costs of schooling are reasonably comprehensive, covering both public expenditure data drawn from government administrative sources and data on the complementary private expenditures needed to access public schooling drawn from the 2016/17 Ghana Living Standards Survey, the latest available round of the national household sample survey administered by Ghana's statistical agency (GSS 2019). Our estimates of the benefits of public schooling are more limited, however, something that should be kept in mind when interpreting our results. In particular, we only measure the benefits to students of estimated future labor earnings increases generated by additional years of schooling. This ignores other benefits of public schooling. For example, Adu Boahen and Yamauchi (2018) find that elimination of fees for primary schooling in 1995 led to reduced teenage fertility and higher age at first marriage in Ghana. Duflo, Dupas, and Kremer (2021) find that tuition-free secondary schooling in Ghana reduced fertility as well. Other authors have posited that public schooling helps to form better citizens, though this is more difficult to measure.[2]

There are many studies on the impact of public schooling in Ghana and around the world.[3] Our initial intention was to limit ourselves to studies that generate well-identified estimates of the impacts of schooling. Doing so for quality improvements limits us to two studies that examine a remedial education approach known as "teaching at the right level,"[4] one study on

[1] See https://www.copenhagenconsensus.com/ghana-priorities (accessed January 24, 2022).
[2] Duflo, Dupas, and Kremer (2021) find no evidence that tuition-free secondary schooling increased voting in either presidential or district assembly elections, though this is a narrow conception of "better citizens."
[3] Evans and Mendez Acosta (2021) provide a recent review for Africa, including many studies on Ghana.
[4] See https://www.teachingattherightlevel.org/ (accessed January 24, 2022).

school feeding in primary and junior secondary schools, and one study on distance education in primary schools. Each of these studies provides estimates of the impact on test scores from a well-defined intervention, but none follow their study participants long enough to estimate the impact on future labor earnings. To go from test scores to monetary benefits, we rely on the nonexperimental work of Evans and Yuan (2019), who estimate the effect of improved test scores on future labor earnings in Ghana and elsewhere.

With respect to the quantity of schooling, we found only one experimental study, Duflo, Dupas, and Kremer (2021), that assesses the impact of additional years of (senior secondary) schooling. This study does follow study participants for many years, but it remains incomplete in the sense that some of the study participants have yet to begin working. Perhaps because of this, the study finds no impact from increased secondary schooling on labor earnings, a result that runs counter to our prior beliefs about the value of schooling.

To complement that study, then, we take a more traditional, nonexperimental approach to estimating the benefits of an additional year of public schooling, so-called Mincer regressions (Patrinos and Psacharopoulos 2018). The limits of this approach are long debated (e.g., Card 1999) and we review them here. But we view it as our best option.

All the results we use, including the experimental ones, are vexed by the problem that there is a long lag between going to school and the labor earnings that one eventually gains from that schooling. For cross-sectional estimates such as our Mincer equations, this means that we are estimating the gains that today's students will achieve in the future based on today's labor earnings of those who went to school many years ago. But even for experimental studies such as Duflo, Dupas, and Kremer, any eventual estimates of the impact of additional years of schooling on future labor earnings will be for students who went to school circa 2012. These may not be externally valid for students in school at the time when the researchers eventually gather data on labor earnings for the past students in the study sample.

Overall, we find that public spending toward the quantity and quality[5] of schooling offers good value for money: All our benefit-cost ratios exceed one. But we also find that all our benefit-cost ratios are modest when compared to some of the more spectacular ratios found in a typical Copenhagen Consensus study like the Ghana Priorities project. However, most of the

[5] This being limited to quality improvements we can study carefully: remedial education and school feeding.

highest benefit-cost ratios are found for health interventions, the evaluation of which depends on an approach to valuing mortality reductions that may be exaggerated.[6]

We also find that the benefit-cost ratios for teaching at the right level are higher than those for additional years of schooling, which may present policy makers with an important trade-off: Should government dedicate more resources to improving the quality of schooling for existing students because that has a higher benefit-cost ratio, or should it use those resources to expand the coverage of public schooling to those not currently enrolled, perhaps on equity grounds?

However, the two sets of results are not strictly comparable, for two reasons. First, the results for the quality-of-schooling interventions are for a marginal expenditure that, one supposes, benefits from the existing expenditure on schooling in general, while the costs associated with our quantity-of-schooling analysis are average expenditures, absorbing their "fair share" of all costs of schooling. If we were to force the quality-of-schooling interventions to pay some share of the average costs of schooling, it would lower the benefit-cost ratios for these interventions. Second, the estimates of impacts on test scores of the quality-of-schooling interventions are all short-run effects over one or two years. Some studies for other countries find that effects fade with time.[7] If that were to happen with the interventions we examine, our calculations would overestimate the future labor earnings gains and, thus, the benefit-cost ratios.

The remainder of the paper is organized as follows. Section 2 provides background information on schooling, the macroeconomic environment, and the labor market in Ghana. Keeping in mind the problem generated by the time lag between schooling and labor earnings, we describe the long-term evolution of these characteristics. Section 3 discusses benefit-cost ratio estimates for the quantity of schooling in Ghana. Section 4 discusses benefit-cost ratio estimates for gains in test scores generated by interventions in public schools, specifically, remedial education and the Ghana School Feeding Programme. Section 5 concludes.

[6] See Barofsky and Younger (2022) for a discussion.

[7] Other studies do not. We are unaware of any studies in Ghana that examine the potential fading of the effect of quality-of-schooling interventions. Evans and Yuan (2019) discuss the literature on the problem of fading effects and how it affects calculations such as the ones we do here.

## 2 Background

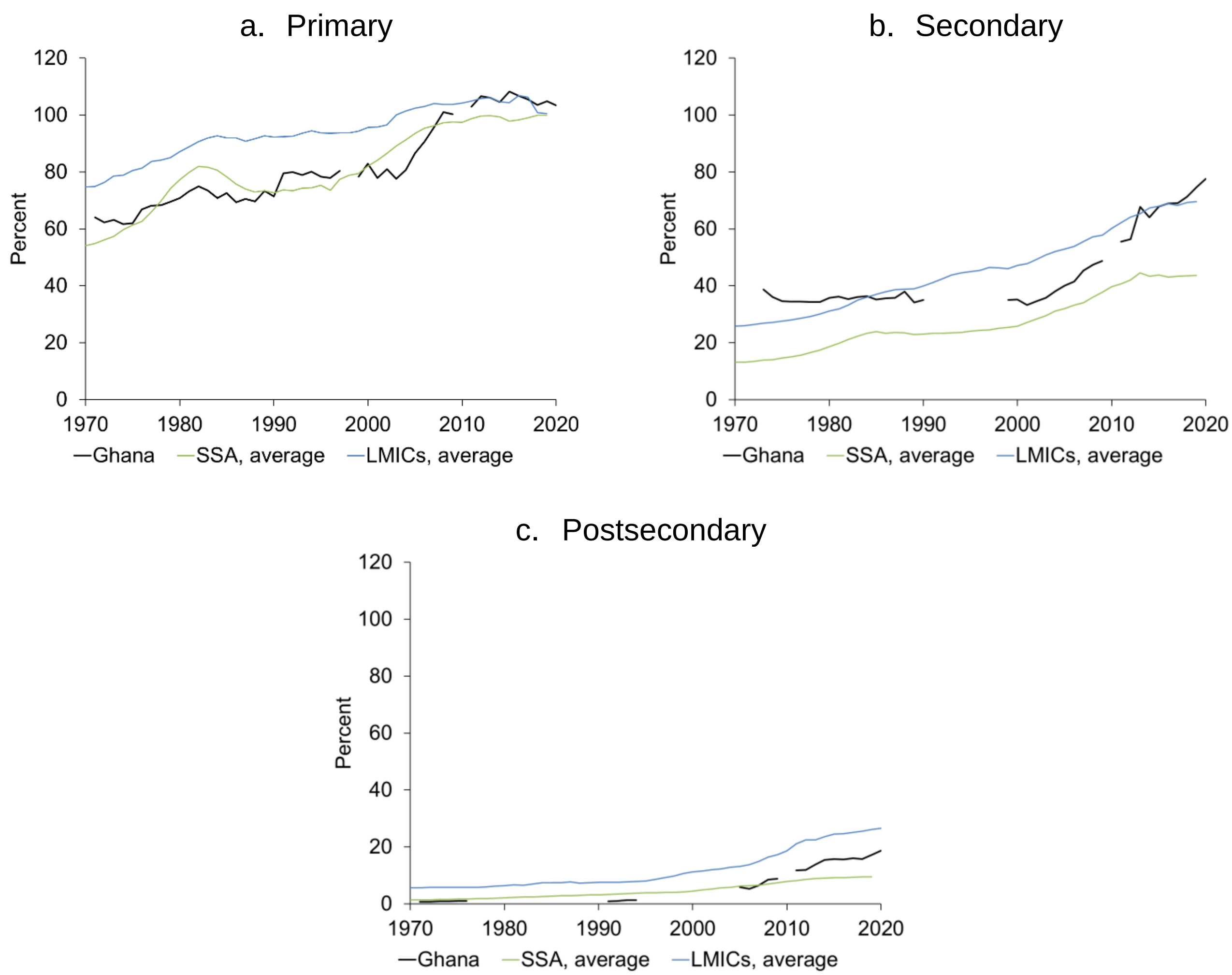
### a. Education

Schooling in Ghana comprises two years of preschool (ages 4 and 5); nine years of basic education, divided into six years of primary school (ages 6–12) and three years of junior secondary school (ages 12–15); three years of senior secondary school (ages 15–18); and postsecondary schooling of between two and four years depending on the field. Before 1995, the system was significantly different, with nine years of primary school, four years of O-levels, and two years of A-levels followed by any postsecondary education. This is something to take into account when comparing years of schooling completed in adult populations.

Currently, all public schooling through senior secondary school has no school fees, though there are other nontrivial charges for books, materials, uniforms, transport, and in some cases, boarding. Historically, however, school fees have figured prominently in funding public schooling. Before 1995, the payment of school fees was required at all levels. School fees for public primary and junior secondary schooling were eliminated in 1995, with free public preschool added in 2012. School fees for public senior secondary schools were removed in 2017.

Enrollment and completion rates at all schooling levels have increased steadily over the past few decades in Ghana (figures 1 and 2). The primary enrollment rate has improved steadily to 100 percent on a trajectory similar to the average for the rest of Sub-Saharan Africa. It is interesting that there was no sharp increase in the primary enrollment rate around 1995, when school fees were removed. Instead, the sharpest increase occurred in the middle of the following decade. The secondary enrollment rate was historically high relative to Sub-Saharan Africa and lower-middle-income countries, but did not improve in Ghana between 1970 and 2000. The enrollment rate then improved quickly, reaching nearly 80 percent at present. This rate is similar to the average for other lower-middle-income countries and significantly higher than for Sub-Saharan Africa in general. There was no noticeable change in this upward trend in 2017, the year senior secondary school fees were eliminated. The postsecondary enrollment rate was historically low in Ghana but has accelerated quickly since about 2005.

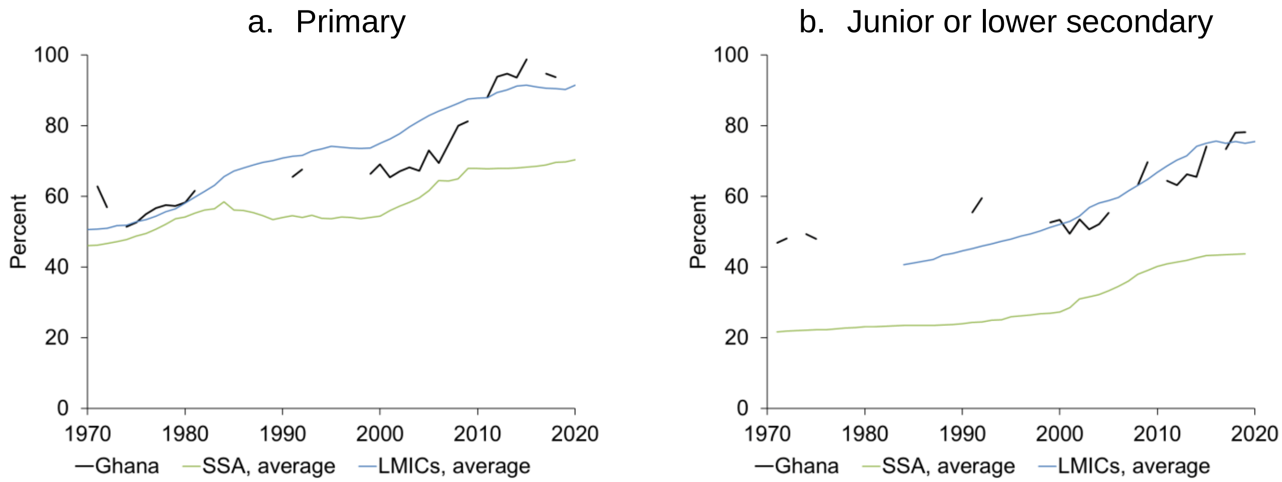
**Figure 1: School Enrollment Rates**




*Source*: Statistics obtained from the World Bank's World Development Indicators databank.

*Note*: SSA = Sub-Saharan Africa. LMICs = Lower-middle-income countries. The time series for Ghana is fragmented because of missing data. School enrollment rate = gross enrollment rate. Gross enrollment rate is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the given level of education.

**Figure 2: School Completion Rates**




*Source*: Statistics obtained from the World Bank's World Development Indicators databank.

*Note*: SSA = Sub-Saharan Africa. LMICs = Lower-middle-income countries. The time series for Ghana is fragmented because of missing data. Primary completion rate = gross intake ratio to the last grade of primary education. Junior secondary (or lower secondary) completion rate = gross intake ratio to the last grade of lower secondary education.

Ghana's primary completion rate was historically high compared to that for Sub-Saharan Africa, but remained relatively flat until about 2005, when it increased sharply. The rate is now near 100 percent, similar to the average for other lower-middle-income countries. The junior secondary completion rate shows a similar pattern but at lower levels.

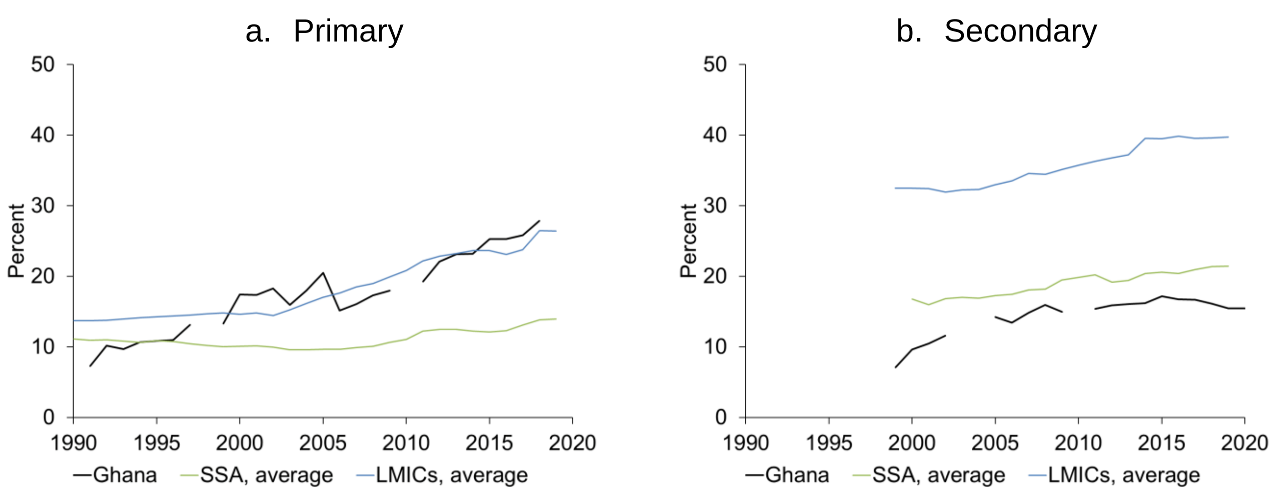
Overall, then, the supply of better-educated workers has been increasing in Ghana, especially over the past two decades. One might expect that this would reduce the returns to schooling, and a recent analysis does in fact find a reduction in the return to a year of schooling, from 13.3 percent in 2005/06 to 10.7 percent in 2016/17 (Nxumalo and Raju 2020). But these rates are actually higher than estimates for the mid-1980s (Glewwe 1996). As Patrinos and Psacharopoulos (2018) note, the returns can be affected by the price of schooling as well as the future labor earnings that schooling produces. The "price" of schooling is dominated by teachers' salaries, which have increased significantly recently, especially in the wake of the single spine salary structure reform in 2012. Still, there is no evidence of a long-term decline in the returns to a year of schooling.

Despite these solid improvements in enrollment and completion rates, many studies for Ghana indicate concern about the quality of schooling that children receive. World Bank (forthcoming) includes a catalog of these concerns. Pass rates for both the Basic Education

Certification Exam (BECE), given at the end of junior secondary school, and the West African Senior School Certificate Examination (WASSCE), remain low, and Ghanaian students' performance on one international exam, the Trends in International Mathematics and Science Study (TIMSS), is extremely low and did not improve between 2003 and 2011.

Concerns about the quality of public schooling may explain the share of students who attend private schools (figure 3). Historically, the share of students in private primary schooling was low in Ghana but the rate has steadily increased from well below the average for Sub-Saharan Africa and lower-middle-income countries to more than both in recent years. The share of students in private secondary schooling has increased as well, but remains lower than for either Sub-Saharan Africa or lower-middle-income countries. It is notable that neither of these shares varies much for Ghana at the time that school fees were eliminated in public schools (in 1995 at the primary and junior secondary levels and in 2017 at the senior secondary level).

**Figure 3: Share of Students in Private Schooling**




*Source*: Statistics obtained from the World Bank's World Development Indicators databank.

*Note*: SSA = Sub-Saharan Africa. LMICs = Lower-middle-income countries. The times series for Ghana is fragmented because of missing data.

*Ghana School Feeding Programme*

One of the most studied aspects of basic schooling (primary and junior secondary) in Ghana is the Ghana School Feeding Programme (GSFP). GSFP hires caterers to provide one cooked meal per school day to students in selected schools. Begun as a pilot in 10 schools in 2005, the program expanded rapidly to cover 5,682 schools and 1.6 million students by 2016/17, though it is still not universal. Its primary goal is to encourage school attendance and thus improve schooling outcomes. In addition, the program initially intended to improve the distribution of income by targeting schools in the poorest areas of Ghana; that is, it is a transfer scheme. While the program's expansion has surely diluted this goal, the program remains highly progressive (Dadzie, Raju, and Younger forthcoming). Finally, the program aims to promote Ghanaian agriculture by buying locally produced food.[8]

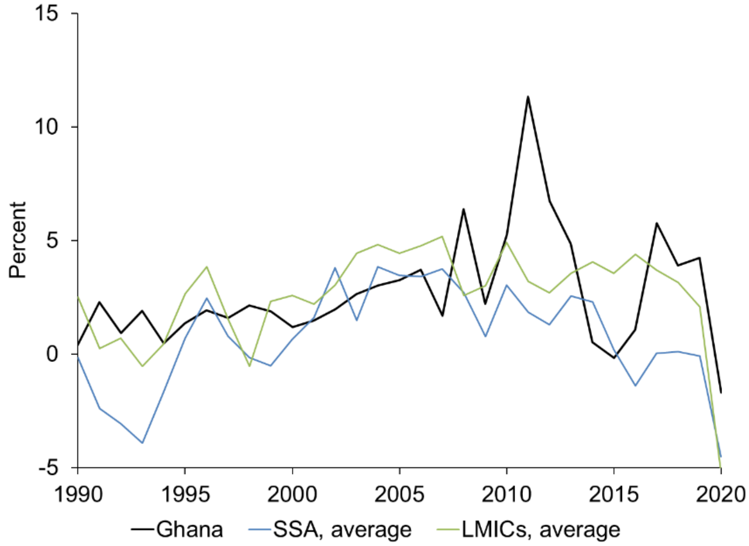
The impacts of GSFP have been evaluated in a school-level experiment (Gelli et al. 2019; Aurino et al. 2019). We discuss these results later in this study, but the broad conclusions are that GSFP has had little nutritional impact but a significant impact on test scores. One possible mediating factor in the study is increased school enrollment, but only in schools in the poorest areas (which makes sense since basic school enrollment rates are already near 100 percent in most areas). A second is improved school attendance, though the evidence for this is weaker.

### b. Economic Growth

Because estimates of the returns to schooling depend on current labor earnings of those educated in the past, it is important to keep in mind the macroeconomic context those workers have experienced. Figure 4 shows Ghana's growth in gross domestic product (GDP) per capita measured in purchasing power parity dollars to compare to other countries. Until 2007, Ghana's growth was quite steady, somewhat higher than the average for Sub-Saharan Africa and roughly similar to that for lower-middle-income countries. Ghana's economic growth rate has become quite volatile in recent years, affected by the discovery of significant offshore oil and gas reserves, a serious drought that impacted electricity supply, the Covid-19 pandemic, and perhaps a political business cycle.[9]

[8] There is little evidence on this aspect of the program.
[9] Ghana holds national elections every four years, with the most recent in 2020. See Younger (2016) for a discussion of macroeconomic developments in Ghana, including political business cycles.

**Figure 4: GDP Per Capita Growth Rates**




*Source*: Statistics obtained from the World Bank's World Development Indicators databank.

*Note*: SSA = Sub-Saharan Africa. LMICs = Lower-middle-income countries. GDP = Gross Domestic Product. GDP per capita growth rate = annual percentage growth rate of GDP per capita based on constant local currency.

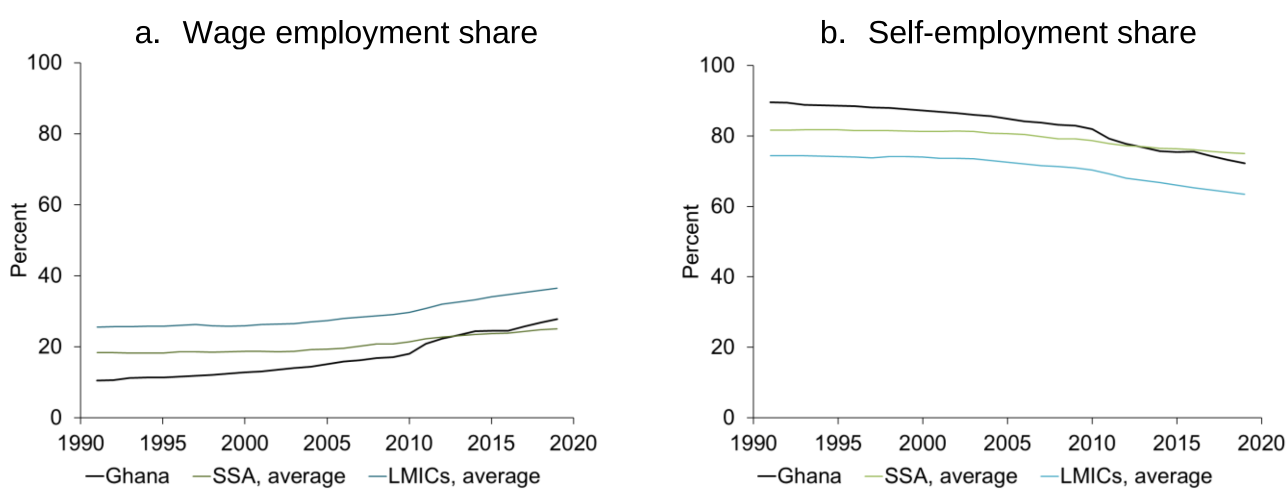
During the time when GDP grew significantly due to the oil discovery, civil service salaries increased substantially, doubling in some cases. The relationship between these two events is complex (see Younger 2016), but for our purposes, it is important to recognize that the public sector workers we observe in our data have received a substantial pay increase. While our empirical work checks for differences in results when we exclude public sector workers (and finds only small effects), given that public sector employment is large compared to private sector formal employment, it may be that the increases in public sector salaries spilled over into wages and salaries for private sector employees in the formal sector, though perhaps not to the much larger informal economy (Younger and Osei-Assibey 2017). We should also note that the government tried to claw back the increases in public sector salaries by refusing to adjust nominal salaries for inflation in subsequent years.

### c. Labor Market

Nxumalo and Raju (2020) provide a thorough review of Ghana's labor market. Employment patterns in Ghana have been similar to those in other developing countries historically, with the country's share of employment in agriculture and in self-employment (which overlap strongly) decreasing gradually over time from 90 percent in 1990 to 72 percent in 2019 (figure 5).[10] Until the advent of the oil and gas boom in 2012, movement of workers was almost entirely into services rather than industry, unlike the experience of many rapidly developing economies (figure 6). In the past decade, however, Ghana's sectoral employment shares have diverged from the typical pattern in other developing countries, with much sharper drops in the agricultural employment share from 50 percent to 30 percent between 2010 and 2019; a jump in the industrial employment share from 14 to 21 percent; and an acceleration in the growth of the services employment share from 36 to 49 percent in the same period. This appears to be driven by the oil and gas boom (Nxumalo and Raju 2020) and associated increases in construction.

Somewhat surprisingly, labor productivity has increased fastest in agriculture since 2006, at 6.3 percent per year, compared to 3.6 percent and 0.5 percent for industry and services, respectively, but labor productivity in agriculture still remains well below that for industry or services (Nxumalo and Raju 2020).

**Figure 5: Shares in Wage Employment and Self-Employment**

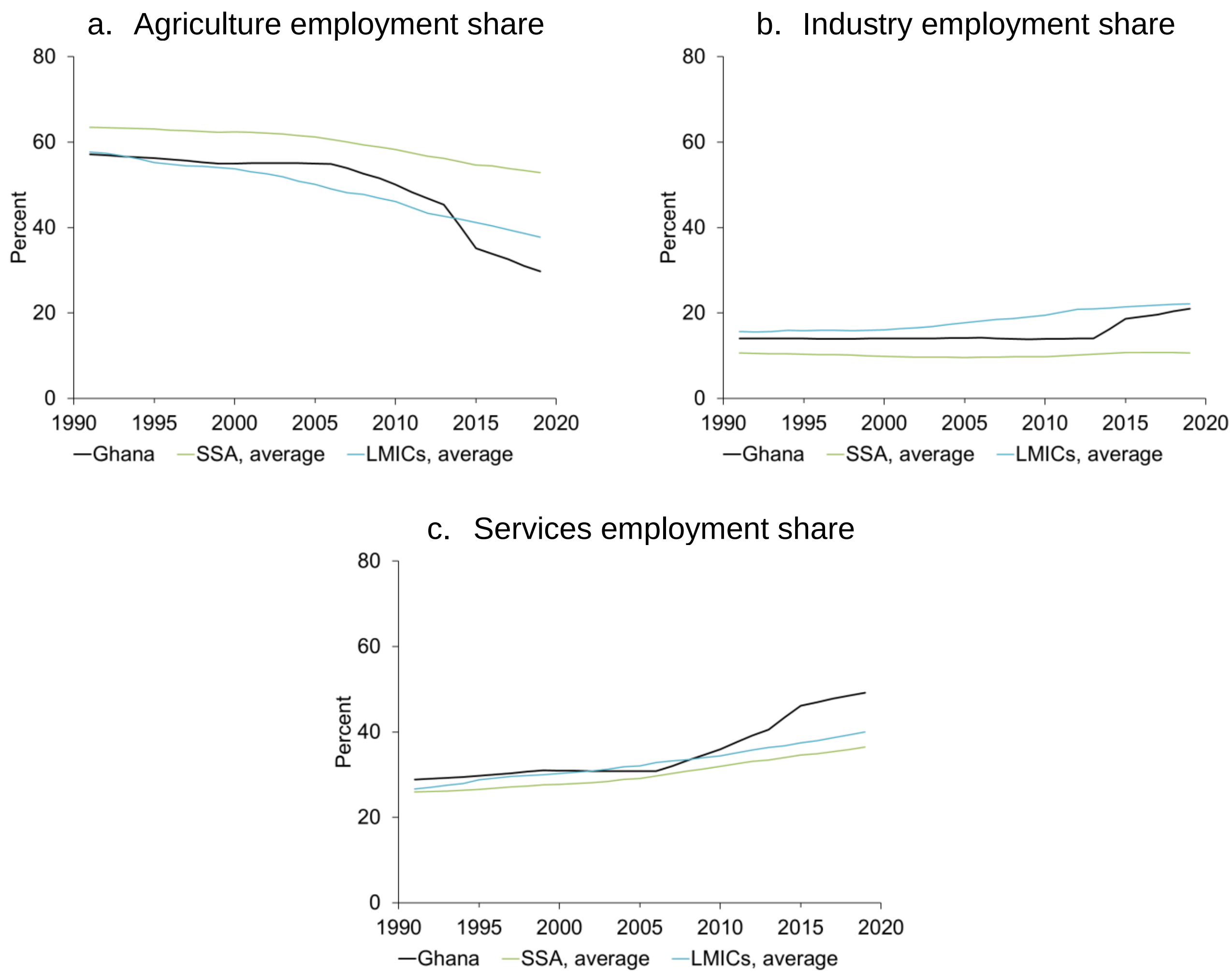



*Source*: Statistics obtained from the World Bank's World Development Indicators databank.

*Note*: SSA = Sub-Saharan Africa. LMICs = Lower-middle-income countries. Wage-employment = wage and salaried employment. Self-employment includes employers, own-account workers, and contributing family workers. Statistics are ILO-modeled values.

[10] It is important to keep in mind the low share of workers who are in wage employment as this is the sample for the estimates in section 3b.

**Figure 6: Sectoral Employment Shares**




*Source*: Statistics obtained from the World Bank's World Development Indicators databank.

*Note*: SSA = Sub-Saharan Africa. LMICs = Lower-middle-income countries. Statistics are ILO-modeled values. Agriculture = agriculture, hunting, forestry and fishing. Industry = mining and quarrying, manufacturing, construction, and public utilities. Services = wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services.

## 3 Value of the Quantity of Public Schooling

### a. Experimental Evidence

Our review of the literature found only one experimental study that examines the impact of the quantity of schooling, i.e., additional years of schooling, in Ghana, and indeed the authors of that study remark that there are very few such studies worldwide (Duflo, Dupas, and Kremer 2021).

That study began in 2009 when the authors identified about 2,000 junior secondary school graduates who had been admitted to senior secondary school but did not intend to go. Study participants lived in rural areas in southern parts of Ghana, where a government scholarship program already existed. The vast majority cited the cost as the main deterrent to continuing their studies. (Ghana still charged school fees for senior secondary schooling at that time.) The study offered a scholarship for three years of senior secondary schooling at a nearby public high school to a randomly selected group of those students and followed the participants for 12 years, up to about age 29 (and continues to follow them).

This experiment is about as close to the general question of the value of the quantity of public schooling as one can get: It estimates the impact of providing tuition-free secondary schooling. Still, as the authors note, the study population is a marginal one—those students who could not afford to attend school when faced with fees—rather than the average secondary school student.

The results are sobering. While the authors find significant impacts on senior secondary school graduation, university admissions, test scores, and delayed fertility, the impact on labor earnings is small—about 74 cedis ($36 in purchasing power parity dollars) per year in 2019—statistically insignificant, and dwarfed by the cost of three years of senior secondary schooling (the scholarship's value), totaling about 12,000 cedis, even when the difference in labor earnings is accumulated and discounted over a working life. Viewed from the perspective of future labor earnings alone, then, this result casts doubt on the value for money provided by secondary schooling in Ghana, at least for this population.

### b. Nonexperimental Evidence: Mincer Regressions

*Mincer regressions and their critics*

We take a straightforward approach to estimating the increase in labor earnings generated by attendance at public schools. We estimate a Mincer regression of (log) labor earnings on years of schooling and years of experience in a cross-section—the 2016/17 Ghana Living Standards Survey (2016/17 GLSS)—and use those estimates to calculate the increase in the present discounted value of lifetime earnings for each additional year of school. Such estimates are traditionally made with ordinary least squares (OLS):

$$\ln(\text{earnings}) = \beta_0 + \beta_1 \times \text{experience} + \beta_2 \times \text{experience}^2 + \beta_3 \times \text{years of schooling} + \varepsilon, \qquad (1)$$

sometimes with (proxies of) controls for student ability and/or school quality. Equation (1) is the standard approach, as in, for example, Patrinos and Psacharopoulos (2020) with the easy interpretation that $\beta_3$ is closely related to the rate of return to one additional year of schooling. However, this approach forces the proportional increase in labor earnings from one year of schooling to be the same whether that year is at the primary level or the postsecondary level. Many studies, including in Ghana, find that returns are higher for higher levels of schooling, especially postsecondary schooling. See, for example, Urzúa (2019) or Turkson and Baffour (2020) for Ghana. To account for this, we estimate a semiparametric version of the same model:

$$\ln(\text{earnings}) = \beta_0 + \beta_1 \times \text{experience} + \beta_2 \times \text{experience}^2 + f\left(\text{years of schooling}\right) + \varepsilon, \qquad (2)$$

adding controls for region and area (urban/rural) of residence and mother's and father's level of schooling.

There is an extensive literature criticizing regressions such as equations (1) and (2), the most common criticism being ability bias: those with greater innate ability are both more likely to complete more years of schooling and have greater labor earnings. Since neither equation (1) nor equation (2) includes ability, the omitted variables bias for $\beta_3$ is positive. Despite this intuitive argument, an early review of the literature by Griliches (1977) argues that ability bias is likely to be small in equation (1) and may be overwhelmed by larger negative biases. Card (1999) echoes that argument and uses twins data to estimate that the bias in the average return to schooling is about 10 percent when using OLS. Card also finds that many instrumental-variables estimates are *higher* than OLS estimates, casting doubt on the ability to find an easy econometric fix for the OLS bias.

Another potential source of bias in equations (1) and (2) is the absence of controls for school quality. As first argued by Behrman and Birdsall (1983), if better-quality schools increase both the number of years students stay in school and their labor earnings later in life, then again,

$\beta_3$ will be biased upward. Behrman and Birdsall (1983) actually find only a small bias in their empirical estimates, however.[11]

Finally, and contrary to the fairly benign results presented so far, using data from the 1988/89 Ghana Living Standards Survey, Glewwe (1996) finds significant selection bias in the estimation of equation (1) because it typically is estimated only on wage-employed workers, ignoring the large share of the labor force that is self-employed in Ghana. He also uses a unique set of test scores collected in the survey to control for ability. He finds that controlling for ability and selection into wage employment reduces the coefficient on years of schooling from 8.5 percent to between 3.6 and 6.1 percent depending on the age of the worker and whether he or she works in the public or private sector.

Given the weight of the evidence and Card's general observation that the bias is unsigned, and lacking any data on ability or schooling quality, we proceed with the straightforward equation (2).[12]

In all our estimates, we are unable to distinguish between wage-employed workers who attended public versus private school, so we must assume that the returns to public and private schooling are similar. In appendix A, we show that between 25 and 38 percent of primary school students are enrolled in private schools, but this share falls to 10 to 15 percent for secondary school and university students. As we show below, a significant part of the return to primary schooling is the option to continue on to higher levels where labor earnings increase more sharply with additional education and where the vast majority of students attend public schools.

### *Calculating monetary benefits of an additional year of schooling*

One difference between our paper and much of the literature is that our aim is to estimate the benefits, in Ghanaian cedis, of an additional year of schooling rather than a rate of return because we want to compare those benefits to the cost of providing them. In the basic model, the additional benefits of attending year $j$ of school are calculated as the difference between the present discounted value of future labor earnings having attended $j$ years of schooling less the labor earnings having attended $j$–1 years, as in Patrinos and Psacharopoulos (2020):

[11] The original study reported a large bias, but Eaton (1985) points out a calculation error, acknowledged by the authors in a reply.

[12] We have also estimated equation (1), with results similar to others found in the literature for Ghana and other low-income countries.

$$\Delta_j = \sum_{t=j+1}^{60} e_{j,t} d^{(t-j)} - \sum_{t=j}^{60} e_{j-1,t} d^{(t-j)} \quad (3)$$

where $\Delta_j$ is the additional benefit; $e_{j,t}$ are labor earnings *t* years into the future having completed *j* years of schooling; and *d* is a discount factor equal to one over one plus the discount rate. We assume a maximum working age of 60. Note that the second sum for having completed *j*–1 years of schooling includes an extra term to reflect that going to school for an extra year delays one's working life by a year.

Soares (2019) notes that when the return to an additional year of schooling varies by year, it is important to consider that, in addition to the additional labor earnings generated by completing exactly *j* years of schooling, going to school for the $j^{th}$ year offers one the opportunity to continue schooling, thus increasing future labor earnings even further. For the last possible year of schooling (say, 16 years), this possibility would not matter, so the marginal return to completing the last year is calculated as in equation (3). However, for the penultimate year of schooling (say, 15 years), we need to consider the possibility of advancing further in one's schooling. Thus:

$$\delta_{15} = \left(1 - p_{15,16}\right)\Delta_{15} + p_{15,16}\delta_{16}d, \quad (4)$$

where $p_{15,16}$ is the probability of advancing to year 16 having completed year 15, *d* is a discount factor, and $\delta_{15}$ is the return to studying year 15 including the possibility of continuing on to year 16. Note that for year 16, assumed to be the last year of schooling, $\delta_{16} = \Delta_{16}$. So, the benefit of studying year 15 is the probability of stopping at the end of that year, $\left(1 - p_{15,16}\right)$ times the labor earnings differential defined in equation (3) for 15 years of schooling plus the probability of completing 16 years of schooling conditional on having completed 15 years times the labor earnings differential in equation (3) for 16 years of schooling, discounted one year to account for the fact that these labor earnings will come one year in the future. It is straightforward to recurse equation (4) back from the maximum number of years of schooling. More generally:

$$\delta_j = (1 - p_{j,j+1})\Delta_j + p_{j,j+1}\delta_{j+1}d, \qquad (5)$$

Note the difference between $\Delta_j$ and $\delta_j$. $\Delta_j$ is the simple difference in the net present value (NPV) of labor earnings for those with *j* years of schooling compared to those with *j*–1 years. Later, we will call this the "one year" gain to completing year *j*. $\delta_j$ is a probability weighted recursion of the gains to completing years of schooling beyond *j*. We will call this the "forward-looking" gain to completing year *j*.

Note that either $\Delta_j$ or $\delta_j$ is an estimate in cedis of the NPV of completing year *j* of schooling. As such, we can use these estimates directly to compare to the costs of providing that year of schooling to obtain a benefit-cost ratio. We draw information for the government's costs of providing schooling from the Ghana Ministry of Education.[13] We also include private costs incurred using the average amount reported for tuition and fees, expenditure on books, uniforms and sports clothes, transport to school, and parent-teacher association (PTA) dues in the 2016/17 GLSS for students in public schools, by level.

### *Data and specification*

The data for the regressions come from the 2016/17 GLSS. We use the labor earnings of workers ages 15 to 45 because older workers attended school in a prior regime that included many more years (15) of primary and secondary education than the current regime. We include only wage-employed workers as the 2016/17 GLSS does not ask about the labor earnings of self-employed workers.[14] The 2016/17 GLSS also does not ask about years of work experience in either one's current job or one's working life, so we assume that experience is equal to age less the number of years spent in school plus five, a common assumption in the literature. See appendix A for precise definitions for these variables as well as for years of schooling and mother's and father's level of schooling.

We assume that work occurs between the ages of 15 and 60, and use a discount rate of 8 percent. This is higher than most education studies (e.g., Evans and Yuan 2019), but consistent

[13] We exclude "internally generated funds"—mostly tuition—from these data and include estimates of tuition and fees paid from the 2016/17 GLSS in the private costs estimate.
[14] There is an extensive agricultural questionnaire in the 2016/17 GLSS that allows the estimation of farm profits, but at the household level.

with the many Copenhagen Consensus studies that attempt to make benefit-cost comparisons consistent across many types of public spending (Wong and Dubosse 2019). Finally, very few people report more than 18 years of schooling, so we capped the total at 18.

### *Results*

Table 1 and figure 7 present the regression estimates. The parametric and nonparametric estimates for the years-of-experience variables are very similar. Coefficients on place of residence vary more, but they also have large standard errors. The coefficients on father's education attainment are not significantly different from zero[15] except for fathers who are university graduates; they have a strong positive effect on labor earnings in all the regression models except the regression for women. The coefficients on mother's education attainment are also mostly insignificant, though they are large for university graduates, with very large standard errors. The important exception is that women whose mothers completed primary, junior secondary, or senior secondary schooling have significantly higher labor earnings.

The parametric estimates on years of schooling in the first two columns are somewhat lower that those reported in Patrinos and Psacharopoulos (2020) for Africa, but similar to all developing countries. They are also somewhat lower than the results in Montenegro and Patrinos (2014) for Ghana in 2005 and 2012 (10.3 percent and 12.5 percent per year, respectively) but much higher than their estimate for 1991 (5.3 percent per year). This may reflect the improved macroeconomic and labor market conditions over time and, for 2012, the effect of the single spine salary scheme. Note that adding the control variables decreases this coefficient only slightly in our estimates, unlike the results in Glewwe (1996).

In figure 7, we see, however, that the returns to an additional year of schooling[16] increase sharply for men at 13 years of school, the beginning of postsecondary schooling, and at 10 years for women, the beginning of secondary schooling. This is the main motivation for the more complicated calculation of lifetime benefits in equation (5). Note also that the labor earnings pattern is almost identical regardless of whether we exclude public sector workers from the sample.

[15] But recall that these estimates are conditional on the individual's schooling, captured through the nonparametric estimate.
[16] Because the vertical axis is the natural log of labor earnings, the slope of the function is approximately the percentage increase in labor earnings for an additional year of schooling.

**Table 1: Mincer Regressions, Estimates**

| Covariates | Wage-employed workers, ages 15–45 | | | | | |
|---|---|---|---|---|---|---|
| | All | | | Men | Women | All, private sector |
| | OLS | OLS | Semi parametric | Semi parametric | Semi parametric | Semi parametric |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Experience | 0.071*** | 0.067*** | 0.071*** | 0.066*** | 0.061*** | 0.071*** |
| Experience squared | –0.001*** | –0.001*** | –0.001*** | –0.001*** | –0.001*** | –0.001*** |
| Years of schooling | 0.090*** | 0.080*** | | | | |
| *Region* | | | | | | |
| Western | | –0.015 | –0.012 | 0.048 | –0.110 | 0.038 |
| Central | | –0.113* | –0.144** | –0.142* | –0.204** | –0.160** |
| Volta | | –0.311*** | –0.323*** | –0.285*** | –0.441*** | –0.401*** |
| Eastern | | –0.113 | –0.107 | –0.150* | –0.050 | –0.131 |
| Ashanti | | –0.010 | –0.008 | –0.004 | –0.098 | 0.021 |
| Brong Ahafo | | –0.245*** | –0.242*** | –0.159* | –0.394*** | –0.281*** |
| Northern | | –0.134 | –0.225*** | –0.312*** | –0.122 | –0.292*** |
| Upper East | | –0.184 | –0.273** | –0.302** | –0.210 | –0.338** |
| Upper West | | 0.025 | –0.044 | –0.125 | 0.012 | –0.118 |
| Rural | | –0.060 | –0.064 | –0.137** | 0.001 | –0.067 |
| *Father's schooling level* | | | | | | |
| Primary | | –0.031 | –0.008 | 0.027 | –0.075 | –0.030 |
| Junior secondary or middle | | 0.040 | 0.065 | 0.084* | 0.027 | 0.044 |
| Senior secondary or secondary | | 0.083 | 0.079 | 0.183 | –0.117 | 0.048 |
| Postsecondary, nonuniversity | | –0.018 | –0.046 | –0.056 | 0.042 | –0.035 |
| University | | 0.294*** | 0.242*** | 0.328*** | 0.124 | 0.346*** |
| *Mother's schooling level* | | | | | | |
| Primary | | 0.009 | 0.032 | –0.038 | 0.221*** | –0.033 |
| Junior secondary or middle | | 0.024 | 0.017 | 0.003 | 0.100* | –0.009 |
| Senior Secondary or secondary | | 0.174 | 0.163 | 0.018 | 0.392** | 0.095 |
| Postsecondary, nonuniversity | | 0.184 | 0.083 | 0.128 | 0.071 | –0.169 |
| Postsecondary, university | | 0.385 | 0.300 | 0.424* | 0.186 | 0.544** |

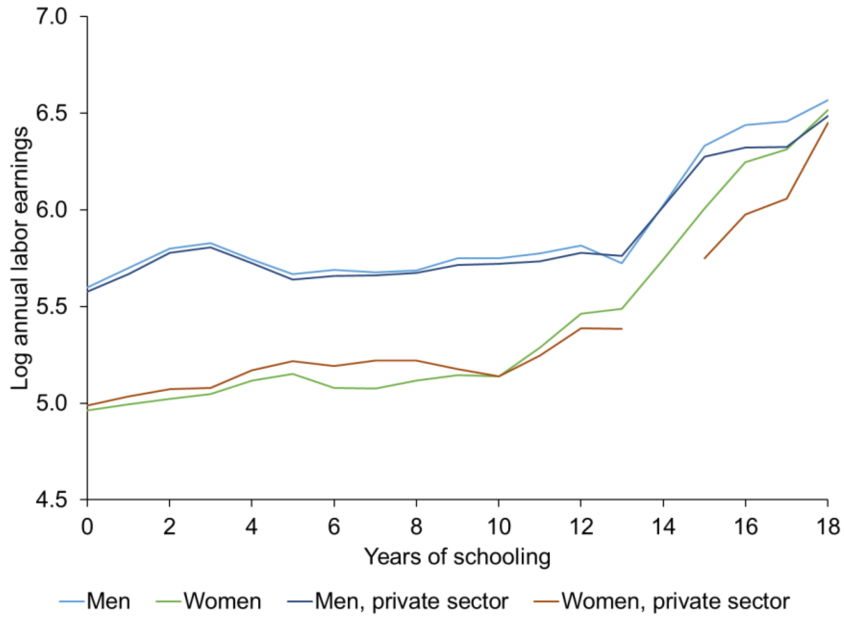
**Table 1: Mincer Regressions, Estimates**

| Covariates | Wage-employed workers, ages 15–45 | | | | | |
|---|---|---|---|---|---|---|
| | All | | | Men | Women | All, private sector |
| | OLS | OLS | Semi parametric | Semi parametric | Semi parametric | Semi parametric |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Intercept | | 4.792*** | | | | |
| *N* | | 4,291 | 4,291 | 2,886 | 1,405 | 3,276 |
| *R*-squared statistic | | 0.207 | 0.097 | 0.106 | 0.109 | 0.104 |

*Source*: Authors' estimations based on data from the 2016/17 GLSS.

*Note*: OLS = ordinary least squares. Samples for all regressions are restricted to wage-employed workers ages 15–45. Reference region is Greater Accra. Reference category for father's and mother's schooling level is none. "Postsecondary, nonuniversity" includes teacher training, nurse training, and a variety of technical training programs ranging from one to three years of study. Robust standard errors reported in parentheses.
Significance level: * = 10 percent, ** = 5 percent, *** = 1 percent.

**Figure 7: Average Log Labor Earnings by Years of Schooling**




*Source*: Authors' estimates based on data from the 2016/17 GLSS.

*Note*: Estimates are based on semiparametric regressions with controls. Sample for the underlying regressions is restricted to wage-employed workers ages 15–45.

Figure 7 also shows that labor earnings are significantly higher for men than women, with the gap decreasing as years of schooling increase. However, the *return* to an additional year of schooling, the slope of the function, is higher for men at the lowest levels of schooling, up to three years of schooling, but higher for women from 11 to 13 years of schooling and at the highest levels of schooling.

Table 2 reports our calculation of $\Delta_j$ and $\delta_j$, the year-by-year estimate of additional labor earnings ("one-year NPV") and the recursed estimate defined in Equation (5) ("forward-looking NPV"), along with our estimate of the probability of advancing from one year to the next. We also include in the "public costs" column estimates from the Ghana Ministry of Education for per-student public expenditure by level of schooling, excluding internally generated funds (tuition) which we capture in the "private costs" column. The latter is estimated as the average reported private costs for public school students, based on the 2016/17 GLSS. For results that combine males and females – the "All" columns – the advancement probabilities and private costs do not take gender into account – again, the "All" columns. For male and female-specific results, we use the gender-specific advancement probabilities and private costs.

**Table 2: Net Present Value of an Additional Year of Schooling, by Years of Schooling Completed, 2017 Dollars ($)**

| Years of schooling | Probability of advancing an additional year of schooling | | | Public costs ($) | Private costs ($) | | | Wage-employed workers, ages 15–45 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | All | | Men | Women |
| | All | Male | Female | | All | Male | Female | One-year NPV ($) | Forward-looking NPV ($) | Forward-looking NPV ($) | Forward-looking NPV ($) |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| 0 | 0.87 | 0.91 | 0.84 | 0 | | | | -- | -- | -- | -- |
| 1 | 0.99 | 0.99 | 0.99 | 367 | 70 | 72 | 69 | 2,696 | 954 | 708 | 752 |
| 2 | 0.98 | 0.99 | 0.98 | 367 | 70 | 72 | 69 | 3,484 | 1,016 | 745 | 814 |
| 3 | 0.98 | 0.98 | 0.97 | 367 | 70 | 72 | 69 | 2,893 | 1,050 | 750 | 886 |
| 4 | 0.97 | 0.98 | 0.97 | 367 | 70 | 72 | 69 | –1,778 | 1,084 | 798 | 969 |
| 5 | 0.95 | 0.95 | 0.95 | 367 | 70 | 72 | 69 | –1,096 | 1,258 | 997 | 1,033 |
| 6 | 0.91 | 0.93 | 0.90 | 367 | 70 | 72 | 69 | 817 | 1,492 | 1,304 | 1,134 |
| 7 | 0.91 | 0.92 | 0.90 | 790 | 133 | 137 | 130 | 105 | 1,680 | 1,454 | 1,559 |
| 8 | 0.90 | 0.91 | 0.89 | 790 | 133 | 137 | 130 | 1,363 | 1,977 | 1,780 | 1,881 |
| 9 | 0.60 | 0.64 | 0.56 | 790 | 133 | 137 | 130 | 1,982 | 2,208 | 2,086 | 2,184 |
| 10 | 0.86 | 0.87 | 0.84 | 1,015 | 749 | 697 | 812 | 277 | 2,546 | 1,974 | 3,801 |
| 11 | 0.90 | 0.90 | 0.90 | 1,015 | 749 | 697 | 812 | 1,639 | 3,153 | 2,490 | 4,932 |
| 12 | 0.48 | 0.48 | 0.47 | 1,015 | 749 | 697 | 812 | 2,015 | 3,586 | 2,909 | 5,508 |
| 13 | 0.92 | 0.92 | 0.92 | 1,881 | 1,940 | 1,965 | 1,904 | –1,382 | 5,742 | 4,753 | 6,883 |
| 14 | 0.99 | 0.99 | 1.00 | 1,881 | 1,940 | 1,965 | 1,904 | 13,338 | 6,866 | 5,996 | 8,024 |
| 15 | 0.85 | 0.85 | 0.85 | 1,881 | 1,940 | 1,965 | 1,904 | 17,929 | 7,377 | 6,416 | 8,664 |
| 16 | 0.74 | 0.77 | 0.68 | 1,881 | 1,940 | 1,965 | 1,904 | 7,683 | 5,891 | 4,379 | 8,823 |
| 17 | 0.43 | 0.44 | 0.39 | 1,881 | 1,940 | 1,965 | 1,904 | 1,302 | 5,646 | 3,685 | 7,404 |
| 18 | 0.00 | 0.00 | 0.00 | 1,881 | 1,940 | 1,965 | 1,904 | 12,551 | 12,551 | 8,481 | 14,282 |

*Source*: Authors' estimations based on data from the 2016/17 GLSS and the Ghana Ministry of Education.

*Note*: NPV = net present value. Discount rate for the calculations is 8 percent. Calculations assume a working life from age 15 to 60, except when the individual is in school; they also assume that students have no labor earnings. The probability of advancing an additional year of schooling is estimated for all individuals ages 15–45. We use advancement probabilities and private costs for each gender in the gender-specific results, and the "all" columns for the results that combine both genders.

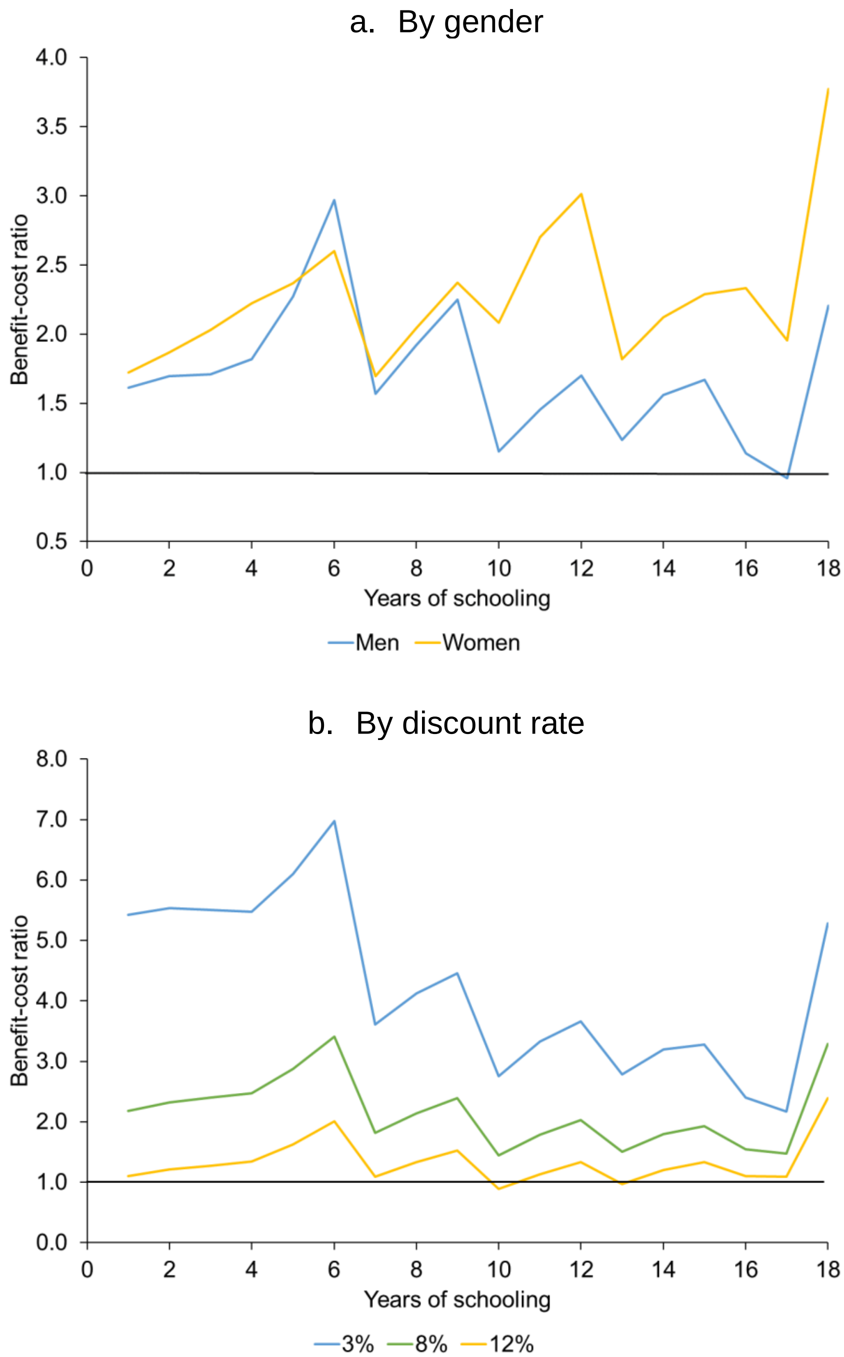
The probabilities of advancing one additional year of schooling conditional on having completed prior years are interesting. Thirteen percent of the sample, 9 percent of boys and 16 percent of girls, never attended school, but for those who began school, most finished primary and junior secondary schooling. But only 60 percent of those who completed junior secondary schooling (64 percent of boys and 56 percent of girls) go on to senior secondary school, where the advancement probabilities again increase until the end of senior secondary schooling (12 years). Similarly, while only 48 percent of those who completed senior secondary schooling entered university, once there, the advancement probabilities are again high.

The costs of a year of school combine Ghana Ministry of Education data for public expenditure per student plus the average amount reported for tuition and fees, expenditure on books, uniforms and sports clothes, transport to school, and PTA dues in the 2016/17 GLSS for students in public schools, by level. These are quite similar across males and females except for senior secondary school where they are 18 percent higher for girls.

Note that some of the year-by-year net present value calculations actually show losses in labor earnings for an additional year of schooling. These correspond to years when the slope in figure 7 is flat or negative so that the loss of a year of work is greater than the additional labor income earned. However, the recursed estimates smooth this out as there is a benefit to, for example, the fourth year of schooling beyond the difference in labor earnings compared to those with only three years: the chance to advance to lucrative higher years of schooling. Note that the benefits to additional years of schooling are higher for women than men even though their labor earnings are lower, especially after completion of junior secondary school.

Figure 8a shows our estimate of the benefit-cost ratios for men and women by year of schooling completed. The benefit-cost ratios are always greater than one except for men who complete exactly 17 years of schooling, i.e., those who drop out after one year of graduate school. The ratios also spike at the completion of each level of schooling. Note also that the benefit-cost ratios for men are higher at lower levels of schooling than they are for higher levels, a function of the much higher costs of secondary and postsecondary schooling. For women, though, gains in labor earnings at higher levels are so great that the benefit-cost ratios are flatter through the years.

**Figure 8: Benefit-Cost Ratios by Years of Schooling**




*Source*: Authors' estimates based on data from the 2016/17 GLSS and the Ghana Ministry of Education.

Table 2 uses a discount rate of 8 percent, which is high. Most education studies use 3 percent or 5 percent. Figure 8b shows that the benefit-cost ratios increase significantly if we discount at 3 percent, as in, for example, Evans and Yuan (2019). In addition, we show the ratios for a discount rate of 12 percent to highlight the fact that the internal rate of return to schooling for any number of years will be at least 12 percent (because the benefit-cost ratios are all above one), and not too much higher.

## 4 Value of Achievement Gains from Interventions in Public Schools

Most (quasi-)experimental studies in education do not assess the monetary value of the changes in pedagogical practice that they study. However, many evaluation studies in education examine the impact of those changes on test scores. These studies range from small changes such as using flip charts in class (Glewwe et al. 2004) to large programs such as the Ghana School Feeding Programme (Aurino et al. 2019). Our literature review identified four such studies for Ghana which we summarize here. While the studies estimate the impact on test scores of various interventions, none of the studies estimates the monetary value of a gain in test scores.

Following Turkson and Baffour (2020), we use the approach of Evans and Yuan (2019) to address this gap. They propose a method to convert standard deviations for test scores into "equivalent years of schooling" and/or monetary values. While intended for international comparisons, the example analysis includes Ghana as a case study, so we use Evans and Yuan's Ghana-specific values in our analysis. While the language tests in Evans and Yuan are not identical to those in studies we review below, they usually are similar, so we assume that the relationship between a one-standard-deviation improvement in test scores and equivalent years of schooling or future labor earnings is the same as in Evans and Yuan (2019).

The range of studies for which we have results in Ghana is narrow: Two examine variants of "teaching at the right level" in primary school, a change in pedagogy found to be effective in India and Kenya (Banerjee et al. 2007, 2017). One looks at school feeding in primary and junior secondary school. And one looks at distance education in primary school.

All the studies estimate the impact of the interventions on standardized test scores. We make two distinct calculations to derive monetary benefits associated with the interventions examined in these studies: test scores to labor earnings, and test scores to years of schooling to labor earnings. For the test scores to labor earnings calculations, the benefits are calculated as a 17.8 percent increase in labor earnings per year for each standard-deviation improvement in test scores (Evans and Yuan 2019) times the estimated improvement in test scores. The base of the increase in labor earnings is the labor share of GDP in 2017 times gross national income (GNI) per capita in cedis in 2017 converted to international dollars at the 2017 purchasing power parity (PPP) conversion factor for GDP. We assume this increase in labor earnings is constant throughout a working life from age 15 to 60.[17] We calculate the present value of those labor earnings increases at a discount rate of 8 percent. This is much higher than for Evans and Yuan, who use 3 percent, but is consistent with recommendations from the Copenhagen Consensus for benefit-cost analysis (Wong and Dubosse 2019) and also with calculations we make elsewhere in our study.[18]

For our test scores to years of schooling to labor earnings calculations, the benefits are calculated as 4.4 years of increased schooling for each standard-deviation improvement in test scores (Evans and Yuan 2019) times our estimate of the net present value in 2017 cedis of completing the relevant year(s) in school by target children under a given evaluation, converted to international dollars using the PPP conversion factor for GDP in 2017. Details on the benefit and cost calculations for each of the studies we discuss next are provided in appendix B.

### a. Teaching at the Right Level, Fourth and Fifth Grades

Beg et al. (2020) report on an experiment with three arms. The first trained teachers of fourth and fifth grade in methods designed to teach to students' knowledge level rather than their age or grade level. The second, motivated by concerns that implementation of similar programs in other settings had been weak, included the same training for teachers with additional training for head teachers and circuit supervisors on these methods. The third was a control group.

The experiment took place during the 2018–19 school year in 140 circuits (groups of schools) in the 20 districts where the United Nations Children's Fund (UNICEF) operates in Ghana. A first level of randomization allocated 70 circuits to the head teacher and circuit supervisor training. Within those circuits, 70 schools were chosen at random for the intervention. A second level of randomization took place in the other 70 circuits, where 70 schools were chosen for the teacher training and 70 chosen as controls. All schools were public schools. The intervention was designed by Innovations for Poverty Action (IPA) and carried out by the Ghana Ministry of Education and the Ghana Education Service.

[17] This implies that for interventions with young children, we assume that the stream of benefits does not start until they reach 15 years of age.
[18] See appendix B for details for this and all calculations.

The experiment tested impact on students' test scores in math and English at the beginning of each term of the school year and at the end of the year, along with several implementation indicators. The tests included questions developed by the Ministry of Education and the Ghanaian National Education Assessment Unit (for grades 4 and 6); they also included questions from the Early Grade Reading Assessment (EGRA) and Early Grade Mathematics Assessment (EGMA).

Table 3 presents the results.[19] Teacher-only training increased combined English/math test scores by 0.108 standard deviations and English test scores by 0.065 standard deviations. The teacher-plus-administrator training increased combined English/math test scores by 0.107 standard deviations and English test scores by 0.076 standard deviations. All results are statistically significant at the one percent level.[20]

The benefit-cost ratios for the teacher-only training are higher than our estimates for the quantity of schooling, and about twice as high when using our own estimates of the value of completing fifth grade versus the Evans and Yuan (2019) calculation based on GNI per capita. Including head teachers and circuit supervisors in the training has much lower benefit-cost ratios, the difference between the two experimental arms being entirely one of greater costs for the latter. The impact on test scores is very similar across the experimental arms.

[19] Table C.3 presents the monetary costs and benefits per student in terms of 2017 cedis.
[20] Beg et al. do not break out their results by gender.

**Table 3: Benefit-Cost Ratios for Teaching at the Right Level, Fourth and Fifth Grades**

| | Test scores to labor earnings | | Test scores to years of schooling to labor earnings | |
|---|---|---|---|---|
| | Teacher-only training | Teacher, head teacher, and circuit supervisor training | Teacher-only training | Teacher, head teacher, and circuit supervisor training |
| | (1) | (2) | (3) | (4) |
| **Cost per student, 2017 PPP $** | 69 | 124 | 69 | 124 |
| **Test score effect size, s.d.'s** | | | | |
| Combined math/English | 0.108 | 0.107 | 0.108 | 0.107 |
| English | 0.065 | 0.076 | 0.065 | 0.076 |
| **Benefit per student, 2017 PPP $** | | | | |
| Combined math/English | 465 | 461 | 953 | 945 |
| English | 280 | 327 | 574 | 671 |
| **Benefit-cost ratio** | | | | |
| Combined math/English | 6.8 | 3.7 | 13.9 | 7.6 |
| English | 4.1 | 2.6 | 8.4 | 5.4 |

*Note*: See appendix B for details on the calculations. s.d. = standard deviation. PPP = purchasing power parity.

**Table 4: Benefit-Cost Ratios for Teaching at the Right Level, Second and Third Grades**

| | Test scores to labor earnings | | | | Test scores to years of schooling to labor earnings | | | |
|---|---|---|---|---|---|---|---|---|
| | In-class remedial, with assistant | After-school, remedial with assistant | Split class, with teacher and assistant | In-class remedial, no assistant | In-class remedial, with assistant | After-school, remedial with assistant | Split class, with teacher and assistant | In-class remedial, no assistant |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Annual cost per student, 2017 PPP $** | 46 | 46 | 44 | 25 | 46 | 46 | 44 | 25 |
| **Test score effect size, s.d.'s** | | | | | | | | |
| English, two-year treatment | 0.129 | 0.174 | 0.079 | 0.085 | 0.129 | 0.174 | 0.079 | 0.085 |
| Foundational English, two-year treatment | 0.127 | 0.178 | 0.077 | 0.130 | 0.127 | 0.178 | 0.077 | 0.130 |
| English, persistence | 0.033 | 0.089 | 0.088 | –0.020 | 0.033 | 0.089 | 0.088 | –0.020 |
| Foundational English, persistence | 0.063 | 0.114 | 0.104 | 0.021 | 0.063 | 0.114 | 0.104 | 0.021 |
| **Annual benefit per student, 2017 PPP $** | | | | | | | | |
| English, two-year treatment | 220 | 297 | 135 | 145 | 242 | 327 | 148 | 160 |
| Foundational English, two-year treatment | 217 | 304 | 132 | 222 | 238 | 334 | 145 | 244 |
| English, persistence | 113 | 304 | 301 | –68 | 124 | 334 | 165 | –75 |
| Foundational English, persistence | 215 | 390 | 356 | 72 | 237 | 428 | 391 | 79 |
| **Benefit-cost ratio** | | | | | | | | |
| English, two-year treatment | 4.8 | 6.5 | 3.1 | 5.8 | 5.3 | 7.1 | 3.4 | 6.4 |
| Foundational English, two-year treatment | 4.7 | 6.6 | 3.0 | 8.9 | 5.2 | 7.2 | 3.3 | 9.7 |
| English, persistence | 2.4 | 6.6 | 6.8 | –2.7 | 2.7 | 7.2 | 3.7 | -3.0 |
| Foundational English, persistence | 4.7 | 8.5 | 8.1 | 2.9 | 5.1 | 9.3 | 8.8 | 3.1 |

*Note*: See appendix B for details on the calculations. s.d. = standard deviation. PPP = purchasing power parity. Two-year treatment: the impact for children who participated in the program for two years, in both second and third grades. Persistence: impact on children who participated only in the third grade but were tested a year later, at the end of their fourth grade.

**Table 5: Benefit-Cost Ratios for the Ghana School Feeding Programme**

| | Test scores to labor earnings | | | Test scores to years of schooling to labor earnings | | |
|---|---|---|---|---|---|---|
| | All Children | Boys | Girls | All Children | Boys | Girls |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Annual cost per student, 2017 PPP $ | 142 | 142 | 142 | 142 | 142 | 142 |
| Test score effect size, s.d.'s | 0.132 | 0.076 | 0.205 | 0.132 | 0.076 | 0.205 |
| Annual benefit per student, 2017 PPP $ (half the two-year treatment effect) | 284 | 163 | 441 | 333 | 191 | 627 |
| Benefit-cost ratio | 2.0 | 1.2 | 3.1 | 2.3 | 1.3 | 4.4 |

*Note*: See appendix B for details on the calculations. s.d. = standard deviation. PPP = purchasing power parity. Half the two-year treatment effect: The full treatment includes a two-year intervention and two years of costs. To be comparable to information on costs per year provided in Aurino et al. (2019), we use only half the estimated benefits here.

### b. Teaching at the Right Level, Second and Third Grades

Duflo, Kiessel, and Lucas (2020) report on a large experiment with five arms. The first had a teaching assistant hired through the National Youth Employment Programme to do remedial work with the weakest students during school hours. The second had the teaching assistant do remedial work after school hours. The third split classes randomly with the teacher and teaching assistant each teaching half the class and alternating groups each day. The fourth had no teaching assistant, but classroom teachers were trained in remedial methods. The fifth was a control group. The experiment involved students in second and third grades[21] in public primary schools and collected several different test scores. We focus on the scores for the English test and the "foundational" English test (a test of more basic concepts) as these are closer to the test scores used in Evans and Yuan (2019). In addition to students who participated for two years, students who were in the third grade as the experiment began participated for only one year only but were tested after two years, so their results reflect the persistence of the impact. We also consider those scores for English and foundational English.

The study began in the third term of the 2010–11 school year and continued for two additional school years, ending in 2012–13. The sample included public primary schools in 42 randomly selected districts in Ghana, stratified to ensure coverage of urban and rural areas in all the (hitherto) 10 regions in the country. The Ghana Ministry of Education designed both the training and the achievement tests.

Table 4 presents the results.[22] The costs across the first three interventions are similar, while those for the fourth are about half the others. Recall that the mains results are for students who participated for two years while the "persistence" results are for students who participated only for one year (their third grade) and then waited another year for *ex post* testing. For the main group, then, the costs to produce the results shown are twice the annual amount show in the table, while for the persistence results, the costs are for one year only.

For students participating for two years, English scores increased between 0.079 and 0.174 standard deviations, all statistically significant but not significantly different from one another.[23] For students who participated only in the first year, the results are more varied. The

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[21] The experiment actually began in the last term of first grade and extended through third grade.
[22] Table C.4 presents the monetary costs and benefits per student in terms of 2017 cedis.
[23] Standard errors reported by the authors range between 0.04 and 0.05 standard deviations for the various impacts.

remedial assistance provided only by the teacher had little impact on either test scores and the in-class remedial assistance from the teaching assistant had no impact on overall English test scores. While the other treatments have persistent impacts, they are significantly less than the impacts for those participating for two years, except for the split class approach, whose persistent impacts are as large or larger than the two-year impacts.

As with the Beg et al. (2020) results for remedial education in fourth and fifth grades, the benefit-cost ratios here are generally high except in the cases where the impact on test scores is not significantly different from zero. The ratios for the split classes are the lowest when using the tests of two-year participants, but among the highest when using the persistence results. This reflects both the stability of the test score results and the fact that the persistence results cost half as much as the main results.

Duflo, Kiessel, and Lucas allow for heterogeneous effects by gender in an appendix in their paper, but do not report the coefficient for the base case (boys), only the difference between girls and boys. This difference is always positive, that is, the effect is larger for girls, and statistically significant in three out of four specifications. Further, the authors report that the coefficient for boys is mostly statistically insignificant, so the only effect seems to be for girls.

Turkson and Baffour (2020) calculate benefit-cost ratios for two of the experimental arms in the Duflo, Kiessel, and Lucas (2020) study: in-class remedial instruction without an assistant and in-class remedial instruction with an assistant. They use somewhat different assumptions, particularly regarding future labor earnings, and the overall test score improvements rather than only for English, to find benefit-cost ratios of 8.3 and 6.0, respectively, for the two interventions.

Overall, these two studies suggest that improving the quality of primary schooling through remedial teaching at the right level provides good value for money in Ghana.

### c. Ghana School Feeding Programme

Aurino et al. (2020) report on an expansion of the Ghana School Feeding Programme (GSFP) to previously uncovered districts. The expansion was randomized by school for two years; the control schools also received the intervention after the experimental study ended. GSFP pays caterers to provide one meal per day to students in primary and junior secondary school.

The study took place over two years beginning with the 2014–15 school year, though baseline data were collected before the 2013–14 school year. The study sample was drawn from

58 districts (across all regions of the country) identified as high priority during a retargeting effort meant to better direct the program to poorer children. A variety of indicators, including standardized test scores, were collected at baseline and again at the end of the study. Delivery of GSFP under the experimental study was done in the same way as in schools that already received the program, through private caterers hired to provide the meals.

Table 5 presents the results.[24] After two years, Aurino et al. (2020) find that those receiving school meals improved 0.132 standard deviations on an English test relative to the control group. The difference was much larger for girls, 0.205 standard deviations, than boys, 0.076 standard deviations.

To calculate the costs of the intervention, Turkson and Baffour (2020) use the daily payment per student made to caterers. Noting that introduction of GSFP extended the school day by 0.36 hours per day, they add an estimate of the opportunity cost of students' and teachers' time. We have not included the opportunity cost of students' time as they must spend time eating regardless of GSFP participation, so they are just substituting time spent eating at home with time spent eating at school.[25] Rather than value teachers' time at Turkson and Baffour's estimate of teachers' wages, we use the minimum wage as it is unlikely that teachers could earn their professional salary for work done after school.[26] For benefits, we use the same calculations described at the beginning of section 4. We estimate the benefit-cost ratios for these improvements to be lower overall—2.0 to 2.3 for all children—and for boys, 1.2 to 1.3, while the results for girls are higher and more similar to those from the two teaching-at-the-right-level experiments.

Turkson and Baffour (2020) calculate a more favorable benefit-cost ratio for all students, 4.8, based on the same study, largely because they use a much higher estimate of the value of future labor earnings than we report in table C.1 or that is used by Evans and Yuan (2019).

Note that the calculations here are based only on improved test scores. There is evidence from longitudinal data that improved nutrition also increases future labor earnings (see Ramirez-Zea and Mazariegos 2020 for a review), but those improvements are for infants and preschool

[24] Table C.5 presents the monetary costs and benefits per student in terms of 2017 cedis.
[25] Regardless, this is only about 17 percent of the costs in Turkson and Baffour (2020).
[26] Regardless, this is only 4 percent of the costs in Turkson and Baffour (2020).

children. Turkson and Baffour (2020) show that there is little reason to expect gains in future labor earnings through better nutrition for primary-school-aged children due to GSFP.

### d. Distance Education

Johnston and Ksoll (2017) report on an experiment of interactive (live) distance education for public primary schools in poor, rural areas of Greater Accra and Volta regions. The schools were equipped with satellite equipment, projectors, cameras, microphones, and solar power, which allowed them to connect to a studio in Accra. Specially trained teachers for grades 2–5 provided math instruction for one hour a day and literacy instruction for another hour per day in the first year of the intervention. The teachers reduced times in the second year of the intervention, to one hour each for both math and literacy instruction on Mondays, Tuesdays, and Wednesdays for grades 2–3, and one hour each for both math and literacy instruction on Thursdays and Fridays for grades 4–5.

The intervention improved math test scores significantly by 0.23 standard deviations, but did not have a significant impact on literacy test scores. Even though the intervention ran for two years, gains in math scores after one year account for the entirety of the improvement.

The evaluation study does not provide sufficient cost information for us to calculate benefit-cost ratios, but it does report cost-effectiveness figures for improvements in math test scores.[27] Because fixed costs figure prominently in this intervention, cost-effectiveness depends on the number of years we assume the intervention will run, ranging from 0.06 standard deviations of math test scores per $100 spent for a one-year intervention to 0.10 standard deviations per $100 spent for a 10-year intervention. By comparison, Duflo, Kiessel, and Lucas (2020) report cost-effectiveness ratios for their interventions ranging from 0.21 to 0.38 standard deviations per $100 spent. It seems likely, then, that distance education will have lower benefit-cost ratios than the other interventions that produced achievement gains reviewed here, due entirely to the high cost of the distance-education intervention.

[27] Since the impact for literacy test scores is small and insignificantly different from zero, they do not report similar calculations for those tests.

### e. Summary

Table 6 summarizes our benefit-cost ratio results and, for comparison, table 7 reports the quantile values of benefit-cost ratios from the complete set of benefit-cost ratios prepared under the Ghana Priorities project. In table C.5, we also locate our estimates among the intervention-level benefit-cost ratios estimated under the Ghana Priorities project.

One of our estimates of benefit-cost ratios for remedial teaching methods is in the top quartile of the full set of benefit-cost ratios reported by the Ghana Priorities project and the rest are in the third quartile. The benefit-cost ratios for GSFP and additional years of schooling are mostly in the second quartile. However, almost all interventions examined by the Ghana Priorities project with higher benefit-cost ratios than those we estimate for remedial teaching methods are for health and nutrition interventions.[28] Calculating benefits for these interventions relies on estimates of the value of a statistical life, which are quite uncertain but tend to produce spectacular benefit-cost ratios around the world, not just in Ghana. Excluding these, our benefit-cost ratios for remedial education are among the best in the remaining sample, while those for GSFP and additional years of schooling remain in the second quartile.

**Table 6: Summary of Benefit-Cost Ratios**

| | Intervention | BCR |
|---|---|---|
| 1 | Provide teachers of grades 4–5 with training in remedial instruction | 8.3 |
| 2 | Support weaker students in grades 1–3 with remedial lessons, in class | 8.0 |
| 3 | Support weaker students in grades 1–3 with teaching assistants, after school | 7.1 |
| 4 | Support weaker students in grades 1–3 with teaching assistants, in class | 5.2 |
| 5 | Provide teachers of grades 4–5 and their supervisors with training in remedial instruction | 4.9 |
| 6 | Support weaker students in grades 1–3 with teaching assistants, split class | 3.3 |
| 7 | Provide Ghana School Feeding Programme | 3.3 |
| 8 | One additional year of basic schooling | 2.4 |
| 9 | One additional year of senior postsecondary schooling | 1.9 |
| 10 | One additional year of secondary schooling | 1.8 |

*Note*: BCR = benefit-cost ratio. BCR for rows 1, 2, 4, and 5 is the average of BCRs for the full test of English and the test of foundational English calculated via test scores only and via equivalent years of additional schooling. BCR for rows 3 and 6 is the average of BCRs for the combined English and math test and the English-only test calculated via test scores only and via equivalent years of additional schooling. BCR for row 7 is the average of BCRs calculated via test scores only and via equivalent years of additional schooling. BCR for rows 8 to 10 are the average of BCRs for each year of schooling at each level; primary and junior secondary are years 1 to 9; senior secondary is years 10 to 12; postsecondary is over 12 years.

[28] The rest are usually administrative reforms that require little in the way of budget.

**Table 7: Distribution of Benefit-Cost Ratios of Various Selected Interventions in Ghana, Ghana Priorities**

| | Quantile | | | | |
|---|---|---|---|---|---|
| | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
| | (1) | (2) | (3) | (4) | (5) |
| BCRs, all interventions | 1.2 | 1.7 | 3.3 | 8.0 | 34.0 |
| BCRs, w/o health and nutrition interventions | 1.2 | 1.6 | 2.5 | 5.1 | 9.0 |

*Source:* Information obtained from the Ghana Priorities project. See https://www.copenhagenconsensus.com/sites/default/files/ghana_outcome_doc.pdf (Accessed January 28, 2022).

*Note*: BCR = benefit-cost ratio.

## 5 Conclusion

We have estimated benefit-cost ratios for spending on public schooling in Ghana. The measures of public schooling we look at are the quantity of schooling in terms of years of schooling completed, as well as gains in test scores from selected interventions in public schools. Although imprecise, we refer to these interventions as quality improvements. Our motivation is to consider both the value for money that Ghana gets for this spending and to compare the benefit-cost ratios to similar ratios for a wide variety of public spending options. In relation to quality improvements, we have limited our analysis to studies that have good prospects for identifying the impact of a particular type of spending on test scores. There are few of these, covering only variations of remedial teaching methods in primary school and school feeding. Clearly, interventions that yield quality improvements involve much more than this, an argument for further experimental studies on what produces good schooling outcomes in Ghana. For the quantity of schooling, there is only one as yet incomplete experimental study, so we resort to a standard approach to the problem, Mincer labor earnings regressions.

In general, we find that the benefit-cost ratios are greater than one, so public spending on schooling in Ghana provides good value for money. We also find that several different types of remedial teaching methods have considerably higher benefit-cost ratios than does providing an additional year of schooling at any level. This suggests that the returns to improving the teaching of students already in school may be higher than getting more students in school, an uncomfortable policy dilemma, particularly in light of the fact that children not currently in school are likely to be among the poorest and most disadvantaged in the country.[29] In this regard, one of the results of the Aurino et al. (2019) study of the Ghana School Feeding Programme is that the impact on test scores is significantly higher for girls, for children living in poor households, and for children living in the northern regions (the most disadvantaged regions) of the country. This highlights the possibility that an intervention with a modest benefit-cost ratio overall can nevertheless be equity improving, something that may soften the dilemma, but not eliminate it.

There are two reasons to be cautious about this conclusion, however. First, the results for the quality-of-schooling interventions are for a *marginal* expenditure that, one supposes, benefits from the existing expenditure on schooling in general, while the costs for the quantity-of-schooling analysis are *average* expenditures. If we were to force the marginal intervention to pay some share of the average costs of schooling, it would lower the benefit-cost ratios for the marginal interventions. Unfortunately, we can think of no coherent way to do this. Second, the impact estimates on test scores are all short-run effects over one or two years which we assume persist through time and are reflected in higher labor earnings as estimated by Evans and Yuan (2019) who use a contemporaneous correlation between test scores and labor earnings for their estimates. Our estimates, however, are for changes in test scores while in school, the effect of which may fade over time. We have assumed that they do not in our calculations.[30] If that is wrong, our calculations would overestimate the future labor earnings gains and, thus, the benefit-cost ratios for the quality-of-schooling interventions.

There is much else to be cautious of in these estimates. For our quantity estimates, the limitations of Mincer regressions are well-established and discussed. While it seems natural that OLS estimates should be biased upwards, in fact, there are theoretical reasons for the bias to go either way, as discussed in Card (1999). Further, the fact that these estimates vary in a fairly narrow range over time and across countries gives us some confidence in them despite the possible biases.

[29] While none of the studies we use except Aurino et al. (2019) was designed to break down results by poverty status, it seems likely that students most in need of better remedial teaching methods are also among the poorest students.

[30] Some studies find that these effects of interventions fade with time and others do not. We are unaware of any studies in Ghana that attempt to estimate the potential fading of effects of these interventions. Evans and Yuan (2019) discuss the literature on the problem of fading effects and how it affects calculations such as the ones we do here.

For the estimates of quality improvements, we have used experimental evidence, but only for the link between any particular intervention and outcomes on standardized tests. To obtain *monetary* benefits, we must again rely on nonexperimental evidence linking test scores to future labor earnings, or test scores to additional years of schooling to future labor earnings. In both instances, we rely on Evans and Yuan (2019) who, fortunately for our work, include Ghana as one of their case studies. Those estimates are, presumably, subject to most of the potential biases of Mincer regressions. In addition, while all the tests used to evaluate the effectiveness of the various interventions are similar, they are not identical, nor are they identical to the tests used in Evans and Yuan (2019). So, in effect, we must assume that a standard-deviation improvement in scores in each of these tests measures the same thing. While it might seem desirable to standardize such tests in all trials, that probably is not possible even within a country, let alone internationally. Instead, a better sense of how a one-standard-deviation improvement in scores in each test relates to all other tests would be helpful.

All studies of the impact of schooling on future labor earnings face the problem of the long time lag between schooling and labor earnings. Even if one were to run a careful experiment and follow the children into their labor-earning years, there is no guarantee of external validity for children in the future once the study's results are known.

Given these problems, it might seem better to eschew benefit-cost analysis for cost-effectiveness analysis, as in Kremer et al. (2013). What we gain from the extra analysis needed to establish benefit-cost ratios is the ability to compare spending in other areas that is not meant to improve test scores. For policy makers who must determine budget priorities across many fields, not just with respect to the education sector and its outcomes, this is useful information.

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## Appendix A

## Mincer Labor Earnings Regressions

## Definitions of Selected Variables

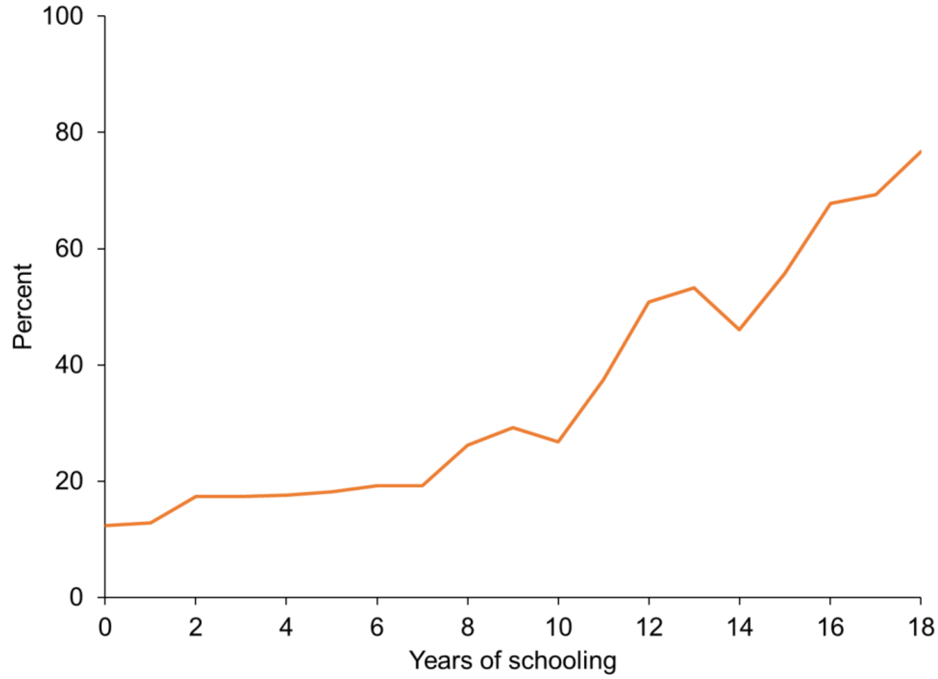
*Labor earnings from wage employment*

We estimate total monthly labor earnings as wages and salaries, other cash payments, and in-kind payments from primary and secondary jobs held in the past two weeks. This information is drawn from sections 4a and 4b of the 2016/17 GLSS questionnaire. In the questionnaire, these amounts can be reported for variable time periods (hourly, daily, weekly, etc., up to annual). We checked for outliers that may have been generated from miscoding the time period by comparing reported (individual) labor earnings to total reported household consumption. For 81 reported wage values and three in-kind receipts from primary jobs, we adjusted the reported time period to make the monthly earnings more consistent with reported household consumption. We made the same adjustment for 11 reported wage values and one in-kind receipt from secondary jobs.

Note that we include only those individuals who report labor earnings as wage or salaried employees as labor earnings data for other categories of workers are unavailable in the 2016/17 GLSS. If part of the return to schooling is to select out of self-employment (especially farming and trade services, where average labor earnings are presumably low) and into wage-employment, our exclusion of the self-employed may bias down our estimates of the returns to schooling because we exclude people who have both below-average years of schooling and presumed below-average labor earnings.

Figure A.1 shows the share of employed workers ages 15–60 who are in wage or salaried jobs by years of schooling completed. The share is flat, in the range of 10 to 20 percent, through primary and junior secondary schooling, but increases sharply after that.

**Figure A.1: Wage Employment Share among Employed Workers, by Years of Schooling, 2016/17**




*Source*: Authors' estimations based on data obtained from the 2016/17 GLSS.

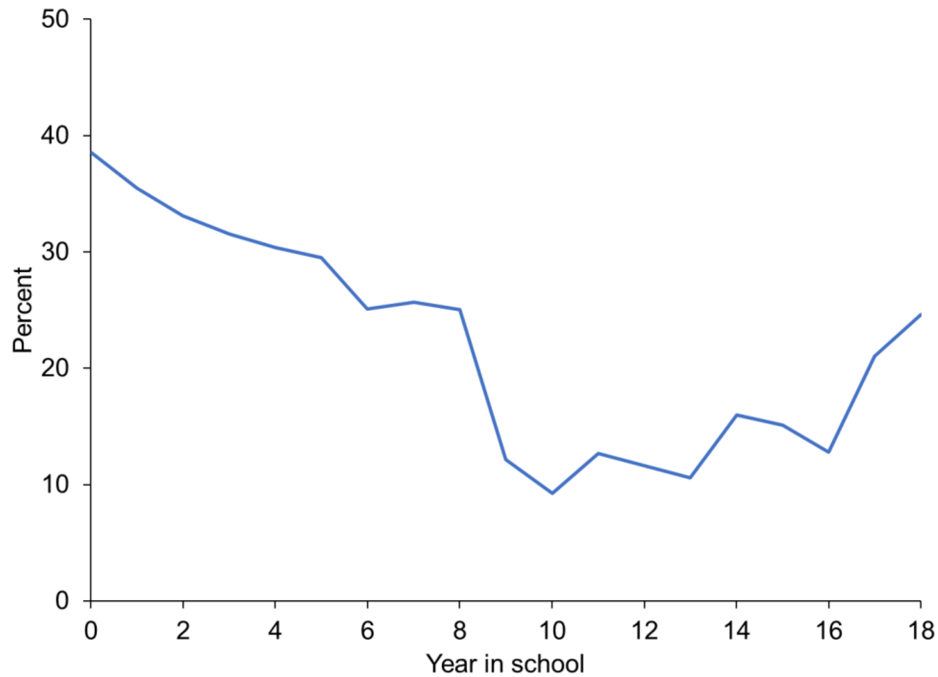
*Note*: Wage employment = wage or salaried employee.

### *Years of schooling*

We use the information reported in question 2 of section 2, part A in the GLSS questionnaire to calculate years of schooling completed, distinguishing between the old system (nine years of primary, four years of O-level, two years of A-level) and the new system (six years of primary, three years of junior secondary, three years of senior secondary). We do not count years of preschool or kindergarten. Because few observations report more than 18 years of schooling, we cap the years at 18.

Note that we cannot distinguish between public and private schooling for those not currently attending school (which is everyone in our sample of wage-employed workers), so we assume that the returns to a year of public schooling and private schooling are the same. If private schooling is actually more/less productive than public schooling, this would bias our estimates of the returns to public schooling up/down. Figure A.2 shows the share of students enrolled in private school by current year in school. The share is around 30 percent at the primary and junior secondary school levels. It drops to around 15 percent at the senior secondary and university levels, which have the highest estimated rates of return in our sample.

**Figure A.2: Private School Share of Current Students, by Current Year in School, 2016/17**




*Source*: Authors' estimations based on data obtained from the 2016/17 GLSS.

### *Parents' years of schooling*

We use information reported in question 2 of section 2, part A of the GLSS questionnaire for parents living in the respondent's household, and information from questions 16 and 20 of section 1 of the questionnaire for parents who do not. Because the latter report only highest level of schooling completed, we generate indicators for having completed primary, middle/junior secondary school, secondary/senior secondary school, postsecondary vocational/technical including teacher education and nursing, and university, for mother's and father's schooling. For those individuals who do not know a parent's schooling level, we assumed none.

*Years of experience*

The 2016/17 GLSS questionnaire does not ask about experience in either current or all jobs, so we use age less years of schooling completed less five as our measure of labor market experience, essentially assuming that everyone who is currently working has worked continuously since leaving school, and also that no one repeats one or more years of school. This is a common assumption (for example, see Glewwe 1996).

## Appendix B

## Value of Achievement Gains from Interventions in Public Schools

## Calculations of Costs and Benefits

### 1 Teaching at the Right Level, Fourth and Fifth Grades

#### Costs

Beg et al. (2020) report that the cost is $29.22 per student for the teacher-only training and $52.62 for the teacher, head teacher, and circuit supervisor training, both expressed in 2018 dollars and converted from cedis at market exchange rates. To be comparable to other estimates herein, we reconverted these dollar values to cedis at the average market exchange rate in 2018, deflated to 2017 cedis using gross domestic product (GDP) deflators for the relevant years, and converted to international dollars using the purchasing power parity (PPP) conversion factor for GDP in 2017. That is:

$$C_{2017,PPP\$} = C_{2018,\$} \times er_{2018} \times \frac{GDPD_{2017}}{GDPD_{2018}} / PPP_{2017},$$

where $C_{2018,\$}$ is reported in Beg et al. (2020, p. 22); $er_{2018}$ is the average market exchange rate in 2018, in cedis per dollar; $GDPD_{2017}$ and $GDPD_{2018}$ are the Ghanaian GDP deflators in 2017 and 2018, respectively; and $PPP_{2017}$ is the PPP conversion factor for GDP in 2017, in cedis per international dollar. The values for the Ghanaian GDP deflators and the PPP conversion factor for GDP (the PPP exchange rate) were obtained from the World Bank's World Development Indicators (WDI) databank.

Note that the large difference in the cost estimates we report in section 4 from those reported in Beg et al. (2020) reflect the substantial difference between market and PPP exchange rates.

### Benefits

In our first approach, we estimate benefits as the net present value (NPV) of the increases in labor earnings over a working life, assumed to be ages 15–60. That is, we assume that all participants will finish junior secondary school (at age 15) and begin to work. The equation is as follows:

$$B_{2017,PPP\$} = \sum_{t=15}^{60} \frac{\Delta E_{2017,PPP\$}}{\left(1+d\right)^{(t-12)}},$$

where $\Delta E$ is the annual change in labor earnings, assumed to be constant and described below; $d$ is the discount rate, assumed to be 8 percent; and we assume that labor earnings begin three years after the intervention since the average age of study participants is 12 (Beg et al. 2020, p. 15).

We calculate the annual change in labor earnings following Evans and Yuan (2019), multiplying the estimated change in test scores (in standard deviations) to their Ghana-specific estimate of the effect of a one-standard-deviation improvement in reading test scores on labor earnings, which is 0.178 (Evans and Yuan 2019, table 4).[31] As in Evans and Yuan, we base the percentage increase in the labor share of GDP times gross national income (GNI) per capita (in cedis), both in 2017. We then convert to international dollars using the PPP conversion factor for GDP in 2017. That is:

$$\Delta E_{2017,PPP\$} = \Delta TS \times 0.178 \times LS_{2017} \times GNIpc_{2017} \,/\, PPP_{2017},$$

where $\Delta TS$ is the average change in the test scores from the intervention; 0.178 is the Evans and Yuan coefficient; $LS_{2017}$ is the labor share of GDP in 2017; $GNIpc_{2017}$ is GNI per capita in 2017, in cedis; and $PPP_{2017}$ is the PPP conversion factor for GDP in 2017, in cedis per international dollar. The values for GNI per capita and the PPP conversion factor for GDP were obtained from the World Bank's WDI databank, and the value for the labor share of GDP was obtained from the ILO's ILOSTAT database.

[31] We assume that all changes in test scores have the same effect per standard deviation, regardless of the test because we have no other such estimates.

Our second approach uses Evans and Yuan's (2019) Ghana-specific estimate of the effect of a one-standard-deviation improvement in test scores on equivalent years of schooling completed, which is 4.4 (Evans and Yuan 2019, table 2).[32] We then multiply that gain in equivalent years of schooling by our own estimate of the NPV of completing one year of schooling at the fifth grade (the grade which corresponds to the age of the study participants), 1,727 cedis per year in 2017 prices (table C.1). We then convert to international dollars using the PPP conversion factor for GDP in 2017. That is:

$$B_{2017,PPP\$} = \Delta TS \times 4.4 \times 1,727 / PPP_{2017},$$

where $\Delta TS$ is the average change in the test scores from the intervention; 4.4 is the Evans and Yuan (2019) coefficient; 1,727 is our estimate of the NPV of the lifetime gain from completing fifth grade conditional on having completed fourth grade, in 2017 cedis; and $PPP_{2017}$ is the PPP conversion factor for GDP in 2017, in cedis per international dollar.

## 2 Teaching at the Right Level, Second and Third Grades

### Costs

We take the costs, which are reported in 2012 and 2013 dollars, directly from Duflo, Kiessel, and Lucas (2020, p. 21). We reconvert these to cedis using the average market exchange rate over those two years, inflate to 2017 prices using the Ghanaian GDP deflators for the relevant years, and convert to 2017 international dollars using the PPP conversion factor for GDP in 2017.

### Benefits

In our first approach, we estimate benefits as the NPV of the increases in labor earnings over a working life, assumed to be ages 15–60. That is, we assume that all participants will finish junior secondary school (at age 15) and begin to work. The equation is as follows:

[32] This is Evans and Yuan's regression-based estimate and is the lowest of all the countries they report. Their simple learning trajectory estimate is more than double that, 10.1, and is among the highest that they report.

$$B_{2017,PPP\$} = \sum_{t=15}^{60} \frac{\Delta E_{2017,PPP\$}}{(1+d)^{(t-9)}},$$

where $\Delta E$ is the annual change in labor earnings, assumed to be constant and described below; $d$ is the discount rate, assumed to be 8 percent; and we assume that labor earnings begin six years after the intervention ends in third grade where the typical age of the study participant is 9 years at completion of this grade (Duflo, Kiessel, and Lucas 2020, p. 28).

For the main intervention, these benefits are the result of two years of remedial education and the associated costs, so we divide them by two to report an annual average gain comparable to the annual cost. The "persistence" interventions, however, lasted only one year so we use their full value.

We calculate the annual change in labor earnings following Evans and Yuan (2019), multiplying the estimated change in test scores (in standard deviations) times their Ghana-specific estimate of the effect of a one-standard-deviation improvement in reading test scores on labor earnings, which is 0.178.[33] As in Evans and Yuan, we base the percentage increase in the labor share of GDP times GNI per capita (in cedis), both measured in 2017. We then convert to international dollars using the PPP conversion factor for GDP in 2017. That is:

$$\Delta E_{2017,PPP\$} = \Delta TS \times 0.178 \times LS_{2017} \times GNIpc_{2017} / PPP_{2017},$$

where $\Delta TS$ is the average change in the test scores from the intervention; 0.178 is the Evans and Yuan coefficient; $LS_{2017}$ is the labor share of GDP in 2017; $GNIpc_{2017}$ is GNI per capita in 2017, in cedis; and $PPP_{2017}$ is the PPP conversion factor for GDP in 2017, in cedis per international dollar.

Our second approach uses the Evans and Yuan's (2019) Ghana-specific estimate of the effect of a one-standard-deviation improvement in test scores on equivalent years of schooling completed, which is 4.4. We then multiply that gain in equivalent years of schooling times our own estimate of the NPV of completing one year of schooling at the third grade (the grade that

[33] We assume that all changes in test scores have the same effect per standard deviation, regardless of the test because we have no other such estimates.

corresponds to the typical age of the study participants), 1,423 cedis per year in 2017 prices (table C.1). We then convert to international dollars using the PPP conversion factor for GDP in 2017. That is:

$$B_{2017,PPP\$} = \Delta TS \times 4.4 \times 1,423 / PPP_{2017},$$

where $\Delta TS$ is the average change in the test scores from the intervention; 4.4 is the Evans and Yuan (2019) coefficient; 1,423 is our estimate of the relevant NPV of the lifetime gain from completing third grade conditional on having completed second grade, in 2017 cedis; and $PPP_{2017}$ is the PPP conversion factor for GDP in 2017, in cedis per international dollar.

## 3 Ghana School Feeding Programme

### Costs

The GSFP evaluation study by Aurino et al. (2020) does not report costs, but Turkson and Baffour (2020) calculate the costs as the payment per student made to caterers plus the opportunity cost of time for students and teachers. We take the same approach, but use different parameters. We exclude the opportunity cost of students' time (but not teachers') since they would have to take time to eat whether at school or not. The caterer payment was 0.8 cedis per student per day in 2014, the year the evaluation study was conducted. Aurino et al. find that on average teachers spent 0.36 hours more per day at school due to the school feeding program. We assume 30 students per class (as in Turkson and Baffour 2020) and an eight-hour working day, and we calculate the opportunity cost of teachers' time at the minimum wage in 2014, or 6 cedis per day.[34] Finally, to obtain annual costs, we multiply the daily cost per student by 200 school days per year. All values are deflated to 2017 using Ghanaian GDP deflators and converted to international dollars using the PPP conversion factor for GDP in 2017. That is:

$$C_{2017,PPP\$} = 200 \times \left(0.8 + \left[6 \times \left(0.359/8\right)/30\right]\right) \times \frac{GDPD_{2017}}{GDPD_{2014}} / PPP_{2017},$$

[34] Turkson and Baffour (2020) use a much higher value, the average salary of teachers.

where 200 is the number of school days per year; 0.8 is the per student per day payment to caterers, in cedis; the term in brackets is the opportunity cost of teachers' time, in cedis (6 is the minimum wage in 2014, in cedis; 0.359/8 is the estimated number of extra hours per day for teachers' work; and 30 is the number of students per teacher); $GDPD_{2014}$ and $GDPD_{2017}$ are Ghanaian GDP deflators for 2014 and 2017, respectively; and $PPP_{2017}$ is the conversion factor for GDP in 2017, in cedis per international dollar.

## Benefits

Even though GSFP is ostensibly a nutrition program, Gelli et al. (2019) find little in the way of nutrition or health benefits for participants. So, as in Turkson and Baffour (2020), we include only benefits associated with improved test scores.

In our first approach, we estimate benefits as the NPV of increases in labor earnings over a working life, assumed to be ages 15–60 years. That is, we assume that all participants will finish junior secondary school (at age 15) and begin to work. The equation is as follows:

$$B_{2017,PPP\$} = \sum_{t=15}^{60} \frac{\Delta E_{2017,PPP\$}}{\left(1+d\right)^{(t-11)}},$$

where $\Delta E$ is the annual change in labor earnings, assumed to be constant and described below; $d$ is the discount rate, assumed to be 8 percent; and we assume that labor earnings begin three years after the intervention since the average age of participants is 12 at the end of the intervention. The target beneficiaries for the intervention range from ages 5 to 15 (Aurino et al. 2019, p. 12).

We calculate the annual change in labor earnings following Evans and Yuan (2019), multiplying the estimated change in test scores (in standard deviations) times their Ghana-specific estimate of the effect of a one-standard-deviation improvement in reading test scores on labor earnings, which is 0.178.[35] As in Evans and Yuan, we base the percentage increase in the labor share of GDP times GNI per capita, both measured in 2017. We then convert to international dollars using the PPP conversion factor for GDP in 2017. That is:

[35] We assume that all changes in test scores have the same effect per standard deviation, regardless of the test because we have no other such estimates.

$$\Delta E_{2017,PPP\$} = \Delta TS \times 0.178 \times LS_{2017} \times GNIpc_{2017} / PPP_{2017},$$

where $\Delta TS$ is the average change in the test scores from the intervention; 0.178 is the Evans and Yuan (2019) coefficient; $LS_{2017}$ is the labor share of GDP in 2017; $GNIpc_{2017}$ is GNI per capita in 2017, in cedis; and $PPP_{2017}$ is the PPP conversion factor for GDP in 2017, in cedis per international dollar.

Our second approach uses the Evans and Yuan's (2019) Ghana-specific estimate of the effect of a one-standard-deviation improvement in test scores on equivalent years of schooling completed, which is 4.4. We then multiply that gain in equivalent years of schooling times the average of our own estimate of the NPV of completing one year of school conditional on having completed the previous year, from first grade through the end of junior secondary school, which is 2,023 cedis per year in 2017 prices (see table C.1 for NPVs for each relevant grade). That is:

$$B_{2017,PPP\$} = \Delta TS \times 4.4 \times 2,023 / PPP_{2017},$$

where $\Delta TS$ is the average change in the test scores from the intervention; 4.4 is the Evans and Yuan coefficient; 2,023 is our estimate of the relevant average NPV, in 2017 cedis; and $PPP_{2017}$ is the PPP conversion factor for GDP in 2017, in cedis per international dollar.

# Appendix C

## Supplemental Tables

This appendix reproduces tables 2–5 in terms of 2017 cedis, in tables C.1–C.4. All the equations discussed in appendix B apply to tables C.2–C.4, without the term for the conversion to international dollars using the PPP conversion factor for GDP in 2017. The appendix also provides a table—table C.5—that places our benefit-cost ratio estimates from section 4 in the full list of benefit-cost ratio estimates for a wide range of interventions produced under the Ghana Priorities project.

**Table C1: Net Present Value of an Additional Year of Schooling, by Years of Schooling Completed, 2017 Cedis**

| Years of schooling | Probability of advancing an additional year of schooling | | | Public costs (cedis) | Private costs (cedis) | | | Wage-employed workers, ages 15–45 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | All | | Men | Women |
| | All | Male | Female | | All | Male | Female | One-year NPV (cedis) | Forward-looking NPV (cedis) | Forward-looking NPV (cedis) | Forward-looking NPV (cedis) |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| 0 | 0.87 | 0.91 | 0.84 | 0 | | | | -- | -- | -- | -- |
| 1 | 0.99 | 0.99 | 0.99 | 367 | 124 | 127 | 122 | 4,756 | 1,683 | 1,248 | 1,326 |
| 2 | 0.98 | 0.99 | 0.98 | 367 | 124 | 127 | 122 | 6,146 | 1,791 | 1,314 | 1,435 |
| 3 | 0.98 | 0.98 | 0.97 | 367 | 124 | 127 | 122 | 5,103 | 1,853 | 1,323 | 1,563 |
| 4 | 0.97 | 0.98 | 0.97 | 367 | 124 | 127 | 122 | –3,137 | 1,911 | 1,408 | 1,710 |
| 5 | 0.95 | 0.95 | 0.95 | 367 | 124 | 127 | 122 | –1,934 | 2,220 | 1,758 | 1,822 |
| 6 | 0.91 | 0.93 | 0.90 | 367 | 124 | 127 | 122 | 1,441 | 2,633 | 2,300 | 2,000 |
| 7 | 0.91 | 0.92 | 0.90 | 790 | 235 | 241 | 229 | 184 | 2,963 | 2,566 | 2,749 |
| 8 | 0.90 | 0.91 | 0.89 | 790 | 235 | 241 | 229 | 2,404 | 3,488 | 3,140 | 3,318 |
| 9 | 0.60 | 0.64 | 0.56 | 790 | 235 | 241 | 229 | 3,497 | 3,894 | 3,679 | 3,852 |
| 10 | 0.86 | 0.87 | 0.84 | 1,015 | 1,322 | 1,229 | 1,432 | 488 | 4,491 | 3,482 | 6,705 |
| 11 | 0.90 | 0.90 | 0.90 | 1,015 | 1,322 | 1,229 | 1,432 | 2,891 | 5,561 | 4,392 | 8,700 |
| 12 | 0.48 | 0.48 | 0.47 | 1,015 | 1,322 | 1,229 | 1,432 | 3,554 | 6,326 | 5,131 | 9,716 |
| 13 | 0.92 | 0.92 | 0.92 | 1,881 | 3,422 | 3,466 | 3,359 | –2,437 | 10,129 | 8,385 | 12,141 |
| 14 | 0.99 | 0.99 | 1.00 | 1,881 | 3,422 | 3,466 | 3,359 | 23,527 | 12,111 | 10,577 | 14,155 |
| 15 | 0.85 | 0.85 | 0.85 | 1,881 | 3,422 | 3,466 | 3,359 | 31,627 | 13,013 | 11,318 | 15,283 |
| 16 | 0.74 | 0.77 | 0.68 | 1,881 | 3,422 | 3,466 | 3,359 | 13,553 | 10,392 | 7,725 | 15,564 |
| 17 | 0.43 | 0.44 | 0.39 | 1,881 | 3,422 | 3,466 | 3,359 | 2,296 | 9,959 | 6,500 | 13,060 |
| 18 | 0.00 | 0.00 | 0.00 | 1,881 | 3,422 | 3,466 | 3,359 | 22,140 | 22,140 | 14,960 | 25,194 |

*Source*: Authors' estimations based on data from the 2016/17 GLSS and the Ghana Ministry of Education.

*Note*: NPV = net present value. Discount rate for the calculations is 8 percent. Calculations assume a working life from age 15 to 60, except when the individual is in school; they also assume that students have no labor earnings. The probability of advancing an additional year of schooling is estimated for all individuals ages 15–45. We use advancement probabilities and private costs for each gender in the gender-specific results, and the "all" columns for the results that combine both genders.

**Table C.2: Benefit-Cost Ratio Estimates for Teaching at the Right Level, Fourth and Fifth Grades**

| | Test scores to labor earnings | | Test scores to years of schooling to labor earnings | |
|---|---|---|---|---|
| | Teacher-only training<br>(1) | Teacher, head teacher, and circuit supervisor training<br>(2) | Teacher-only training<br>(3) | Teacher, head teacher, and circuit supervisor training<br>(4) |
| **Cost per student, 2017 cedis** | 121 | 218 | 121 | 218 |
| **Test score effect size, s.d.'s** | | | | |
| Combined math/English | 0.108 | 0.107 | 0.108 | 0.107 |
| English | 0.065 | 0.076 | 0.065 | 0.076 |
| **Benefit per student, 2017 cedis** | | | | |
| Combined math/English | 820 | 813 | 1,682 | 1,666 |
| English | 494 | 577 | 1,012 | 1,184 |
| **Benefit-cost ratio** | | | | |
| Combined math/English | 6.8 | 3.7 | 13.9 | 7.6 |
| English | 4.1 | 2.6 | 8.4 | 5.4 |

*Note*: See appendix B for data sources and calculations. s.d. = standard deviation.

**Table C.3: Benefit-Cost Ratio Estimates for Teaching at the Right Level, Second and Third Grades**

| | Test scores to labor earnings | | | | Test scores to years of schooling to labor earnings | | | |
|---|---|---|---|---|---|---|---|---|
| | In-class remedial, with assistant | After-school remedial, with assistant | Split class, with teacher and assistant | In-class remedial, no assistant | In-class remedial, with assistant | After-school remedial, with assistant | Split class, with teacher and assistant | In-class remedial, no assistant |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Annual cost per student, 2017 cedis** | 81 | 81 | 78 | 44 | 81 | 81 | 78 | 44 |
| **Test score effect size, s.d.'s** | | | | | | | | |
| English, two-year treatment | 0.129 | 0.174 | 0.079 | 0.085 | 0.129 | 0.174 | 0.079 | 0.085 |
| Foundational English, two-year treatment | 0.127 | 0.178 | 0.077 | 0.130 | 0.127 | 0.178 | 0.077 | 0.130 |
| English, persistence | 0.033 | 0.089 | 0.088 | –0.020 | 0.033 | 0.089 | 0.088 | –0.020 |
| Foundational English, persistence | 0.063 | 0.114 | 0.104 | 0.021 | 0.063 | 0.114 | 0.104 | 0.021 |
| **Annual benefit per student, 2017 cedis** | | | | | | | | |
| English, two-year treatment | 389 | 525 | 238 | 256 | 462 | 624 | 283 | 305 |
| Foundational English, two-year treatment | 383 | 537 | 232 | 392 | 455 | 638 | 276 | 466 |
| English, persistence | 199 | 537 | 531 | –121 | 237 | 638 | 315 | -143 |
| Foundational English, persistence | 380 | 687 | 627 | 127 | 452 | 817 | 746 | 151 |
| **Benefit-cost ratio** | | | | | | | | |
| English, two-year treatment | 4.8 | 6.5 | 3.1 | 5.8 | 5.7 | 7.7 | 3.6 | 6.9 |
| Foundational English, two-year treatment | 4.7 | 6.6 | 3.0 | 8.9 | 5.6 | 7.8 | 3.5 | 10.5 |
| English, persistence | 2.4 | 6.6 | 6.8 | –2.7 | 2.9 | 7.8 | 4.1 | –3.2 |
| Foundational English, persistence | 4.7 | 8.5 | 8.1 | 2.9 | 5.6 | 10.0 | 9.6 | 3.4 |

*Note*: See appendix B for data sources and calculations. s.d. = standard deviation. Two-year treatment: the impact for children who participated in the program for two years, in both second and third grades. Persistence: impact on children who participated only in the third grade but were tested a year later, at the end of their fourth grade.

**Table C.4: Benefit-Cost Ratio Estimates for the Ghana School Feeding Programme**

| | Test scores to labor earnings | | | Test scores to years of schooling to labor earnings | | |
|---|---|---|---|---|---|---|
| | All children (1) | Boys (2) | Girls (3) | All children (4) | Boys (5) | Girls (6) |
| Annual cost per student, 2017 cedis | 250 | 250 | 250 | 250 | 250 | 250 |
| Test score effect size, s.d.'s | 0.132 | 0.076 | 0.205 | 0.132 | 0.076 | 0.205 |
| Annual benefit per student, 2017 cedis (half the two-year treatment effect) | 501 | 288 | 779 | 724 | 347 | 991 |
| Benefit-cost ratio | 2.0 | 1.2 | 3.1 | 2.9 | 1.4 | 4.0 |

*Note*: See appendix B for data sources and calculations. s.d. = standard deviation. Half the two-year treatment effect: The full treatment includes a two-year intervention and two years of costs. To be comparable to information on costs per year provided in Aurino et al. (2019), we use only half the estimated benefits here.

**Table C.5: Comparison with Intervention-Level Benefit-Cost Ratio Estimates under the Ghana Priorities Project**

| Sector | Investment/Intervention | BCR |
|---|---|---|
| Health: Infectious diseases | Tuberculosis patient education for adherence | 190.0 |
| Health: Infectious diseases | Logistics for faster and more accurate tuberculosis testing | 166.0 |
| Health: Infectious diseases | Universal malaria testing and health facility treatment | 133.0 |
| Land and natural resources | Land titling program | 91.0 |
| Health: Infectious diseases | Raise and sustain coverage of malaria bed nets | 44.0 |
| Health: Infectious diseases | Active tuberculosis case finding in high-risk groups | 38.0 |
| Health systems and access | Strengthen community health system (GEHIP) | 38.0 |
| Nutrition | Complementary feeding promotion | 36.0 |
| Gender and equality | Family planning for married women | 34.0 |
| Gender and equality | Family planning for unmarried women | 29.0 |
| Health systems and access | Health worker home visits for pregnant and newborn | 28.0 |
| Nutrition | Breastfeeding promotion | 24.0 |
| Health systems and access | Incentive schemes for health workers in remote areas | 21.0 |
| Health systems and access | Ambulance maintenance in rural areas | 21.0 |
| Fisheries | Monitoring devices on trawl ships | 21.0 |
| Nutrition | Micronutrients and calcium in pregnancy | 18.0 |
| Health: Infectious diseases | Preventive malaria medicine for children in Guinea Savannah | 14.0 |
| Trade and industrialization | Credit reference bureau | 12.0 |
| Trade and industrialization | Management training for medium-sized enterprises | 10.0 |
| Governance | Digitized property and business fees | 9.0 |
| Energy and air pollution | Improved cookstoves promotion to reduce rural air pollution | 9.0 |
| **Education: Our estimates** | **Provide teachers of grades 4–5 with training in remedial instruction** | **8.3** |
| Energy and air pollution | Improved cookstoves promotion to reduce urban air pollution | 8.0 |
| Education | Organize all 1-3 graders according to learning level | 8.0 |
| **Education: Our estimates** | **Support weaker students in grades 1–3 with remedial lessons, in class** | **8.0** |
| **Education: Our estimates** | **Support weaker students in grades 1–3 with teaching assistants, after school** | **7.1** |
| Trade and industrialization | Capital grants for micro enterprises | 7.0 |
| Mental health | Depression screening and treatment | 7.0 |
| Trade and industrialization | Management consults for large manufacturers | 6.0 |
| Health systems and access | Emergency obstetric and neonatal care (EmONC) | 6.0 |
| Education | Support weaker 1-3 graders with teaching assistants | 6.0 |
| **Education: Our estimates** | **Support weaker students in grades 1–3 with teaching assistants, in class** | **5.2** |
| Fisheries | Replacement of illegal gears | 5.1 |
| Water and sanitation | Sludge to energy plants | 5.0 |

**Table C.5: Comparison with Intervention-Level Benefit-Cost Ratio Estimates under the Ghana Priorities Project**

| Sector | Investment/Intervention | BCR |
|---|---|---|
| Water and sanitation | Subsidize urban toilet constructions | 5.0 |
| **Education: Our estimates** | **Provide teachers of grades 4–5 and their supervisors with training in remedial instruction** | **4.9** |
| Education | Expand school feeding | 4.8 |
| Water and sanitation | Biogas to energy plants | 4.7 |
| Mental health | Anxiety disorders screening and treatment | 4.6 |
| Energy and air pollution | Electricity grid for less remote communities | 4.5 |
| Water and sanitation | Stabilization ponds for remote areas | 4.4 |
| Agriculture | Extend fertilizer subsidies | 4.4 |
| Water and sanitation | Enforcement by-laws and latrine subsidies in urban areas | 4.2 |
| Gender and equality | Community dialogues on schooling & early marriage | 3.8 |
| Agriculture | Hybrid maize seed subsidies | 3.6 |
| Health systems and access | Mass screening and treatment of hypertension | 3.3 |
| **Education: Our estimates** | **Support weaker students in grades 1–3 with teaching assistants, split class** | **3.3** |
| Water and sanitation | Comprehensive fecal sludge treatment plants | 2.9 |
| Gender and equality | Free school uniforms for girls | 2.9 |
| Agriculture | Increase mechanization through tractor services | 2.8 |
| Gender and equality | Conditional asset transfer for girls enrolled in school | 2.7 |
| Education | Apprenticeships | 2.4 |
| **Education: Our estimates** | **Provide Ghana School Feeding Programme** | **2.4** |
| **Education: Our estimates** | **Provide one additional year of basic education** | **2.4** |
| Agriculture | OPV maize seed subsidies | 2.3 |
| Gender and equality | Compulsory sexual and reproductive health education for high school boys and girls | 2.2 |
| Health systems and access | Eliminate NHIS premiums for the poor | 2.1 |
| Energy and air pollution | Expanded rural liquified petroleum gas distribution for cooking | 2.1 |
| Trade and industrialization | Reduced industrial electricity tariff | 1.9 |
| Energy and air pollution | Reduced liquified petroleum gas tax for cooking | 1.9 |
| **Education: Our estimates** | **Provide one additional year of postsecondary education** | **1.9** |
| **Education: Our estimates** | **Provide one additional year of senior secondary education** | **1.8** |
| Housing and urbanization | Storm drain widening | 1.8 |
| Gender and equality | Poverty graduation | 1.8 |
| Energy and air pollution | Diesel microgrids for more remote communities | 1.8 |
| Agriculture | Build warehouses to reduce post-harvest losses | 1.8 |
| Water and sanitation | Rural community led total sanitation with latrine subsidies | 1.7 |
| Energy and air pollution | Solar microgrids for more remote communities | 1.7 |
| Mental health | Schizophrenia screening and treatment | 1.6 |

**Table C.5: Comparison with Intervention-Level Benefit-Cost Ratio Estimates under the Ghana Priorities Project**

| Sector | Investment/Intervention | BCR |
|---|---|---|
| Gender and equality | Increased cash transfers (Livelihood Empowerment Against Poverty) | 1.6 |
| Gender and equality | Increased microfinance | 1.6 |
| Transport | Revamp rail network for rural transport | 1.5 |
| Transport | Urban bus rapid transport system | 1.5 |
| Trade and industrialization | Doubled research and development spending | 1.5 |
| Education | Subsidize private senior high schools to increase seats | 1.5 |
| Agriculture | Revamp irrigation schemes | 1.5 |
| Nutrition | Home garden and poultry training | 1.4 |
| Water and sanitation | Rural community led total sanitation | 1.3 |
| Housing and urbanization | Retention ponds in Accra | 1.3 |
| Education | Vocational education | 1.3 |
| Transport | Feeder roads for rural transport | 1.2 |
| Transport | Ferries and ports on Volta | 1.2 |
| Land and natural resources | Formalize mining co-operatives | 1.2 |
| Fisheries | Fishing licenses and aquaculture | 1.2 |
| Water and sanitation | Localized solid waste management by community members | 1.1 |
| Trade and industrialization | State sponsored alumina industry | 1.1 |
| Energy and air pollution | Electricity grid for more remote communities | 1.1 |
| Housing and urbanization | Social housing construction | 1.0 |
| Trade and industrialization | Special Economic Zones | <1 |

*Source*: Information obtained from the Ghana Priorities Project. See https://www.copenhagenconsensus.com/sites/default/files/ghana_outcome_doc.pdf (Accessed January 28, 2022).

*Note*: BCR = Benefit-cost ratio. Our estimates in this table are averages of the estimates we present in section 4.