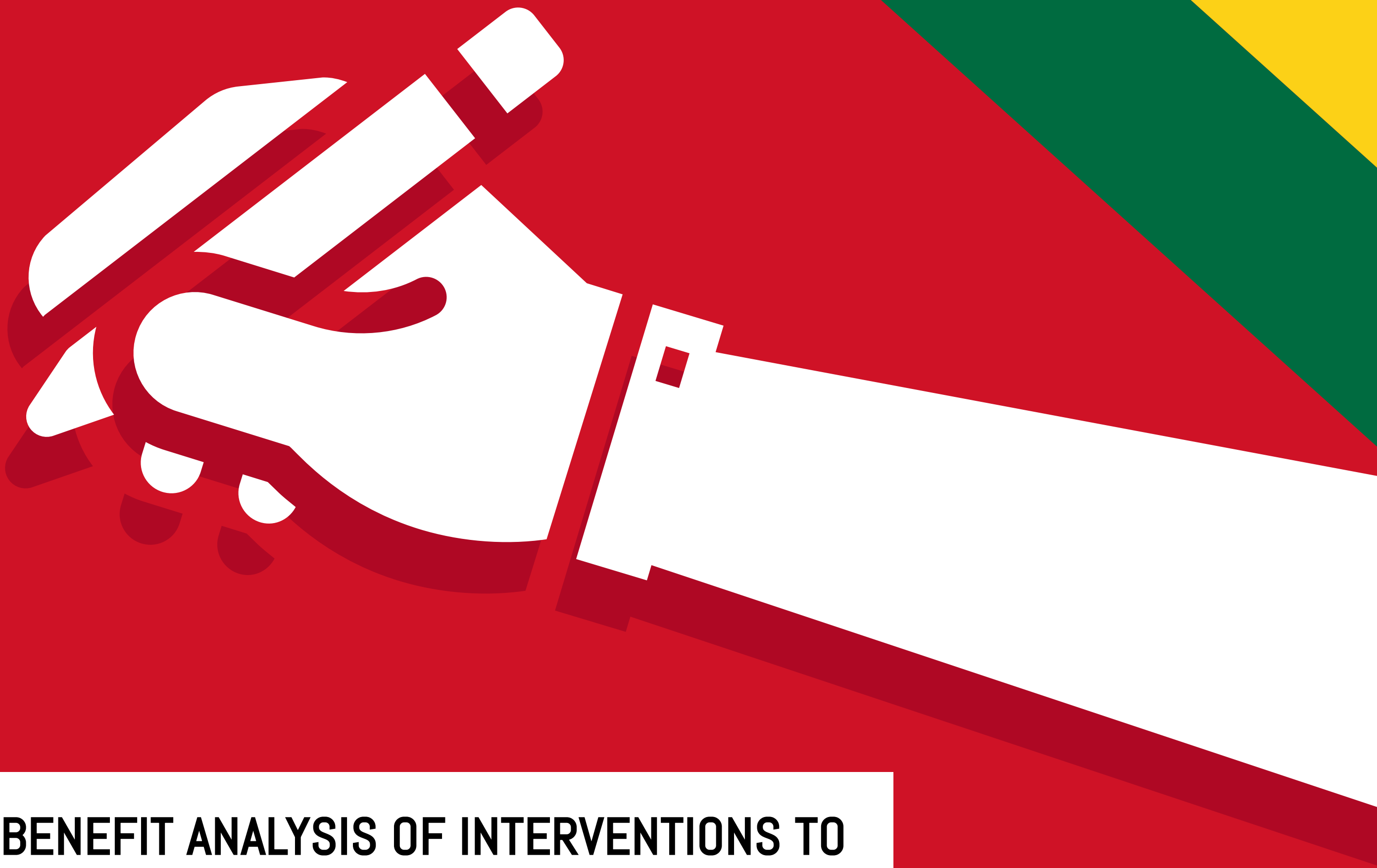

COST-BENEFIT ANALYSIS OF INTERVENTIONS TO IMPROVE LEARNING IN GHANAIAN SCHOOLS: A COMPARISON BETWEEN SCHOOL FEEDING AND TEACHING AT THE RIGHT LEVEL

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Cost-benefit analysis of interventions to improve learning in Ghanaian schools: A comparison between school feeding and teaching at the right level

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Academic Abstract

In this paper we conduct cost-benefit analyses of two interventions designed to improve learning outcomes of children in Ghanaian schools: school-feeding and teaching at the right level (TaRL). We take advantage of large-scale, randomized control trials to estimate the costs and benefits of the interventions. The analysis indicates that expanding school feeding to an extra 383,000 students (an increase in coverage from 61% to 70% as per government targets) would improve learning and enrolment, increasing future wages of exposed students by 2.7%. The annualized cost of the intervention is GHS 110m and annualized benefits are GHS 526m for a benefit-cost ratio (BCR) of 5, at an 8% discount rate. Additional analyses indicate that school feeding is equity enhancing, driving a disproportionate share of benefits to girls and children from poor households. TaRL is likely a more effective use of resources, with one variant targeting all students delivering a BCR of 8, and another focusing on weaker students having a BCR of 6. Importantly, if the same funds earmarked for increased coverage of school feeding to 383,000 students were instead deployed to a broad-based TaRL it would be enough to deliver the intervention to 50% of children in grades 1-3. For the variant focusing on weaker students, 70% of children who do not meet minimum standards in English and almost half of children who do not meet minimum standards in mathematics could be reached with the same funds. While there may be strong equity arguments for favoring school feeding, our analysis indicates that if deployed over broad-based TaRL, it would leave GHS 200m of social benefits ‘on-the-table’ per year.

Key Words: cost-benefit analysis, primary school learning, school feeding, teaching at the right level, equity-efficiency tradeoff.

Policy Abstract

Key Takeaways

- Teaching at the right level (TaRL) - a pedagogical approach that targets instruction to the learning needs of children – is likely a more efficient use of resoures than school feeding. One variation of TaRL targeted at all children returns 8 cedis for every cedi spent, and another variation targeted at weaker students returns 6 cedis for every cedi spent.
- School feeding returns 5 cedis for every cedi spent. However, school feeding is equity enhancing, providing a greater than expected share of benefits to girls and the poor.
- School feeding is expensive relative to TaRL. For GHS 80m per year the government could provide:
  - school feeding to 383,000 students (9 percentage point increase in coverage) or/
  - Broad-based TaRL to 1.2m students in grades 1-3 or/
  - TaRL for 520,000 weaker students equivalent to ~70% of children who do not meet minimum standards in English and ~50% of children who do not meet minimum standards in mathematics
- Deploying school feeding – a potentially more equity enhancing strategy – versus universal TaRL would leave GHS 200m of benefits 'on-the-table' per year.

The Problem

Ghana has made great strides in education enrolment in the MDG and SDG era, with near universal primary school enrolment and equality between boys and girls (World Bank, 2019). However, as with many developing countries, the quality of education and the extent to which children actually learn remains the critical challenge. A 2016 assessment showed 45% and 30% of 4th graders could not meet minimum standards in mathematics and English respectively (National Education Assessment, 2016).

Intervention 1: Expansion of school feeding to 383,000 students

Overview

This intervention involves scaling up school feeding from 61% of children to 70% of children in basic school or 383,000 students.

Implementation Considerations

We estimate that this would require GHS 80m of government funds per year. Additional costs would be born by households of students and by teachers who would stay longer at school.

Costs and Benefits

Costs

The intervention costs GHS 1.1 per child per day in direct costs paid to caterers and equals GHS 80m per year. Students would spend more time at school, as well as teachers – roughly 20 min per day on average. The total cost of the intervention is GHS 110m per year.

Benefits

The intervention would increase learning levels in students equivalent to an extra half year of junior high school. In the future, students would earn 2.7% more or GHS 2,300 in today's money if they are exposed to school feeding for two years. Additionaly, there would be benefits to households worth GHS 160 per child from spending less on food. Certain vulnerable sub-groups (girls and the poor) would have even larger benefits including improved nutrition and health.

Intervention 2a: Teaching at the Right Level for 50% of students in grades 1-3

Overview

Teaching at the right level (TaRL) is a pedagogical approach that targets instruction to the learning needs of children. It involves splitting up children into classes based on learning levels, rather than age. This occurs for two hours per day, with the remaining days for normal curriculum teaching. It was developed in India and has been trialled in Ghana in the past.

Implementation Considerations

If the GHS 80m for school feeding per year were instead spent on TaRL – delivered by public school teachers – it could be delivered to 50% students in grades 1-3. Because this would be a new intervention in Ghana, training would be required as well as communication to parents and students. It would be important to make sure children do not feel inferior or less capable after being separated into different classes. Therefore class names for the separated groups should be considered that do not reflect any real or perceived ranking (e.g. names of flowers or animals rather than class A, B or C).

Costs and Benefits

Costs

The cost per child per year for TaRL is GHS 65 and consists mainly of training for teachers, as well as materials and monitoring. Total social costs are GHS 87m per year.

Benefits

The intervention would provide a modest learning boost to all students. If children are exposed to TaRL for three years this learning improvement would be worth 1.5% of earnings over their lives, or roughly GHS 1040 in today's money. The total social benefits are GHS 717m per year.

Intervention 2b: Teaching at the right level for 520,000 students with low learning levels, using teaching community assistants

Overview

This intervention is the same as the previous one but with a greater focus on weaker students, using teaching community assistants to assist regular teachers. Teacher community assistants are early career youth, looking to gain experience in the workforce.

Implementation Considerations

If the GHS 80m for school feeding expansion were spent on this version of TaRL it could reach 520,000 students in grades 1-3 or enough to almost cover those identified who did not meet minimum learning standards. This intervention would require the identification, training and management of 17,350 teacher community assistants.

Costs and Benefits

Costs

The cost of this intervention is GHS 15 per child per year, with 32% of the cost for teaching community assistants. Total social costs are GHS 87m per year.

Benefits

The intervention woud provide a sizeable learning improvement for weaker students. This would increase their earnings by 2.6% over their life and is worth GHS 1,775 in today's money. Total social benefits are worth GHS 518m per year.

BCR Summary Table

Summary Table

Interventions	Benefit per year (GHS m)	Cost per year (GHS m)	BCR	Quality of Evidence
Expansion of school feeding to 383,000 students	526	110	4.8	Strong
Teaching at the right level for 50% of students, using existing teachers	717	87	8.3	Strong
Teaching at the right level for 520,000 students with lower learning levels, using teacher community assistants	518	87	6.0	Medium

Notes: All figures assume an 8% discount rate

1. Introduction

Ghana has made great strides in education enrolment in the MDG and SDG era, with near universal primary school enrolment and equality between boys and girls (World Bank, 2019). However, as with many developing countries, the quality of education and the extent to which children actually learn remains the critical challenge. A 2016 assessment showed 45% and 30% of 4^{th} graders could not meet minimum standards in mathematics and English respectively (Ghana Ministry of Education, 2016).

This paper undertakes cost-benefit analyses of two interventions that are designed to improve learning levels in Ghanaian schools and for which there is rigorous evidence of impacts. The first is an expansion of Ghana's School Feeding Program (GSFP), which provides one hot meal to students in public basic school (grades 1 to grade 9). We assess an increase from current levels to 70% as per recent government targets for 2020 (Ministry of Gender, Children and Social Protection, 2019).

The second intervention is called 'Teaching at the Right Level' (TaRL), a pedagogical approach first developed in India that more closely directs instruction to the learning needs of children. This is accomplished by splitting children into class groups based on learning levels rather than age, for one or two hours per day. Outside of several experimental programs, TaRL has not been deployed on a large-scale basis in Ghana. In this paper we assess two forms of TaRL, one focused on weaker students (and requiring the use of assistants from the community) and another potentially involving all students in grades 1-3 using existing teachers.

Our cost-benefit analyses draw upon large, government co-implemented, randomized controlled trials, allowing us greater confidence in the causal effects of the interventions. Our results indicate that school-feeding expansion has a BCR of 4.8. If scaled up to 383,000 students in basic school, it would require annualized costs of GHS 110m (8% discount rate), ~80% of which would be in government expenditure to caterers to deliver the program. It would improve learning levels by 0.15 s.d., or the equivalent of half a year of junior high school and boost future wages by 2.7% on average. There are also nutrition and health benefits, and transfer benefits to the children of receipient households. These would deliver annualized benefits of GHS 526m to society.

In contrast, a similar amount of government money could be used to scale up a low-cost variant of TaRL focusing on all students. This would have smaller benefits per child, increasing average learning levels by only 0.08 s.d. equivalent to a future wage boost of 1.5% over the lifetime. However due to its lower unit cost (65 GHS per child per year) it could reach potentially half student in grades 1-3, providing society with large benefits overall. TaRL to 1.2m students in grades 1-3 has an annualized cost GHS 87m and would deliver annualized benefits of GHS 717m for a BCR of 8. The variant of TaRL that focuses on weaker students could reach 20% of school going children in the target grades or 520,000 beneficiaries. This figure is important due to aforementioned levels of inadequate learning in grade 4 students in Ghana. This variant of TaRL, if it could identify weaker students early, could reach 70% those who do not meet minimum standards in English and almost 50% all those who do not meet minimum standards in mathematics.

Our results provide important information to decision makers. The headline recommendation is that broad-based TaRL provides the largest benefits to society for a given level of cost and a welfare maximizing policy maker should prefer this intervention to others. However, the alternative interventions – TaRL targeted at weaker students and school feeding – have important equity implications. Sub-group analysis for school feeding suggests a disproportionate share of benefits accrue to vulnerable sub-groups namely girls and children from poor households. School feeding is equity enhancing and could help lessen wage inequality in the future. Similarly, the version of TaRL targeted at weaker students results in larger average gains than the universal version, which could indicate an equity-enhancing outcome (though sub-group analysis could not be done for TaRL with the available information so we cannot assert this for sure). This paper shows that adopting school feeding relative to the broad-based TaRL leaves Ghanaian society as whole worse off by around GHS 200m per year. It is up to decision makers to determine if the perceived and real equity gains from school feeding are worth 'leaving-on-the-table' these large aggregate social benefits.

2. Learning improvements and cost-benefit analysis: an overview of the evidence

The literature on costs and benefits of education in LMICs is more than half a century old and began with seminal studies examining the returns to increasing enrolment across different education levels. For example, Psacharopoulos (1985) (besides being a 30-year old returns to education study itself) describes a 1967 *Human Resources* paper examining returns to education in Mexico! These studies typically linked the costs of schooling (direct costs plus opportunity costs) to future earnings boosts derived from Mincerian regressions of cross-sectional earnings data.

In more recent times, coinciding with the proliferation of randomized controlled trial (RCT) methods, the focus of education research has been on improvements to learning, as opposed to enrolment. Education economists do not yet have a standardized approach to monetizing the impact of increased learning levels as they do for increased enrolment. Evans and Yuan (2017) offer one approach, translating improvements in test scores to increases in lifetime wages using relationships between adult earnings and measures of reading comprehension derived from cross-sectional data from the World Bank's STEP Skills Measurement Program. In essence, they employ the approach of traditional education economists, but replace years of schooling with standard deviations of test score improvement (and include a dummy variable to account for lower female earnings). This approach suffers from same challenges associated with traditional returns to schooling methodology – most notably an assumption that the association identified in adults is applicable to current school aged children. An additional assumption required is a persistent relationship between test scores in childhood and test scores in adulthood of which the evidence is thus far inconclusive (Evans and Yuan, 2017).

Another limitation of this approach is that data is not available for every country. Luckily, one of the five countries surveyed in STEP Skills Measurement Program is Ghana. The results from Evans and Yuan (2017) indicate a 17.8% boost to weekly income from a one standard deviation improvement in reading test scores. For the purposes of this cost-benefit analysis we adopt this relationship to estimate the impact from improved learning in childhood. Despite the strong assumptions underlying this approach, this value lies in the range documented in several longitudinal and cross-sectional studies from other countries (mostly developed) – that is a 10 to 20% boost to wages per 1.s.d. improvement in test scores (Mulligan et al. 1999; Murnane et al. 2000; Lazear, 2003; Chetty et al. 2011; Aslam et al. 2010; Hanushek and Woessman, 2008; Hanushek et al. 2015; Hanushek and Zhang, 2009).

3. Expansion of the school feeding program from 61% to 70% of children in basic school

3.1 Description of intervention

Ghana's school feeding program (GSFP) was first implemented in 2005 starting initially with 10 schools. Since then it has expanded significantly covering 2.8m children or 61% of public enrolments in basic school. The scheme provides one hot meal per child in basic school and is implemented via local caterers who are compensated per child fed per day. Currently, the Ministry of Gender, Children and Social Protection oversees the GSFP.

This analysis considers an expansion of the intervention from 61% to 70% of enrolments, or approximately 383,000 children, as per Ministry targets (Ministry of Gender, Children and Social Protection, 2019) though the BCR is unlikely to differ much for expansion to larger coverage levels up to 90%. To simplify the analysis, we envisage an instantaneous scale up of GSFP to these children for two years and we model the increase in lifetime productivity and other benefits from this intervention over the lifetime.

3.2 Evidence on the effects of school feeding in Ghana and around the world

This cost-benefit analysis draws heavily from recently completed analyses of large-scale, government implemented, randomized control trial of school feeding expansion in Ghana (Aurino et al. 2018; Gelli et al. 2019). These analyses took advantage of a 2012 retargeting exercise involving scale up across schools in 58 districts. The experiment treated 45 schools with school feeding and held 46 schools in the same districts as controls. Researchers surveyed 912 households with 1,668 children (aged 5-15) in the communities around the treated schools and 756 households with 1,502 children around control schools at end line two years after implementation (see Gelli et al. (2019) for overview of the randomization and survey process). The results reported below are community level intent-to-treat (IIT) values for surveyed children, including ten percent of children who went to private schools and were likely not exposed to the intervention whatsoever. Results indicate that 63% of children in treatment arms received a hot meal at school in the week before survey while only 2% of children in control arms received a hot meal. Restricting the sample to those who went to public school indicates 83% of children received a hot meal in treatment arms.

Analysis indicated that children in communities exposed to school feeding experienced an increase in learning levels. Standardized scores across mathematics, literacy, standardized progressive matrices and digit span tests were 0.12 s.d. to 0.16 s.d. higher in treatment arms relative to control communities (Aurino et al. 2018). A composite index of all tests indicates 0.15 s.d. improvement in scores from exposure to school feeding. In contrast to previous studies (Drake et al. 2018) school feeding in Ghana did not have a statistically significant impact on enrolment, though this is likely due to the fact that enrolment levels in Ghana are already near-universal.

In a separate analysis focusing on nutrition, the researchers noted a small, statistically insignificant effect at conventional levels on anthropometry outcomes (Gelli et al. 2019). Children in communities exposed to school feeding had height-for-age z-scores (HAZ) 0.05 higher than in control communities (p=0.298). BMI-for-age z-scores (BAZ) were 0.08 higher in treatment communities (p=0.158)

Importantly, both analyses indicate significantly larger benefits for vulnerable sub-groups. Girls in treatment arms had test scores 0.23 s.d., HAZ 0.12 and BAZ 0.08 larger than girls in treatment arms. Children from households below the poverty line had test scores 0.33 s.d. higher and HAZ 0.11 larger in treatment versus control communities. Similar effects were documented for children in the Northern region for test scores and children aged 5-8 for nutrition outcomes. Additionally, analysis indicates an increase in enrolment, attendance conditional on enrolment and time spent at school for girls, the poor and children in the northern region, suggestive that more time at school is driving the learning results (Aurino et al. 2018).

One interpretation of these findings is that school feeding helps the most vulnerable children in Ghana to a significant degree, with perhaps minimal or non-existent effects for the remaining groups. For example, boys in the school feeding arm did not experience statistically significant changes in HAZ or BAZ (Gelli et al. 2019). The small positive but statistically insignificant result across the full sample is therefore an average of null result for boys and the large effect for girls. Given the well-known associations between nutrition and cognitive ability (Glewwe and Miguel 2008; Grantham- McGregor and Ani 2001) it is possible that a similar phenomenon is driving the results for learning. Aurino et al. (2018) did not report results only for boys, non-poor and non-Northern regions and thus we cannot assert this for sure.

The results from Ghana are similar to results of school feeding documented in other countries. Drake et al. (2017) review effects of school feeding from LMICs and note that improvements in composite test scores from school feeding average 0.14 similar to the finding in Ghana of 0.15. To cite one country example, Chakroborty and Jayaraman (2016) report that five years of exposure to school feeding program in India lead to an increase in test scores of 0.09 s.d. to 0.17 s.d., a range that encompasses the results from Aurino et al. (2018).

Regarding anthropometric outcomes, Drake et al. (2017) report findings from a Cochrane Review of three RCTs (Kristjansson et al. 2009), which notes modest effects on weight (statistically significant) and height (not statistically significant). This aligns with the small positive effects documented in Gelli et al. (2019) for Ghana. Interestingly, Singh, Park and Dercon's (2014) quasi-experimental study shows that India's scheme also acts as important nutritional safety net for vulnerable populations, improving anthropometry measures during periods of severe food insecurity. Taken together it appears that school feeding in Ghana and around the world has only modest nutrition effects averaged across a large group, but is important for vulnerable sub-groups.

3.3 Cost-benefit analysis

We conduct a formal cost-benefit analysis of school feeding using the average IIT effects from Aurino et al. (2018) and Gelli et al. (2019). Despite heterogeneity of effects, this should still lead to correct aggregate costs and benefits of school feeding. Acknowledging the likely heterogeneous impacts of school feeding we also conduct some exploratory analyses on vulnerable sub-groups. As noted above, this is a prospective cost-benefit analysis for an expansion in feeding to 383,000 children in basic school over two years.

Costs

There are three primary costs associated with the intervention. The first is the cost of school feeding itself, including the value of food, preparation and logistics. The second cost is the induced effect on increased time at school for students whether via increased enrolment or time spent at school, conditional on enrolment. The third cost is the extra instruction time provided by teachers.

The cost of school feeding is captured in the payments from government to caterers. Assuming that these transfers cover caterers' costs and profit margins in the long run, this is an appropriate estimate of direct school feeding costs. As of writing, the current payment is 1 GHS per child per day, though there are plans to increase this to 1.5 GHS in 2020 (Ministry of Gender, Children and Social Protection, 2019). The quantum of payment influences the quality of food and the potential benefits from the intervention. Since we are adopting benefits from Aurino et al. (2018), we should use the (inflation adjusted) value from the time of that experiment to accurately match costs to benefits. This equals GHS 1.1 per child per day, using World Bank GDP deflators. Assuming 200 school days per year the direct cost of the intervention is GHS 80m per year (160m GHS total) for 383,000 students.

The intervention increases time spent at school across the beneficiaries by 0.359 hours per school day (Aurino et al. 2018). This value incorporates both new enrolments as well as extra time spent in school by those already enrolled. While not measured specifically in the RCT, Aurino et al. (2018) mention that teachers qualitatively noted an increase in the length of instruction time to accommodate school feeding. These 0.359 hours were almost offset by reductions in time spent doing chores and paid or agricultural work, indicating a real cost to households from school feeding. Following *Ghana Priorities* standardized assumptions (Wong and Dubosse, 2019) we do not value time from children below the age of 10 due to uncertainties around the opportunity cost of time. However for children aged 11 to 13 exposed to the intervention we value time at the implied wage rate of primary school graduates which equals GHS 5,119 per year (see appendix to this series) and apply a 75% factor to account for age. The value of student time from increased schooling equals GHS 17 million per year (34 million over two years).

We also estimate the extra time spent by teachers due to school feeding. Assuming a pupil-teacher ratio of 30 for primary school and 15 for junior high school (Ministry of Education, 2018) and that the extra daily instruction time for teachers equals the average extra time children spent in school (0.359 hours per day)[1] suggests an extra 1.1m hours of instruction time per year for the 383,000 students. Assuming a teacher salary of GHS 800 per month and that half of the extra instruction time substitutes teacher leisure time and the rest non-instruction productive time (e.g. preparing for school classes or grading homework) provides an extra teacher cost of GHS 4m per year.

[1] Aurino et al. (2018) mention that teachers spent 'about 45 minutes' more in instruction time. However, this was not precisely measured in the RCT so we use the more conservative, and perhaps more plausible figure of the average extra time spent in school for children in the sample.

Overall costs of the intervention are therefore GHS 204m undiscounted. At an 8% discount rate the cost is GHS 189m.

Benefits

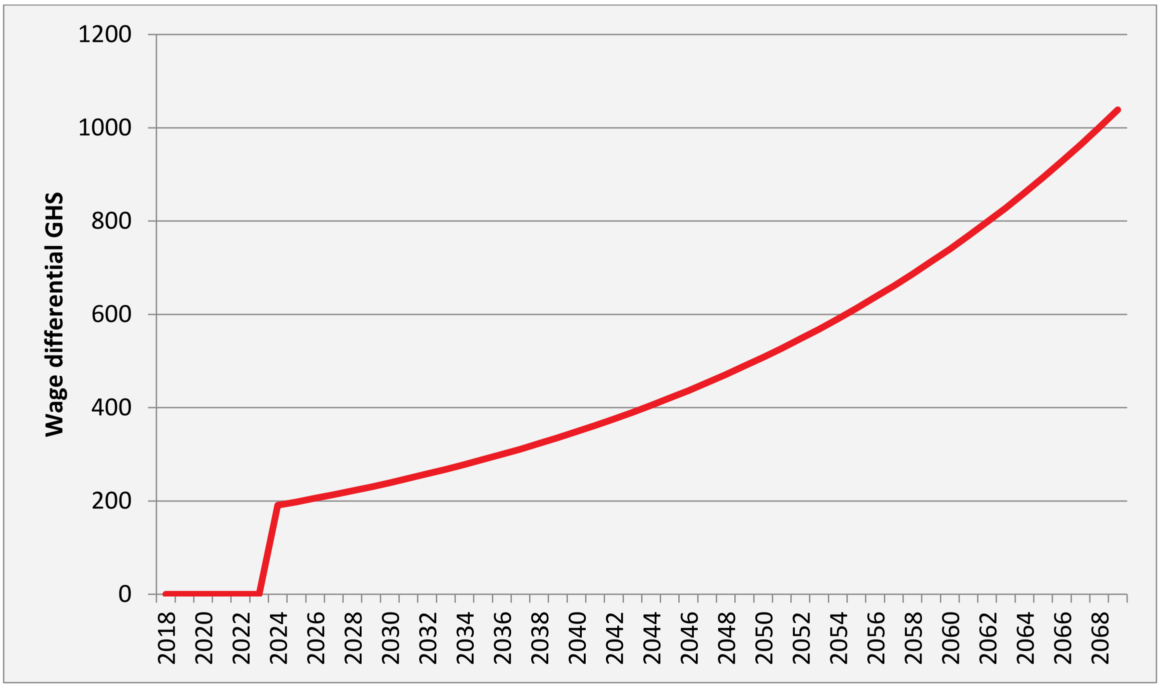
There are several benefits from the intervention. The first benefit is the increase in learning from the intervention that should lead to an increase lifetime productivity and wages (see Section 2). The second benefit is the in-kind transfer to households due to the provision of a household expenditure item. The third potential benefit is an improvement in nutritional status, which could lead to improved health and cognition *beyond learning impacts*.

As discussed previously (see Section 2), a 1 s.d. increase in test scores is associated with a 17.8% increase in wages in Ghana (Evans and Yuan, 2017). Given that the intervention increases learning by 0.154 s.d. after two years, the boost to income from increased learning due to school feeding is estimated at 2.7% across the lifetime. We apply this effect to the stream of anticipated future wages for the beneficiary group, assuming they no longer continue school after the intervention. This reflects the 'traditional' approach to education cost-benefit analysis historically applied to increases in years of schooling (but here we substitute more years of schooling with increased learning levels). Clearly, this abstracts from real-world complexity where children can and do go on to further years of schooling with both additional costs and additional benefits, but provides for a 'cleaner' test of the intervention's costs and benefits.

The beneficiary group is assumed to consist of nine cohorts of children aged 5 to 13, weighted by expected class sizes in 2018 as documented by Ministry of Education Ghana (2018). Individuals are assumed to work from age 15 to age 60, with real increase in income as per *Ghana Priorities* standardized assumptions. The baseline (non-intervention) wage rate is estimated from Mincerian analyses on GLSS 7 data (see appendix to this paper), and in 2018 equals GHS 5120 for children aged 5-10, GHS 5,333 for children aged 11, GHS 5,555 for children aged 12 and GHS 5,786 for children aged 13. Children aged 5-10 have the same wage rate because Mincerian analysis indicates that extra years of primary schooling do not confer an increase in wage relative to no education.

An example of the benefit profile for a child aged 9 is depicted in Figure 1 below.

Figure 1: Annual wage differential for child aged 9 from exposure to school feeding



Overall, the intervention is expected to increase incomes across the beneficiary population by GHS 876m at an 8% discount rate, or roughly GHS 2,300 per student over their lifetimes.

The second benefit from the intervention is the potential savings to households from the provision of food. Fernandes et al. (2017) note that 17% of Ghanaian households reduced the amount of food provided to children at home. Overall households also reduced the amount of money given to children to buy food by 16 pesewas[2] (in 2018 GHS) per day per child on average. We use these figures to estimate the transfer benefits from the school feeding program. We assume that each Ghanaian household which reduces the food provided to children reduces it by one meal per school day and that meal is valued at 1.5x the cost of the meal in school. The total transfer value in food and cash is estimated at GHS 32m per year (GHS 20m in food and GHS 12m in cash).

There is well-known association between improved nutrition, cognition and health though much of this evidence is for children under the age of five, with relatively less evidence for children of school-going age (Glewwe and Miguel 2008; Grantham- McGregor and Ani 2001; Prendergast and Humphrey, 2014). Regarding cognition we note that the main pathway for this

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[2] Fernandes et al. (2017) report a reduction per day of 8 pesawas. We assume this to be in 2013 GHS and make the necessary inflation adjustments to report in 2018 GHS.

benefit is through improved learning, which has already been assessed above. Therefore we do not include additional nutrition-induced cognition benefit to avoid double counting.

Improved nutrition would also lead to improved child health. As with cognition, this additional benefit would be largely captured by learning outcomes e.g. via reduced absenteeism from school or increased ability to concentrate. However, other benefits such as the intrinsic value of not being sick or avoided caretaker productivity loss would not be included in the learning outcomes benefit. Unfortunately, there does not appear to be as much evidence on the link between improved anthropometric outcomes and health for school aged children as there is for under-five children (e.g. Olofin et al. 2013) that would allow us to calculate these additional benefits with precision. One would expect improved nutrition to reduce susceptibility to infection, with major causes of mortality and morbidity among children 5-14 being malaria, diarrhea and respiratory infection (IHME, 2019). We do not formally include an additional health benefit but provide an order of magnitude estimation using associations between stunting and *under-5* mortality for diarrhea, malaria and respiratory infection from Olofin et al. (2013). This is likely to be an overestimate of impact since under-5 children are much more susceptible to poor nutrition outcomes than children aged 5-14. The analysis indicates that school feeding reduces the prevalence of stunting by 7% (from 17.9pp to 16.6pp) with additional health benefits around 0.5 deaths avoided and roughly 25,000 cases of child illness avoided per year (see appendix for detail). Using standardized valuation assumptions this equals GHS 4m per year for the beneficiary population or about 1% of the total benefit. Due to the uncertainty around the evidence and the small size of the benefit, we do not report further on nutrition-related health benefits in subsequent prose.

3.4 Summary and discussion

The results of the cost-benefit analysis are summarized in Table 1 below. The results indicate that at an 8% discount rate the BCR is 4.8. For two years of school feeding, the total benefits equal GHS 938m with 93% of the benefits from improved productivity. The total costs would be GHS 196m with 79% of the costs representing direct costs of feeding.

Table 1: Summary of costs and benefits for two years of school feeding for 383,000 additional students

	5%	**8%**	**14%**
Productivity benefits from improved learning	1,761	876	314
Transfer benefits	63	62	61
TOTAL BENEFITS (2018 GHS millions)	**1,824**	**938**	**375**
Direct costs of school feeding	157	155	151
Opportunity costs for students and teachers	42	42	40
TOTAL COSTS (2018 GHS millions)	**199**	**196**	**191**
BCR	**9.2**	**4.8**	**2.0**

The choice of discount rate has a large effect on the BCR, which is unsurprising given that the main benefits are improved productivity over the lifetime, stretching up to 55 years after the intervention.

The BCR of this cost-benefit analysis is higher than a government commissioned cost-benefit analysis on the school-feeding program completed in 2018, which identified a BCR of 3.3 at a 7% discount rate (Dunaev and Corona, 2018). The 2018 study identified a direct cost per child of GHS 1.1 as per this study, but did not include any additional opportunity costs from increased time spent at school. Additionally, the productivity benefits per beneficiary are very similar in both studies (GHS 2,300 in this study compared to GHS 2,200). However, the main difference is that the 2018 study includes eight years of school feeding to generate the benefits whereas we consider only two as per Aurino et al. (2018). Additionally, the former cost-benefit analysis identifies a higher transfer benefit, a higher health benefit as well as including a household return on investment from the money saved from school feeding. The report is not clear on the methodologies employed to estimate these benefits, particularly the health and ROI benefit.

Our analysis incorporates the rigorously measured effects of a recently completed, large-scale, government implemented, randomized control trial in Ghana. The external validity of the results can be classified as very strong in terms of effects and costs. Nevertheless there are still some areas of significant uncertainty, notably the long-term relationship between improvements in learning and wages used to monetize the learning benefits (Evans and Yuan, 2017). Additionally, of the few education RCTs which have followed up beyond the initial end line, many have noted a decline in learning outcomes after the intervention has finished (e.g. Muralidharan, 2012). It is uncertain how such reported declines affect productivity in the long term. Overall, we assess the evidence for the cost-benefit analysis as strong.

The preceding analysis is based on average IIT effects from Aurino et al. (2018) and Gelli et al. (2019). However, as discussed much of the benefits of the intervention likely accrue to various vulnerable sub-groups such as girls and the poor. Here we briefly explore some of the implications of this to inform decision makers though of course we note that from a policy perspective it is difficult if not impossible to target school feeding to any of these vulnerable sub-groups (e.g. provide school feeding only to girls but not boys).

We focus on two vulnerable sub-groups, girls and children from poor households since these are the only two sub-groups for which results are published in both Aurino et al. (2018) and Gelli et al. (2019). The aim is to assess how much of the total benefit accrues to these sub-groups relative to what would be expected if effects were homogenous. Several assumptions are used in this distributional analysis: we assume girls make up 50% of enrolments in basic school, while poor make up 8% of enrolments (GLSS 7). The effects of school feeding on these groups are as described in Section 3.2, and both are higher than the average effect. Finally we assume that girls will earn 25% less than the average wage as per Mincerian analyses conducted in support of this paper (see appendix), while the poor will earn 50% less than the average wage.

Table 2 below reports the findings. If school feeding affected all children in the same way, we would expect girls to accrue 35% of the benefits of the intervention, while the poor would accrue 4%. This figure is a combination of the vulnerable group's share of the population and the inequality in the group's wage levels compared to average wage levels. Given the larger impacts on learning for vulnerable sub-groups, girls actually accrue 51% share of the benefits while poor accrue 7% of the benefits. Both of these figures indicate that the GSFP is equity enhancing, driving a larger than expected share of benefits to two vulnerable sub-groups rather than reinforcing existing wage inequalities. This does not include any additional health benefits from improved nutrition outcomes which might be non-trivial in the case of vulnerable populations.

Table 2: Actual versus expected share of benefits accruing to vulnerable sub-groups

Sub group	**Estimated total benefits to sub-group (millions of GHS)**	**% actual share of total benefits**	**% expected share of total benefits**
Girls	481	51%	35%
Poor	67	7%	4%

4. Teaching at the Right Level

4.1 Description of intervention

Teaching at the Right Level (TaRL) is a pedagogical approach developed and refined by the Indian NGO Pratham. The main idea behind the intervention is to sort students (typically those in primary school) into learning levels rather than age groups, in order to provide instruction in mathematics and reading more specifically targeted to the educational needs of children. This intervention generally requires only one to two hours per day, with the remaining hours devoted to regular curriculum teaching. When implemented at scale in India it has involved the use of teaching assistants along with regular teachers. The intervention can be targeted at those with the lowest learning levels so that it more closely resembles remedial education, or towards all children across the range of learning levels (TaRL, 2019).

In developing countries, TaRL is one of the most widely studied education interventions using rigorous evaluation approaches. The research institutions Abdul Latif Jameel Poverty Action Lab (JPAL) and Innovation for Poverty Action (IPA) have undertaken multiple randomized controlled evaluations of the intervention across two decades, initially in small out-of-school summer camps and later in large-scale programs in conjunction with state Indian governments (Banerjee et al. 2007; Banerjee et al. 2011; Banerjee et al. 2017). It has also conducted several evaluations in Africa, including Ghana (Duflo, Dupas and Kremer, 2011; Duflo and Kiessel, 2015).[3] These studies have demonstrated consistency in effects with learning levels in mathematics and reading improving by 0.08 s.d. to as high as 0.28 s.d. depending on the study

[3] TaRL was cited by the Nobel Committee as one of the examples of the path-breaking work conducted by Esther Duflo and Abhijit Banerjee when they were awarded the Nobel Memorial Prize in Economics in 2019 (with Michael Kremer).

(teachingattherightlevel.org, 2019). However, Banerjee et al. (2017) note one failed implementation of the program due to lack of buy-in from the partner government.

This cost-benefit analysis envisages a large-scale rollout of TaRL to public school children in grades 1 to 3. We test two variants of the TaRL approach – one targeted to the weakest students, the other targeted to all children, both within normal school hours. The scale of each intervention is set based on how many could be reached using the same amount of government funds required for the equivalent years of school feeding for 383,000 students as per the previous intervention. Outside of IPA-led interventions, TaRL has not been implemented at scale in Ghana. At the time of writing, implementation and evaluation of a large-scale program is underway in partnership with the Ministry of Education in Ghana (teachingattherightlevel.org, 2019).

4.2 Evidence of impacts on TaRL in Ghana

This cost-benefit analysis draws from a 2010-2013 evaluation of TaRL conducted in Ghana across 25,000 students (Duflo and Kiessel, 2014). That analysis tested four approaches two of which we consider here. The first approach focused on children with the lowest learning levels in grades 1 to 3. These children were given targeted instruction for two hours per day, with the help of teaching community assistants (TCA). TCAs are early career individuals with at least senior high school qualifications, working to gain experience for a minimal stipend. The results indicated that this variant of TaRL improved test scores by 0.142 s.d. and would cost USD 20.24 per child per year (2011 figures) if rolled out at scale, *excluding the costs of TCAs*. The second variant focused on providing targeted instruction to all children in grades 1 to 3. This approach did not involve TCAs, with civil-service teachers delivering the method after some training. The intervention improved test scores by a more modest 0.08 s.d. but also would cost 40% less at scale, USD 12.61 per child per year (2011 figures).[4]

Both of these interventions suffered from implementation challenges. In the case of TCA-assisted instruction, failures in payment to TCAs by the government led to increased absenteeism. Over time attendance by TCAs fell from 80% to less than 50%. In the case of teacher-only intervention, observations by surveyors indicated that teachers only split up classes in learning groups on 15% of days. This is against the general challenge of teacher

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[4] We thank Adrienne Lucas, Shahana Hirji and Madeleen Husselman from Innovations for Poverty Action for assistance in interpreting the cost figures from IPA documents.

absenteeism with instructors not coming to classes on average of 1.5 days per week. Nevertheless, both interventions were able to deliver learning gains despite imperfect implementation and should be representative of effects if rolled out at scale.

4.3 Cost-benefit analysis

Costs

For this intervention, we use costs documented in Duflo and Kiessler (2014) as noted above. These costs are 2018 GHS 105 per child per year for the TCA + teacher intervention targeted at the weakest student and GHS 65 per child per year for the teacher only intervention targeted at all students, after inflation and exchange adjustments. The reported figure for the first intervention did not include costs for the TCAs since at the time of the experiment these individuals were already being paid a stipend under the now defunct GYEEDA program. We add the costs of TCAs to this prospective cost-benefit analysis since a future rollout of this program would need to provide for these individuals. We assume TCAs receive the minimum wage (GHS 10.65 per day) for 70% of the full school year or 140 days annually. We further assume that one TCA is required per teacher and given a pupil-teacher ratio of 30 in primary school (Ministry of Education, 2018), this implies a requirement of 0.03 TCAs per student.

A related academic paper by Duflo and Kiessel (2015) note that the effects of interventions are from two year program rollout, so we add two years of TCA salary costs to the GHS 103 figure reported by Duflo and Kiessel (2014). The total cost for two years of TaRL per child is therefore GHS 309 undiscounted for the intervention variant targeting the weaker students only.

The intervention variant that targeted students broadly did not use TCAs so we do not make any further adjustments to that cost, for a final cost per child per year of GHS 65 or GHS 130 for two years.

Benefits

To estimate benefits we use the relationship between earnings and future wages documented in Section 2 i.e. 1 s.d. improvement in test scores leads to a 17.8% increase in future wages. Applying this to the impacts of the two intervention variants (0.14s.d. and 0.08 s.d.) and assuming a primary school wage of GHS 5120, rising with projected income growth, leads to a lifetime benefit of GHS 1,755 per student for the TCA + teacher led intervention and GHS 1,037 for the teacher only intervention (8% discount rate). Both of these impacts are modest implying 2.6% and 1.5% increase in wages over the lifetime, or an effect equivalent to roughly a third to half a year of junior high school education (see Mincerian analysis in appendix).

Potential scale of the intervention compared to GSFP expansion

The results noted above are reported on a per child basis. However, the main concern for policy makers is the overall cost and benefits of a large-scale rollout. To ensure a meaningful comparison to expansion of school feeding, we estimate the potential scale of the interventions if resources were instead used for TaRL. The analysis in Section 3.4 indicates that expanding the GSFP to 383,000 students across basic school would cost the government GHS 80m per year (there are additional costs to teachers and students but these are not considered here). These same funds deployed towards the first variant of TaRL (TCAs + teachers targeted at weaker students) would cover 520,000 beneficiaries for one year, or equivalent to 20% of the potential grade 1-3 cohort. The Ministry of Education Ghana (2016) revealed that by grade 4, 45% and 30% of children could not meet minimum standards in mathematics and reading respectively. If these children could be identified earlier (in grades 1-3), an expansion of TaRL could foreseeably target a large fraction of these children.

For the second variant of TaRL (teacher only for all students), the same funds earmarked for GSFP expansion would be enough to deliver the intervention to 1.2m children per year. Given that there are an estimated 2.5m children in grades 1-3 in public schools in Ghana, there are sufficient funds to provide this variation of TaRL to half the cohort.

4.4 Summary and discussion

A summary of costs and benefits for each intervention at various discount rates is noted below.

Table 3: Summary of costs and benefits per child and at scale for the two TaRL variants

Discount rate	Cost per child (2018 GHS)	Benefit per child (2018 GHS)	Cost at scale (2018 GHS, millions)	Benefit at scale (2018 GHS, millions)	BCR
Variant 1: TaRL for weaker students using TCAs + teachers; 520,000 beneficiaries; two years					
5%	302	3905	157	2033	12.9
8%	298	1775	155	924	6.0
14%	290	531	151	277	1.8
Variant 2: TaRL for all students using teachers; 1.2m beneficiaries; two years					
5%	127	2282	157	2,812	17.9
8%	125	1037	155	1,278	8.3
14%	122	311	151	383	2.5

The results indicate that both variations of TaRL have sizeable returns relative to costs. The variant targeting weaker students using TCAs has a larger benefit per child (GHS 1775 vs. GHS 1037), but also a larger cost (GHS 298 to GHS 125) compared to the variant targeting all students using only teachers. The BCR for variant 1 is 6.0 while for variant 2 it is higher at 8.3 (at an 8% discount rate).

As with school feeding, policy makers who choose to introduce TaRL face an equity-efficiency tradeoff. Variant 2 has a higher BCR as well as larger net benefits. Variant 1 is less efficient but provides a higher per child benefit for weaker students who may also suffer from other social disadvantages such as poverty.

Both interventions draw from a large randomized control trial conducted in Ghana so external validity of results can be classified as strong. However, there is some uncertainty around the appropriate costs of the intervention, particularly with variant 1 involving TCAs. As with school feeding, there is uncertainty around the monetized impacts of improvements in learning levels as measured by standard deviation improvements in test scores. We assess the quality of evidence for variant 1 as medium, and for variant 2 as strong.

5. Conclusion

This paper conducted cost-benefit analyses of two interventions targeting primary school learning in Ghana. The first intervention involved an expansion of GSFP from current coverage levels i.e. 61% of children in basic school to 70% of children in basic school as per current government plans. This represents around 383,000 more children to receive school feeding. The second intervention, TaRL, involves organizing children according to learning levels rather than age and providing dedicated instruction to meet these needs. We analyzed two variants of TaRL, one targeted at weaker students and involving TCAs and teachers, and other variant targeted at all children using only teachers. The same funds for three years of school feeding, if instead deployed to the first variation of TaRL, would be able to reach 20% of students in grade 1-3 that is, 520,000 students. This a value equal to 50-70% of those who fail to meet minimum learning standards by grade 4. If these marginal funds were deployed to the second variant of TaRL it could provide coverage to 1.2 students, or half the grades 1-3 cohort.

Our results suggest TaRL targeted at all students has the highest BCR. The annualized cost of the intervention is GHS 87m and would deliver annualized benefits of GHS 717m for a BCR of 8.3 The other variation of TaRL focusing on weaker students and using TCAs would cost GHS 87m per year and deliver benefits worth GHS 518m for a BCR of 6.0. Expanding school feeding would cost GHS 110m annually and deliver benefits worth GHS 526m for a BCR of 4.8. For a welfare-maximizing policy maker the clear conclusion is to roll out a general TaRL using existing teachers to deliver the intervention. This provides the highest benefits to costs as well as the largest net benefits for a given level of government spending (see Summary Table 1).

Focusing at the child level, school feeding has the largest impact with beneficiaries realizing learning and transfer benefits worth GHS 1,374 at an 8% discount rate. Importantly, a disproportionate share of benefits would fall to vulnerable sub-groups, girls and the poor. The equivalent per child benefits for the two variants of TaRL are GHS 995 and GHS 582 (see Summary Table 2).

The results of this paper provide important information to Ghanaian policy makers. School feeding has large impacts per child, particularly for those in vulnerable sub-groups. However it is expensive and the equivalent funds for a 9pp expansion of school feeding, if instead deployed to TaRL could address 50-70% those who do not meet learning levels in grades 1-3 of basic school or provide broad-based coverage to half of the students depending on the variation deployed. Economists cannot answer which choice is morally better. It is up to politicians and the citizens who vote them in to determine this. However, economists can assist in providing information to quantify the real and perceived tradeoff between equity and efficiency. In this case, adopting school feeding relative to the universal TaRL leaves Ghanaian society as whole worse off by GHS 200m per year.

Summary Table 1: Annualized costs and benefits at scale

Interventions	Discount	Annualized Benefit (GHS, millions)	Annualized Cost (GHS, millions)	BCR	Quality of Evidence
Expansion of school feeding to 383,000 children	5%	981	107	9.2	Strong
	8%	526	110	4.8	
	14%	228	116	2.0	
Rollout of TaRL to 520,000 weaker students using TCAs + teachers	5%	1,093	84	12.9	Medium
	8%	518	87	6.0	
	14%	168	92	1.8	
Rollout of TaRL to 1.2m students using teachers only	5%	1,512	84	17.9	Strong
	8%	717	87	8.3	
	14%	232	92	2.5	

Summary Table 2: Annualized costs and benefits per child

Interventions	Discount	Annualized Benefit per child	Annualized Cost per child	BCR	Quality of Evidence
Expansion of school feeding to 383,000 children	5%	2,562	280	9.2	Strong
	8%	1,374	288	4.8	
	14%	595	304	2.0	
Rollout of TaRL to 957,000 weaker students using TCAs + teachers	5%	2,100	162	12.9	Medium
	8%	995	167	6.0	
	14%	323	176	1.8	
Rollout of TaRL to 2.5m students using teachers only	5%	1,227	68	17.9	Strong
	8%	582	70	8.3	
	14%	189	74	2.5	

Notes:

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Appendix 1: Approach to order-of-magnitude estimation of health benefits from school feeding

Estimating the prevalence of severe, moderate and mild stunting pre and post-intervention, starts with recognizing that the distribution of HAZ scores is by definition, a Z-distribution with standard deviation of 1. The WHO reference distribution has a mean of zero, and stunting is defined by those whose HAZ falls below 2 standard deviations of this reference distribution. Therefore, we identifying the mean of the HAZ z-distribution for the population allows us to infer the rates of stunting by examining the probability density functions below the cutoff values. We note from Gelli et al. (2019) that the baseline HAZ was -1.08 (average of treatment and control groups). This corresponds to severe, moderate and mild stunting prevalences of 2.7%, 17.9% and 53.2% respectively. An increase in mean HAZ documented in Gelli et al. (2019) of 0.05 would decrease these to 2.4%, 16.6% and 51.2% respectively.

Higher HAZ scores are associated with lower risks of mortality, primarily through the pathway of reduced infection (Olofin et al, 2013). Estimates of increased risk of all-cause and cause-specific mortality in children under five years of age with mild, moderate and severe stunting are presented in Table A1 based on Olofin et al (2013). The evidence indicates that severely stunted children are over 5-6 times more likely to die in early childhood from all-cause mortality and diarrheal disease and ALRI (major causes of mortality among children under five) than non-stunted children. Even moderately stunted children are 46-67% more likely to die from these causes than non-stunted children.

Table A1. Relative risk of mortality from stunting in children under five years of age

	Severe	Moderate	Mild	None
All-cause mortality	5.48	2.28	1.46	1.00
Diarrhea	6.33	2.38	1.67	1.00
Acute lower respiratory infections (ALRI)	6.39	2.18	1.55	1.00
Measles	6.01	2.79	1.25	1.00
Malaria	1.92	1.06	0.74	1.00
Other infectious diseases	3.01	1.86	0.95	1.00

Source: Olofin et al (2013). ALRI is acute lower respiratory infections. Other infectious diseases include neonatal sepsis, tuberculosis, and meningitis. Severe stunting refers to a HAZ less than -3. Moderate stunting refers to a HAZ between -2 and -3. Mild stunting refers to a HAZ between -1 and -2. Relative risks are in relation to stunting according to the WHO Child Growth Standards.

The potential impact fraction (PIF) is applied to estimate the change in mortality from a change in the stunting distribution:

$$PIF_j = \frac{\sum_{i=1}^{n} P_i RR_{ji} - \sum_{i=1}^{n} P_i^{'} RR_{ji}}{\sum_{i=1}^{n} P_i RR_{ji}} \quad (1)$$

where RR_{ji} is relative risk of mortality from cause, *j*, for children in each of the stunting categories, *i*, in Table A1; and P_i and P'_i are the pre- and post-intervention prevalence rate of stunting estimated above.

Change in mortality (M), or annual deaths avoided from the intervention is then:

$$M = \sum_{j=1}^{j=m} PIF_j D_j \quad (2)$$

where D_j is baseline annual deaths from cause, *j*, among the cohort at a given age. D_j is taken from the Global Burden of Disease 2016 (GBD 2016). We focus only on three causes: diarrhea, respiratory infection and malaria since these represent the diseases with the largest burden among children aged 5-14. The results indicate that exposure to school feeding would lead to 0.27, 0.34 and 0.20 avoided deaths per year from diarrhea, respiratory infections and malaria. The equivalent cases avoided is 9,635; 16,147; and 279 respectively. Years of life lost avoided are estimated using Ghana Priorities standardized assumptions. The value of cases avoided are drawn from other papers within the series (see sanitation papers, nutrition and malaria papers) and is equal to 196, 100 and 105 cedis respectively. Reasonable changes to these parameters do not alter the main conclusion that health benefits from improved nutrition do not contribute significantly to the benefits.

Appendix 2: Mincerian Analysis on GLSS 7 data

Earnings by School Completion in Ghana: A Quantile Estimation

By

Ebo Turkson, Brad Wong and Priscilla Twumasi-Baffour

Introduction

Human capital development remains a critical condition for the growth and development of an economy. The current United Nations Sustainable Development Goal 4 entreats all member countries to “ensure inclusive and equitable education and promote lifelong learning opportunities for all” by 2030. Further, human capital also remains key in achieving Goals 1 and 8 of ending poverty and creation of decent jobs as it empowers individuals to take up better employment opportunities to improve their earnings capacity and livelihood in in general. In order words, for a nation to grow and escape the multiple ills of poverty, it must place the development of human capital among its citizens at the core of development planning and policies.

Ghana’s education policy has undergone dynamic reforms over the past two decades in furtherance of training quality human resource for national development. Currently, Ghana’s education system is made up of basic education (Pre-school, Primary and Junior Secondary School) constituting the first eleven years in school while post-basic education comprises Senior Secondary School (SSS) and Technical and Vocation Training and tertiary education which is made up of universities, colleges of education and polytechnics (Government of Ghana, 2004). The commitment of the country towards improving its human capital capacity is enshrined in the 1992 constitution. Section 25 (1) of the constitution compels every government of to ensure that every person has the right to educational opportunities including free and compulsory basic education; a progressive introduction of free secondary and higher education; and intensification of functional literacy.

Although access to education improved after the country’s first major educational reforms in 1987, the quality of education at all levels remained unchanged (World Bank, 2004). In an effort to address the issue of quality at the basic level, Free Compulsory Universal Basic Education (FCUBE) was implemented in 1995 where significant resources were devoted towards its implementation (World Bank, 2004). Subsequently, it was noted that the goals of the FCUBE were not fully achieved because auxiliary fees were not completely absorbed. This necessitated the institution of the Capitation Grant in 2005 to absorb such fees which served as a barrier to some families. Other programmes that have been implemented to improve educational outcomes over the years include the school feeding programme and free supply of school uniforms and exercise books. These programmes are known to have contributed significantly to enrolment at all levels. For instance, according to the Ghana Statistical Service (2014), there has been a steady increase in the porportion of persons with secondary and tertiary education but a decline in the proportion for uneducated persons out of the total poulation. While there has long been a free basic education in the county's public schools, the constitutional requirement for free secondary school was recently initiated in 2017.The current free senior high school policy is expected to significantly increase the number of secondary school gradutes in the country.

In the face of various reforms and policy initiatives in the country's educational system, an assessment of the effect of education on earnings of the masses who are receiving such higher education is important. As predicted by the human capital theory, education increases the employment and earning opportunities of existing and potential workers. However, it should be noted, that excess supply of educated individuals that are not matched with demand might have a deteriorating effect on potential education effect on earnings. Thus, from basic economic theory of demand and supply, lower wages would be offered in the presence of surplus labour. Consequently, returns to education although positive, may not necessarily increase monotonically across for all earnings groups. It is against this background that this study examines the returns to education at different quantiles of the earnings distribution in addition to the mean effect.

Literature Review

The basic theory that underpins most studies on determinants of earnings or wages is the human capital theory (see O'Neill, 1990; Bedi & Gaston, 1999; Huggett et. al, 2006). Though, there is no universal definition of human capital, most studies have however provided a working definition in the literature. Human capital is generally defined to include all forms of education, experience, training, skills, health, and other human characteristics that serve as essential inputs of workers' productivity (Huggett et. al, 2006; Abadie et. al, 2002; Xiao, 2001). From a neoclassical perspective, improvement in productivity is expected to reflect in the remuneration of workers.

Empirically, a number of studies have sort to examine how human capital endowment, particularly education and experience, contribute to influencing worker's earnings. A study by Sarwar and Sial (2012) examined how education affects the different parts of the distribution of earnings in Pakistan. The authors found that returns to education tends to increase monotonically from the least quantile to the highest. Another stimulating results that is worth noting is that within each quantile, the effect of the various levels of education differed strongly, with the effect being higher for tertiary than secondary and primary education. In contrast, the study by Lee and Lee (2006) found the rates of return to human capital be marginal in Korea than to other demographic characteristics like age. Lee and Lee (2006) supported their findings with the argument that in the Korean labour market, what matters most is the job skills rather than education which does not essentially provide the required skills that employers seek. As a result, these job skills are often provided by employers in order to improve the efficiency and productivity of their workers with the goal of maximizing profits. The estimation results confirmed a much higher earnings among highly skilled white-collar workers than their counterparts in any other occupation. Across all quantiles, females were found to be more likely to be underpaid relative to males.

Martins and Pereira (2004) studied the potential role of education on wage inequality for 16 developed countries. Result from their descriptive analysis revealed that with the exception of Greece, almost all the other 15 nations followed a particular earning pattern where the returns to education appeared much higher at the upper quantiles compared to those at the bottom end of the conditional distribution of earnings. Separate regression for each country confirmed that the returns to education are higher for more educated workers over the wage distribution than less educated ones.

Billger and Lamarche (2010) used panel quantile regression method to explore the plausible factors accounting for immigrant-native wage differentials in UK and U.S. The results reveal that throughout the conditional earning dispersion, male immigrants from non-English-speaking countries significantly and consistently receive lower wage than their native counterparts in U.K. whereas the findings from the U.S. sample show that male immigrants receive significantly lower wage than natives irrespective of the country of origin. Also, the findings thus show that immigrant women from English speaking countries in the high paid groups tend to earn similar wage to that of the natives in U.S. while in the case of U.K, such differential was found to be hardly significant.

Twumasi-Baffour (2016) made use of two rounds of the Ghana living standards survey 1999 and 2006 to investigate the differential impact of education on earnings of urban workers in Ghana using quantile regression technique. Specifically, the study analyzed returns to education across the entire earnings spectrum to examine whether some workers benefit more from education than others with its attendant implication on inequality. Findings from the study indicates a change in the pattern of returns between the two periods. Earnings inequality reducing trend of education observed in 1999 has changed overtime in the Ghanaian labour market. That is, individuals on the higher spectrum of the earnings distribution in 2006 were found to earn higher educational premiums at all levels in the Ghanaian labour market. The study further observed higher earnings in the formal relative to the informal sector.

Methodology

The earnings model: Empirical specification

This section presents the estimation procedure for the study. A number of studies have examined the role of human capital in the literature on earnings using the Mincerian equation. Following these studies and the theoretical underpinnings of human capital, the study defines the earnings of a typical worker as a function of his/her human capital endowments in the following:

$$Earnings\_\log = F(Edu, PLExp) \tag{1}$$

Where *Earnings_log* is the outcome variable measuring the log of monthly earnings, including all allowances and in-kind payments while the variables *Educ* and *PLExp* are worker's education and potential labour experience respectively which are proxy for human capital.

Undoubtedly, other factors apart from human capital have been identified to also influence the earnings of workers. Based on prior studies, the following control factors are considered: gender, marital status, religion, location, among others. Hence, equation (1) above can be extended so that:

$$Earnings\_\log = F(Edu, PLExp, Controls) \qquad (2)$$

Where *Controls* is a vector of the above factors other than human capital variables. Empirically, the full earnings model in equation (2) can be specified in the form:

$$Earnings\_\log = a + bEduc + cExp + dExp\_square + dControls + u \qquad (3)$$

Where *Exp_square* is the square of potential labour experience. Specifically, as postulated by the human capital theory, we expect education and potential years of experience in the labour market to exert a positive and significant influence on worker's earnings. In order to unambiguously underscore the role of human capital in the earnings distribution of workers, this study defines education in two different ways: years of education and levels of education. While the former measurement can only inform us of the average effect of education on earnings, the latter on the other hand, provides a much clearer and detailed information on varied returns to education at different levels (for instance, basic, secondary and tertiary). On the other hand, this study postulates an increasing effect of potential years of labour experience on earnings but at a decreasing rate. Table 1 provides detail explanations regarding the measurement of human capital and the control variables, as well as their expected or a priori signs.

Table 1: Definition of explanatory variables and their expected sign

Variable Name	Definition	Expected Sign
Dependent variable: Log of earnings	This is the log of workers' monthly earnings, including all allowances and in-kind payments	- - -
Education (Educ)	Education is measured in two ways: A continuous variable for worker' years of education A categorical variable for primary, secondary, vocational and tertiary education; no education is set as the reference group	*Positive (+)*
Potential labour experience (PLExp)	This is a continuous variable measuring the potential years of participating in the labour market excluding the number of years spent in schooling	*Positive (+)*
Square of potential labour experience (PLExp_square)	This is the square of potential labour experience	*Negative (-)*
Sector of work	This is a dummy variable with a value of 1 if a worker operates in the services sector and 0 otherwise	*Positive (+)*
Hours of work	This is the number of weekly hours a worker spend on his/her main job	*Positive (+)*
Female worker	This is a dummy variable with a value of 1 if a worker is a female and 0 otherwise	*Negative (-)*
Urban location	This is a dummy with a value of 1 if a worker is located in an urban area and 0 otherwise (rural)	*Positive (+)*

A major challenge in the literature is the issue of sample selection bias (Heckman, 1979). Some studies have argued that individuals who are dissatisfied with their jobs or anticipate some sort of dissatisfaction easily get discouraged and consequently stay outside the labour market (Gazioglu & Tansel, 2006; Falco et al., 2012). Also, some individuals who are currently unemployed might possess certain characteristics which could lead to differences in their earnings compared to those currently employed. Hence, to arrive at a more robust and reliable estimates, this study seeks to correct for the possibility of sample selection during the estimation process.

Estimation Technique: Unconditional Quantile Regression (UQR)

This section outlines the estimation techniques of the study. Prior studies have applied different techniques to empirically estimate the determinants of workers' earnings. Among others, most of these empirical works have mostly relied on the traditional Ordinary Least Square (OLS). In spite of its wide application, the approach focuses just on conditional mean effects and, hence, completely ignores the possibility that human capital can exert varied influence across the different quantiles or parts of the earnings distribution. Additionally, in the presence of outliers, as the case of most continuous variables like earnings, the traditional OLS often yield to unreliable parameter estimates. To address these limitations, some researchers have applied a quantile regression.

Generally, quantile regression can be classified into two, namely, conditional quantile regression (CQR) by Koenker and Basset (1978) and unconditional quantile regression (UQR) by Firpo et al. (2009). The latter is said to have an advantage of intuitive interpretation and generalization of research findings than the former (see by Firpo et al., 2009; Thu Le & Booth, 2014). Very limited studies have taken advantage of this recently improved technique (thus, UQR), and this is true for empirical analysis of determinants of earnings in the literature.

The following presents the procedures for carrying out the UQR. This technique is underpinned by the influence function (*IF*) and re-centered influence function (*RIF*). Define *v*(*F*) to be a distributional statistic at any quantile of the distribution, so that an influence function, denoted by *IF*(*E; v(F)*), is defined as the influence of a particular observation on *v*(*F*).

Following this, the *RIF* can be defined in terms of *IF* as:

$$RIF\left(E;v(F)\right)=v\left(F\right)+IF\left(E;v(F)\right) \tag{4}$$

The technique assumes a zero expectation of the *IF*, so that the *RIF* in equation (4) above is simply defined as *v*(*F*). Hence, according to Firpo et al. (2009), the UQR can be stated in the following as:

$$RIF(E;q_{\pi})=q_{\pi}+\frac{\pi-\phi\left\{E\leq\pi\right\}}{f_{e}(q_{\pi})}$$

(5)

Where q_{π} is defined as the π th quantile of the unconditional earnings distribution; f_e is the marginal density function of the distribution and; $\phi\left\{E\leq\pi\right\}$ is an indicator function indicating whether the outcome variable is above or below the π th quantile. Since kernel density generally underestimate the standard errors, the authors (thus, Firpo et al., 2009) have opined that one can obtain robust standard errors and estimates through the application of bootstrapping.

With a given set of independent variables (denoted by X), the distributional statistics of the outcome variable (in this case earnings) can just be defined as the conditional expectation of RIF in the following:

$$q_{\pi} = E[RIF(E;q_{\pi})/X] \quad (6)$$

By imposing the law of iteration (a condition that the expectation of the conditional expectation is just the unconditional expectation), equation (6) above is re-written as:

$$q_{\pi} = \int E[RIF(E;q_{\pi})/X]dF(X) \quad (7)$$

So that the conditional expectation of RIF is linearly defined as follows:

$$E[RIF(E;q_{\pi})/X] = BX + \varepsilon \quad (8)$$

Where B *and* ε are the parameters and error terms respectively.

On the assumption that the expected value of the error term is zero, the OLS and UQR will lead to similar estimates at the mean distribution of the earnings function (Firpo et al., 2009). Aside this traditional mean analysis, the partial effects of a particular independent variable on earnings are estimated at three different parts of the distribution, thus, 25^{th}, 50^{th} and 75^{th} quantiles.

Data

This study relies on data from the seventh round of the Ghana Living Standards Survey (GLSS7), which is a nationally representative household survey conducted by the Ghana Statistical Service (GSS) in 2016/17. The data contains detail information on socio-economic factors of individuals and households including age, gender, education, religion, labour force participation, employment types, and earnings, among others. The first stage of the survey involves a random selection of enumeration areas (EAs) according to the administrative regions, as well as the rural and urban locations of the country. On the other hand, the second stage selected a random maximum number of 15 households from the selected EAs to be interviewed which lead to 15,000 potential households from 1,000 EAs. The response rate for the survey is 93.4%, representing 14,009 households. In all, 59,864 individuals or members from these households were successfully interviewed. Following similar studies on Ghana, the sample for this work is limited persons in the working-age group of 15 years and older.

Additionally, due to some missing observations the actual sample for this study is reported to be a little over 4, 500 workers in the defined working-age group.

Table 2 provides a brief descriptive statistic of the variables used for the study in terms of their means and standard deviations.

Table 2: Description statistics

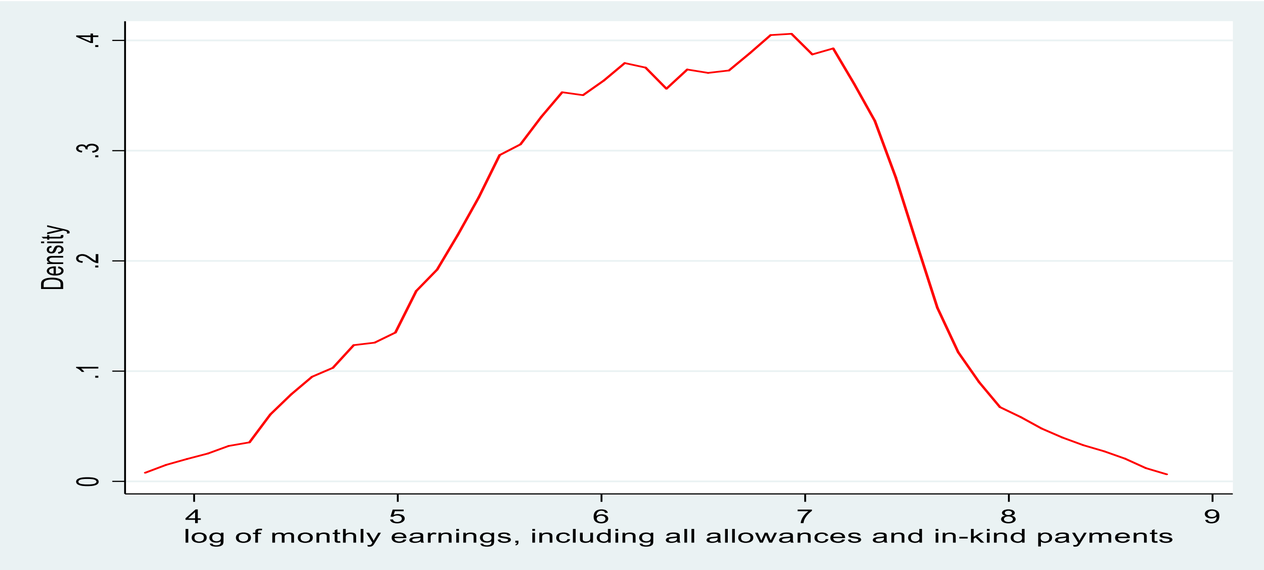
Variable	**Mean**	**Std. Dev.**
Log of monthly earnings	6.3	0.9
Years of education	10.6	4.0
No education	0.1	0.3
Primary education	0.1	0.3
Junior high	0.3	0.4
Secondary education	0.2	0.4
vocational/training	0.1	0.3
Tertiary education	0.2	0.4
Potential labour experience	19.0	12.1
Services sector	0.7	0.4
Working hours (weekly)	36.1	20.8
Female worker	0.3	0.5
Urban location	0.6	0.5

Source: Computed from the GLSS7, 2016/17

The average years of education and potential labour market experience are estimated to be around 10.6 and 19 years respectively. Around 1 out of every 10 workers is found to be without any formal education and this is similar for those with primary and vocational/technical/training education. Approximately 30% and 40% of our sample have junior high and at least secondary education respectively. These statistics seem to suggest higher educational attainment among workers than the traditional dominance of no education and basic education in Ghana. A plausible reason could be due to the fact this study focuses on paid workers and hence, some fraction of the labour force, particularly the own account workers and unpaid workers in the informal sector, are not captured due to missing data points for earnings. These informal workers are predominantly uneducated with few having primary education (GSS, 2008, 2014). The standard deviations show a much wider disparities in the potential years of labour force participation as compared to educational disparities among workers. About 7 out of every 10 paid workers are located in the services sector with the remaining fraction in the agricultural and industry sectors. The averages working hours per week is estimated to be around 36 hours. Females account for about one-third of paid workers. Compared to rural areas, about 60 % of workers reside in the urban areas.

The distribution of log of earnings is shown in Figure 1 below. The earnings distribution is reported to be slightly skewed to the right, as the median value for log of earnings (thus, 6.4) is found to be somewhat above the mean value (6.3 from Table 2 above). Very importantly, the distribution provides a further justification for the use of quantile regression to examine the differential effects of human capital across the earnings distribution.

Figure 1: Kernel Density for monthly earnings (in log)



Discussion of Results

Tables 3a and 3b present the estimates for the basic earnings equation where human capital (thus, education and experience) are considered to be the only explanatory variables while Tables 4a and 4b (in appendix) display the results for the extended equation which controls for other variables. The analysis is carried out to distinguish earnings effects of years of education (Tables 3a and 4a) from that of levels of education (Tables 3b and 4b). In all cases, the estimates show the importance of accounting for sample selection bias and this is shown by the significant coefficients of the selectivity variable (otherwise known as inverse Mills ratio).

The results for education and potential labour market experience meet our earlier expectations. First, the analysis reveals a significant average effect of education on the log of worker's monthly earnings. In addition, to investigate whether education influences earnings inequality, the study employs the quantile regression technique to analyze the effect of education along the earnings distribution.

Table 3a: Earnings effect of human capital variables

Variable	**OLS**	**q25**	**q50**	**q75**
Years of education	0.07***	0.08***	0.11***	0.08***
	(0.00)	(0.01)	(0.01)	(0.01)
Potential labour experience	0.03***	0.03***	0.04***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Potential labour experience square	-0.00***	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Selection variable (inverse Mills ratio)	-0.56***	-0.69***	-0.87***	-0.38***
	(0.06)	(0.10)	(0.09)	(0.06)
Constant	5.34***	4.74***	5.07***	5.85***
	(0.09)	(0.13)	(0.13)	(0.11)
Observations	4,539	4,539	4,539	4,539
R-squared	0.19	0.12	0.17	0.12

*Bootstrap standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

Consequently, we observe along the earnings distribution that, the effects of years of education increased between the lower and middle quantiles and begin to fall. For instance, estimates from the basic model show that an additional year of education increases the log of monthly earnings from 0.08 at the 25th quantile to 0.11 at the middle quantile and declines to 0.08 at the 75th quantile (Table 3a). The estimates are very consistent with those from the extended model (Table 4a in appendix).

Table 3b: Earnings effect of human capital variables

Variables	**OLS (1)**	**OLS (2)**	**q25**	**q50**	**q75**
Basic Education	0.10**				
	(0.04)				
Primary education	-	-0.06	-0.15	-0.15*	-0.04
		(0.06)	(0.10)	(0.09)	(0.06)
Junior education	-	0.13**	0.14*	0.13*	0.09
		(0.05)	(0.08)	(0.08)	(0.06)
Secondary education	0.22***	0.13***	0.13	0.14*	0.12**
	(0.04)	(0.05)	(0.09)	(0.08)	(0.06)
Vocational/training	-	0.65***	0.76***	1.06***	0.48***
		(0.05)	(0.08)	(0.10)	(0.08)
Tertiary education	0.97***	0.93***	0.82***	1.23***	1.06***
	(0.04)	(0.05)	(0.08)	(0.09)	(0.08)
Potential labour experience	0.03***	0.03***	0.03***	0.03***	0.04***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Potential labour experience square	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Selection variable (inverse Mills ratio)	-0.32***	-0.49***	-0.69***	-0.80***	-0.24***
	(0.09)	(0.05)	(0.10)	(0.09)	(0.06)
Constant	5.81***	5.86***	5.37***	5.89***	6.37***
	(0.11)	(0.08)	(0.13)	(0.12)	(0.10)
Observations	4539	4,539	4,539	4,539	4,539
R-squared	0.30	0.24	0.13	0.21	0.17
Other Controls Included	Yes	Yes	Yes	Yes	Yes

*Bootstrap standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

The estimates on the levels of education are very intriguing (from Tables 3b and 4b). Simply put, the earnings effect of education increases generally with the levels of education, with the exception of primary education. However as shown in OLS (1) column of table 3a, when lumped together as basic education the returns to basic education is significantly higher than no schooling. A much interesting finding is the significantly higher effects of vocational/training education on earnings compared to secondary (or senior high) education. A plausible reason could be excess supply of the latter relative to the former. Secondary education in Ghana provides a more general skills as compared to vocational/training education which provides specific and practical skills. From basic economic theory of demand and supply, we would expect a somewhat fall in the price of labour (thus, wage rate) for those with general skills than those with specific and practical skills, all else being equal. Nevertheless, like the case of years of education, returns to these levels of education reduce after the middle quantile. This is a signal that education is to a large extent inequality-reducing among higher earners compared to those along the lower-middle quantiles of the earnings distribution in Ghana.

As expected, returns to potential labour experience is found to have an inverted U-shape. Thus, the positive effect of labour market experience initially increases earnings, reaches a maximum and begin to fall. Apart from the human capital variables, the study finds interesting results for other control variables. For example, female workers earn less than their male counterparts across the entire earnings distribution. Also, workers in urban locations earn significantly higher than rural workers. Paid workers in the services sector generally earn lower than their counterparts in other sectors of the economy.

Conclusion and Policy Recommendations

This study sought to examine the role of effect of education on earnings at the mean and along the earnings distribution. It employed data from the latest nationally household survey by the Ghana Statistical Service (GSS) in 2016/17. By relying on different estimation techniques, the study establishes significant effects of education at all levels on the earnings of Ghanaian workers. Importantly, the study finds differential effects of human capital variables (education and potential labour market experience) along the earnings distribution. Specifically, returns to education first increases from the lower quantile up to the middle quantile and thereafter declines. This observation holds for both measures of years and levels of education. Comparing the different levels of education, the study establishes incremental returns to higher levels of education, with tertiary education having the highest effect followed by vocational/training and secondary education respectively.

These findings imply certain policy directions. First, policy makers are encouraged to strengthen policies that will increase educational attainment at all levels, particularly among households at the lower quantile of the income distribution. Government's recent program of free senior high school is in the right direction as it is designed to improve the educational outcomes of persons in the poor and lower income brackets. Much effect should be geared towards improving the existing vocational/technical schools. Relatedly, the government is encouraged to consider incorporating these vocational/technical schools in the on-going free senior high school programme. However, policy makers are to be conscious of the anticipated number of graduates who may end up increasing the supply of labour and consequently undermine the returns to education. Hence, attempts should be geared towards the creation of employment opportunities and decent jobs to absorb the potential number of new entrants in the labour market.

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Appendix

Table 4a: Earnings effect of human capital variables and other factors

Variables	**OLS**	**q25**	**q50**	**q75**
Years of education	0.08***	0.08***	0.12***	0.08***
	(0.00)	(0.01)	(0.01)	(0.01)
Potential labour experience	0.03***	0.02***	0.04***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Potential labour experience square	-0.00***	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Services sector	-0.35***	-0.45***	-0.44***	-0.23***
	(0.03)	(0.04)	(0.05)	(0.04)
Hours per week	-0.00	0.00	-0.00***	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)
Female worker	-0.21***	-0.25***	-0.27***	-0.19***
	(0.03)	(0.04)	(0.04)	(0.03)
Urban location	0.22***	0.32***	0.21***	0.13***
	(0.03)	(0.04)	(0.05)	(0.04)
Selection variable (inverse Mills ratio)	-0.58***	-0.77***	-0.79***	-0.33***
	(0.07)	(0.11)	(0.10)	(0.08)
Constant	5.55***	5.00***	5.35***	6.01***
	(0.09)	(0.13)	(0.13)	(0.11)
Observations	4,501	4,501	4,501	4,501
R-squared	0.24	0.16	0.21	0.14

Table 4b: Earnings effect of human capital variables and other factors

Variables	OLS	q25	q50	q75
Primary education	-0.05	-0.14	-0.13	-0.02
	(0.06)	(0.10)	(0.09)	(0.06)
Junior education	0.13***	0.14*	0.16**	0.11**
	(0.05)	(0.08)	(0.08)	(0.05)
Secondary education	0.19***	0.18**	0.24***	0.17***
	(0.05)	(0.08)	(0.08)	(0.06)
Vocational/training	0.78***	0.91***	1.23***	0.59***
	(0.06)	(0.09)	(0.10)	(0.08)
Tertiary education	1.02***	0.89***	1.38***	1.15***
	(0.05)	(0.08)	(0.09)	(0.08)
Potential labour experience	0.02***	0.02*	0.03***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Potential labour experience square	-0.00***	-0.00*	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Services sector	-0.38***	-0.48***	-0.49***	-0.27***
	(0.03)	(0.05)	(0.05)	(0.04)
Hours per week	0.00	0.00*	-0.00**	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Female worker	-0.24***	-0.28***	-0.32***	-0.21***
	(0.03)	(0.04)	(0.04)	(0.03)
Urban location	0.20***	0.32***	0.20***	0.08**
	(0.03)	(0.04)	(0.04)	(0.04)
Selection variable (inverse Mills ratio)	-0.47***	-0.77***	-0.69***	-0.14*
	(0.06)	(0.11)	(0.10)	(0.07)
Constant	6.07***	5.64***	6.18***	6.52***
	(0.08)	(0.13)	(0.12)	(0.11)
Observations	4,501	4,501	4,501	4,501
R-squared	0.29	0.18	0.25	0.19

*Bootstrap standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

GHANA PRIORITIES

The Ghanaian economy has been growing swiftly, with remarkable GDP growth higher than five per cent for two years running. This robust growth means added pressure from special interest groups who demand more public spending on certain projects. But like every country, Ghana lacks the money to do everything that citizens would like. It has to prioritise between many worthy opportunities. What if economic science and data could cut through the noise from interest groups, and help the allocation of additional money, to improve the budgeting process and ensure that each cedi can do even more for Ghana? With limited resources and time, it is crucial that focus is informed by what will do the most good for each cedi spent. The Ghana Priorities project will work with stakeholders across the country to find, analyze, rank and disseminate the best solutions for the country.

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Copenhagen Consensus Center is a think tank that investigates and publishes the best policies and investment opportunities based on social good (measured in dollars, but also incorporating e.g. welfare, health and environmental protection) for every dollar spent. The Copenhagen Consensus was conceived to address a fundamental, but overlooked topic in international development: In a world with limited budgets and attention spans, we need to find effective ways to do the most good for the most people. The Copenhagen Consensus works with 300+ of the world's top economists including 7 Nobel Laureates to prioritize solutions to the world's biggest problems, on the basis of data and cost-benefit analysis.