Economist Brief for Ghana Priorities

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Executive Summary

This document is intended for commissioned economists who are partnering with Copenhagen Consensus Center to undertake a cost-benefit analysis in the *Ghana Priorities* project.

Ghana Priorities – a research and advocacy project run by the Copenhagen Consensus Center aims to answer the simple yet bold question:

> *If you had billions of additional Cedis to make Ghana better, how would you spend it to **maximize** your impact?*

Partnering with Ghana's and the world's top economists and researchers, we will undertake **cost-benefit analysis of 60-80 interventions** across a range of fields, to identify the ones with the greatest 'bang-for-buck'. These 60-80 interventions will be chosen via a vetting process that incorporates the input of senior figures in the Ghanaian policy space.

Our projects involve four stages: **consultation, research, prioritization and advocacy**. Commissioned economists are primarily involved in the research stage, though they also have significant involvement in the prioritization stage and if they so wish, the advocacy stage.

The project's theory of change is predicated on the idea that the variation in intervention effectiveness has a long tail - the best interventions are 2-3 orders of magnitude more effective per unit cost than typical or average interventions. Pushing for implementation of these outliers is likely to generate more social welfare than marginal improvements in the entire portfolio of spending.

The academic analysis is predicated on an injection of **new money** available to decision makers. This means that all cost-benefit analyses are prospective and take the existing coverage of interventions as the baseline.

Copenhagen Consensus uses cost-benefit analysis whose approach and methods are well established. However, there are important nuances associated with Copenhagen Consensus' approach that all researchers should note. This document outlines these approaches along with consistent assumptions in the attached spreadsheet.

1. Introduction

Ghana has taken great strides in the first two decades of this century, halving extreme poverty, reducing the numbers suffering from extreme hunger and HIV, and achieving near universal primary education. Now that Ghana is officially a middle-income country, challenges of a different nature are on the horizon.

The new Ghanaian government's transformative agenda to build a 'Ghana Beyond Aid' is bold and ambitious, but which programs should the government prioritize in education, health care, industrialization, agriculture and trade? How can we use lessons from research and international best practices to make Ghana's economy more prosperous and competitive? Like all countries, the scope of problems in Ghana far exceeds the resources available to address them. As such, this requires hard choices about where to invest first.

One organizing principle, though by no means the only one, is that Ghana should spend money on interventions that deliver the largest amount of social, environmental and economic good for every Cedi available. It is this idea that motivates *Ghana Priorities* – a research and advocacy project that will attempt to answer the bold yet simple question:

> *If you had billions of additional Cedis to make Ghana better, how would you spend it to **maximize** your impact?*

Copenhagen Consensus' mission is to influence spending towards interventions and policies that do more good per Cedi (or unit of currency) spent.

Cost-benefit analysis (CBA),[1] also referred to as benefit-cost analysis, is a well-established formal method for identifying interventions that maximize social welfare per unit cost, and is the primary methodology of the Copenhagen Consensus Center. Conceptually, the process of CBA is straightforward: an analyst identifies a given policy and estimates the impacts of this policy relative to a baseline scenario. These marginal impacts are classified into costs and benefits (more on this classification below), and converted into a common metric, typically into the local currency, that reflects market prices or individuals' willingness-to-pay for those benefits and costs. Because all costs and benefits are converted to a common measure, CBA facilitates comparisons across interventions that might have very different outcomes such as lives saved, hectares of forest preserved or increased economic output. All results are summarized as a benefit-cost ratio (BCR: benefits divided by costs).[2]

CBA is typically used to compare a limited set of interventions to inform policy decisions in a single sector. For example, should a regional government authority invest in Road X, Road Y

[1] Copenhagen Consensus conducts social CBAs. The 'social' aspect signals that the cost-benefit analysis accounts for and aggregates the costs and benefits of *all* relevant parties who are affected by the policy, and is distinct from 'private' cost-benefit analysis, which only concerns the impacts on a single party.

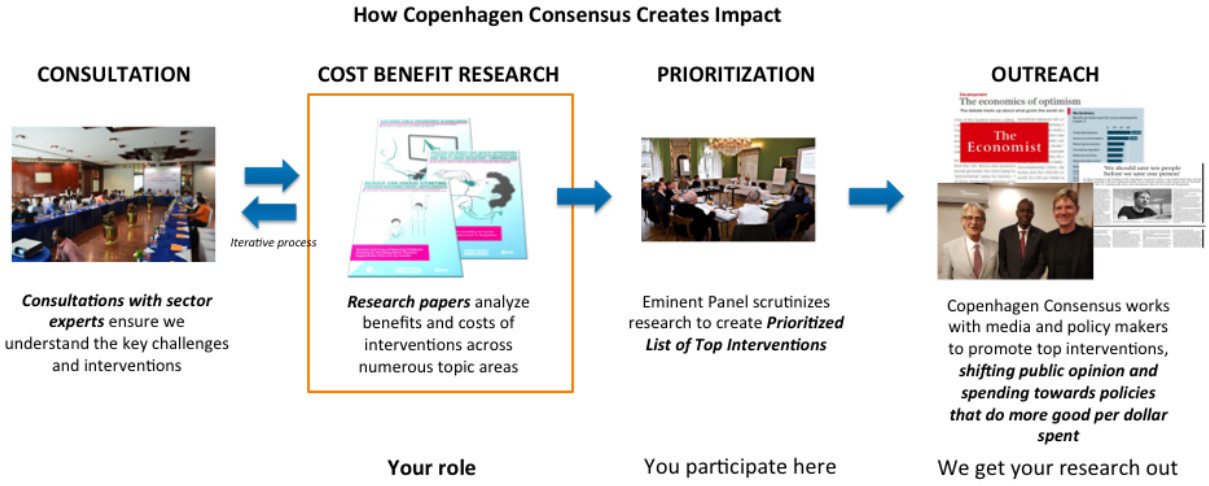
[2] Results of CBA can also be summarized in other ways, such as net benefits, internal rate of return or payback period. Copenhagen Consensus' preferred metric is the BCR as described below.

or Railway Z? The Copenhagen Consensus takes a more holistic approach, **analyzing 60-80 interventions across all relevant sectors in the country, to identify the ones with the largest 'bang-for-buck'.**

The purpose of this document is to outline the Copenhagen Consensus approach to CBA, how it supports our mission and to serve as a guide for commissioned economists who undertake CBA for the Ghana Priorities Project.

2. Broader setting of Ghana Priorities

As stated above, the *Ghana Priorities* project contains several phases. While the focus of this document is the research phase, we first describe the broader context. The figure below provides a broad schematic of Copenhagen Consensus Center's process.



Consultation: in this stage we engage with various sector experts to understand the key challenges of the country and some of the interventions that could address those challenges. Specifically for *Ghana Priorities* we have consulted with academic experts, various government ministries, the National Development Planning Commission, and formed a Reference Group of high-level policy specialists to assist us in this step (see appendix for list of Reference Group members). We have also consulted secondary literature, government reports and international databases to add to the interventions proposed. This has yielded a long list of around 500 interventions, which we will shorten, with the help of the Reference Group, to a manageable list of 60-80 for further research. Preference for the finalized list of interventions to be studied are given to those that are **likely to be highly cost-effective or those backed with significant funding and political will**.

Cost-benefit research: During this phase, we commission leading economists to conduct cost-benefit analyses of one or more interventions identified during the consultation stage. Researchers work in collaboration with the Chief Economist and his team. The Copenhagen Consensus brings its expertise in general cost-benefit analysis and relies greatly on the researcher to provide sector expertise, data, and knowledge of country-specific literature and intervention effects, ensuring that the intervention is adapted to local context. Where

necessary, international economists, having previously undertaken similar analyses, may also be consulted on the CBA model.

Regardless of the nature of the research partnership, all papers will be subjected to formal peer review: internally reviewed at the Copenhagen Consensus Center, and externally reviewed by a (local) sector expert and an economist having experience in cost-benefit analysis (this may be an international expert). Review roundtables will be organized in Ghana with the objective of reviewing all papers, preferably within a given sector. Researchers will then be expected to finalize their drafts.

For a given commissioned economist, the output of this stage of the project is a cost-benefit paper, of academic quality, analyzing the agreed interventions, co-authored with the Copenhagen Consensus and any other parties that have made a significant contribution. For the entire project, the output of this stage is a **menu of 60-80 interventions**, each with accompanying costs, benefits and BCRs.

Prioritization: After the research is complete, all commissioned economists will convene in Accra, Ghana (tentatively scheduled for May 2020) to present their findings to an Eminent Panel. In the past this has included renowned internationally-recognized economists, some Nobel laureates, working alongside prominent Ghanaian economists. The Eminent Panel interrogates the research and prioritizes interventions from first to last, informed by the results of all cost-benefit analyses. The rationale behind this step is to force a conversation about the importance and reality of prioritization. **It is hoped that the top interventions from the prioritized list along with the menu of BCRs, will form the basis of future advocacy efforts in Ghana.**

Note that separate prioritization exercises by other groups may also take place, and, in the past, we have asked youth, rural citizens and government to undertake them.

Outreach: The aim of this stage is to influence future spending towards the most effective interventions emerging from the research and prioritization phases. We will use many different approaches to achieve this – including direct meetings with government, inviting journalists to cover our research, and writing opinion editorials in Ghana's and the world's most prominent media outlets. The latter is one of Copenhagen Consensus' primary strengths, and we have consistently been named in the top 20 think tanks globally in the advocacy category in the Go-to-thinktank rankings. Section 3 describes our theory of change in greater detail.

Also during this phase, an academic volume will be published with the research papers, sector expert commentaries, and commentaries from the eminent panel.

3. Theory of Change

All Copenhagen Consensus exercises, including Ghana Priorities, are processes designed to inject more rationality into the debate around doing good for the world. We believe that by providing information on which interventions are more effective than others, we give headwind to bad ideas, and tailwind to good ideas; i.e. promotion of the highly beneficial interventions. This increases the likelihood that government and philanthropic spending becomes more effective on average. Because the influenceable pool of money is very large, even small changes in allocation can improve effectiveness and hence large improvements in social welfare.

Our mission is influenced by another feature of the distribution of intervention effectiveness:

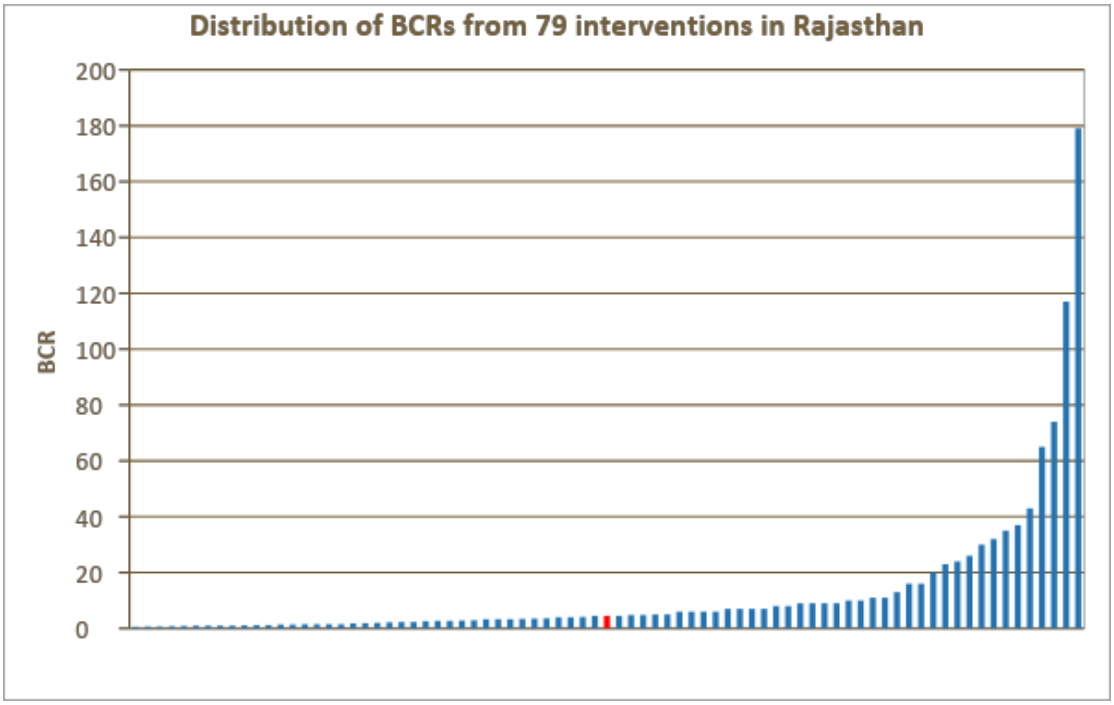
> *The difference between the worst intervention and the best intervention in a distribution is usually **2-4 orders of magnitude**, while the difference between the median intervention and the best intervention is **1-3 orders of magnitude**.*

This has been documented in global health (Ord, 2013), education (McEwan, 2015) as well as all of our country level projects (Copenhagen Consensus, 2015, 2016, 2017, 2018).

For example, Figure 1 below depicts the span of BCRs from the recent *Rajasthan Priorities* project. The top intervention has a BCR of around 180, the median intervention a BCR of 4.5 and the lowest intervention a BCR of 0.9. Because our process aims to filter out very ineffective interventions before they are researched, it is possible the true distribution is 1 or 2 orders of magnitude wider at the lower end.

The implication of this large dispersion of effectiveness is that we focus on identifying the interventions at the top of the distribution and push strongly for their implementation. This is likely to be a superior strategy than making marginal improvements in existing interventions. In the case of the *Rajasthan Priorities* project, a decision maker with 100 rupees could spend 5% of her money on the top intervention and generate more social welfare than spending the remaining 95% on programs that are twice as efficient as the median intervention.

The implications of this for Copenhagen Consensus projects is that it is important that we canvas a wide range of policy options to increase the chances of finding these outliers. Additionally, given that the dispersion is so large, a high degree of precision is not typically required to identify outliers. While of course more precision is preferred to less, it is unlikely for example, that deeply investigating a particular methodological issue that will move an intervention from say, a BCR of 2.2 to 3.7 is required to achieve our aims.

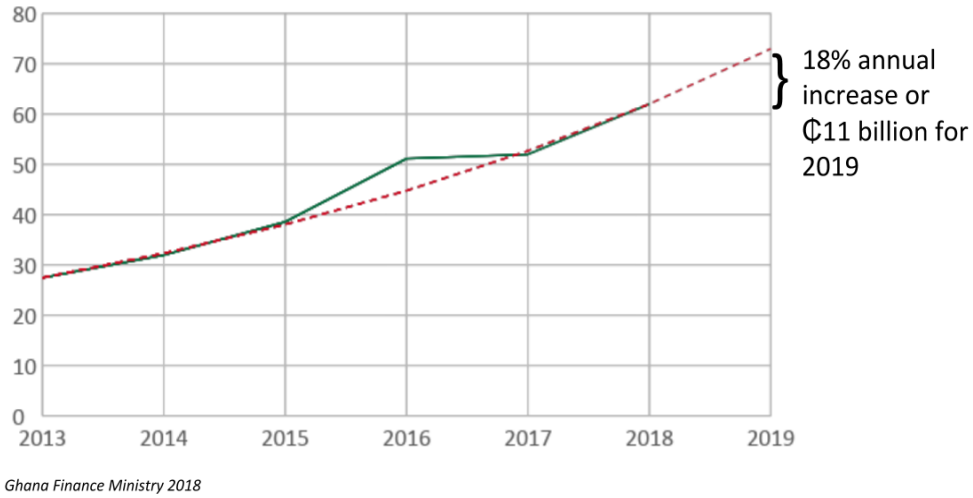


Source: Rajasthan Priorities project. Red bar represents median intervention with BCR of 4.5.

4. Academic exercise

The academic exercise of *Ghana Priorities* is premised on an **injection of new money available to decision makers**, that can only be spent on expanded or new programs. The specific amount is unimportant and conceptually, it only needs to be large enough to cover a reasonable amount of new projects but not so large that it would significantly distort prices in the economy. This scenario reflects the reality of Ghana, which has consistently increased public expenditure annually by 18%, since 2013 (see figure below).

Ghana's total public expenditure, 2013-2019



Ghana Finance Ministry 2018

Importantly, **because the money is new**, it implies:

1. **the baseline for all CBAs is the existing absolute coverage level of interventions** i.e. resources are not being taken away from what is currently being done
2. the CBAs are **a prospective analysis of future expansions of existing programs, or standing up wholly new programs,** and **not** an evaluation of past efforts

This feature is designed to conform to the economic concept of marginal analysis and it also assists in outreach and communication. Since one cannot use our results to predict what would happen if **existing** money was redistributed across portfolios, only what would happen with hypothetical **new** money, it makes the exercise more politically palatable for decision makers and bureaucrats, increasing the chance that the information will be used.

It is important that economists are clear about the baseline scenario assumptions. The approach of considering only marginal money, suggests that the absolute coverage level of interventions is the baseline, with additional expansions either due to population growth or expanding the scope of beneficiaries subject to cost-benefit analysis. In terms of the problem being addressed by the intervention, the economist should estimate a baseline that is consistent with previous trends noting the main drivers of the problem (e.g. demographic transition, wealth, disease transmission etc…).

The unit of analysis in all our projects is an 'intervention'. **An intervention is a specific, concrete and time bound action that can be taken by policy makers** such as '*provide more TB screening and treatment*' or '*allow free movement of vehicles from India through Bangladesh*'. It is not an aspiration without means, e.g. '*eliminate poverty*'. Interventions are typically subset of wider of programs implemented by governments. For example "providing supplementary foods to mothers and children" is one intervention in the wider Integrated Child Development Services program in India. **Our focus is generally at the intervention level, and not the program or mission level.** Papers may cover one or more interventions according to the preferences, availability and expertise of the commissioned economists, and the interventions may fall under a particular programme, but the exercise should not be considered a programme evaluation.

Because interventions will be compared to each other, **it is very important that all commissioned economists use the same assumptions, methods and data**. Section 6 documents the sources and methodology for the most prominent assumptions that will be used in *Ghana Priorities*. It is also important that all analyses estimate **realistic, and not ideal nor conservative** costs and benefits (more on this methodological issue below).

To remain cost-effective, the Copenhagen Consensus encourages researcher to use existing primary data and to focus more on **generating consistent and comparable information for policy makers.** Consequently, there is no expectation that researchers will survey

individuals, conduct experiments or engage in time-intensive data collection, without the express permission of the Chief Economist.

5. Methodological Guidelines

There are numerous textbooks that go deeper into the theoretical foundations of CBA and methods (e.g. Boardman et al., 2018) as well as guidelines that more fully lay out the steps of CBA (e.g. Robinson et al. 2019). These will not be re-explained here. Nevertheless there are important, sometimes subtle methodological differences in how CBA is conducted by practitioners within the field. This section delves into some of the details of the Copenhagen Consensus approach to CBA.

a. Use of evidence

One of the main analytical challenges is discerning the appropriate evidence as it relates to the beneficiary population in question. Determining which literature to adapt can be a complex judgment that should consider contextual relevance, study quality, and literature consistency. For example, it is clear that preference should be given to high quality analyses that are from the country in question, followed by other developing countries in the region and having similar socio-economic and demographic conditions, then developing countries in general and if there is absolutely no other evidence, developed economies. Use of effect sizes from carefully conducted meta-analyses is, of course, also encouraged. However, when the most contextually relevant studies have less robust experimental designs or the literature is divergent in its conclusions, then the parameter choice is less straightforward.

Overall, it is important that economists **build a case** for the parameters that are eventually adopted, noting uncertainty and the quality of evidence behind them. Copenhagen Consensus papers report 'quality of evidence' along with BCRs (see appendix for uncertainty framework adopted by Copenhagen Consensus, adapted from DFID's framework).

b. Estimating all significant costs and benefits

Meaningful comparison across interventions requires that all significant costs and benefits are accounted for. In some cases this will be difficult to achieve due to imprecision or lack of data. Nevertheless, we encourage commissioned economists to make an attempt to estimate these costs and benefits, rather than leaving them off altogether. In many academic papers, conservatism is readily accepted (e.g. "we choose not to estimate these benefits, noting that the results represent an under-estimate"), perhaps because the aim is to merely to assess whether benefits are greater than costs. However, in a multi-sectoral, comparative format like most Copenhagen Consensus exercises, it will lead to potentially incorrect conclusions if some economists are being conservative while others are not.

Therefore, we suggest economists **neither be conservative nor optimistic**, and do their best to include estimates of all costs and benefits that are likely to be significant in the analysis.

This might entail examining benefits outside the primary aim of the intervention. For instance, when looking at climate change adaptation by planting mangroves, the benefit is not just climate protection, but also improved biodiversity and potential higher incomes to fishers. Likewise, an education intervention will not just increase earnings, but also may make it less likely for girls to marry young and teach future mothers to feed their children better. If some of these secondary benefits are more speculative or less robustly estimated in the literature, it is possible to include these aspects as part of sensitivity analysis to get a sense of the scale of potential omitted benefit (or cost).

c. BCR vs. net benefits

While many CBAs highlight net benefits (B minus C), our preferred metric is the benefit-cost ratio (BCR), which is benefit (B) divided by cost (C). The reason for this is that in developing country contexts the ability to raise funds (through taxation or debt), or the ability to enforce regulation is constrained. This is perhaps different to developed countries, which can typically raise money and legislate with much greater ease. Given a fixed pool of available funds (as is the case in our 'thought experiment' set up, as well as in actual political decision making), a strategy that begins with implementing the highest BCR intervention and continues in decreasing order until money runs out will maximize social welfare. A strategy that starts with the highest net benefits intervention continuing in decreasing order, almost certainly will not.

For example, suppose a policy maker has $100 and is faced with the following options

	Benefits	Costs	Net Benefits	BCR
Policy A	$300	$100	$200	3
Policy B	$240	$60	$180	4
Policy C	$200	$40	$160	5

If the policy maker chooses based on the intervention with the highest net benefits, then she would choose policy A, run out of money and generate net benefits of $200. However, if ranked on BCR, she would implement policy C, and then policy B, before running out of money. This would generate $340 in net benefits.

There are two caveats to using BCR. Firstly, artificially high BCRs can be generated if costs are unusually small, which is often the case when an intervention is proposed at scale. So care must be taken to investigate only interventions of a reasonable scope.[3] The second caveat is that costs and benefits need to be consistently classified which is discussed further below.

[3] Incidentally, the net benefits metric has a similar problem with scale but in the opposite direction. An intervention with a low BCR, say 1.1, that takes up the entire government budget will likely have large net benefits measure merely because lots of money is spent.

d. Classification of costs and benefits

It is important that costs and benefits are classified consistently to ensure comparable BCRs. Robinson et al. (2019), suggest that inputs into a process (such as materials and labor) should be classified as costs, while outcomes (such as mortality risk reductions or increased productivity) should be classified as benefits. This approach is intuitive and generally followed in Copenhagen Consensus papers.

An additional principle we employ is that **absolute** benefits and costs should be considered where possible, with **no netting off benefits or costs**. For example if agricultural extension services cost $5 and this leads to increased farm revenue of $45, yet also increased farm costs of $10, we would estimate the benefits as $45, and the costs as $5 + $10 = $15 for a BCR of 3. We would **not** net off the revenue and costs (i.e. profit) for benefits of $35, costs of $5 and a BCR of 7. The reason for this is that the true resource cost of the intervention – the amount that is consumed from the fixed pool of funds available to society is $15 and not $5, and so the result from the first approach better captures the return on investment.

e. Treatment of transfers

Interventions involving transfers are an area where consistent classification matters greatly. Transfers tend to fall under the field of social protection and include unconditional cash transfers, conditional cash transfers, food transfers and subsidized insurance. In this case, **the transfer appears as both a cost and a benefit in the BCR equation.** It should **not** be netted out. For example, consider an unconditional cash transfer of $100. Suppose the administrative costs of delivering the transfer are $5 while the transfer delivers consumption-smoothing benefits of $10 to recipients. In this case, the benefits are $110, while the costs are $105 for a BCR of 1.04. If one were to net out the transfer (incorrectly), the intervention would appear as benefit = $10 and cost = $5 for a BCR of 2. However, as above, the real resource cost of the intervention is $105, not $5, so 1.04 is, in our estimation, more accurate reflection of the social return.

f. Time frame of analysis

In terms of the appropriate time frame of analysis, there is one principle: **the time frame should be long enough to capture the most important future flow-on effects** (typically benefits, but sometimes also costs) from a given intervention. The exact length will vary by analysis. For example, since infrastructure lasts for decades, CBAs of roads, public transport, sewage networks and other major capital works should take at least a 20 year (or more) time horizon to capture all the benefits. In contrast, the costs and benefits of say, crop insurance can be modeled as a one year steady-state intervention, since typically insurance covers only

that year's crop, with next year's insurance covering next year's crop and so on.[4] Importantly, as long as the time frame used captures all material flow-on effects, differences in time do not affect the comparability of interventions when using benefit-cost ratio as the metric of interest.[5]

g. The analytical base year is 2018

The analytical base year for *Ghana Priorities* is 2018. This means that all analyses should take the initial conditions of the year 2018 (or as recently as data allows), assuming the intervention begins in this year and assess the effects against this baseline. Additionally, all costs and benefits should be reported in 2018 Cedis.[6] Costs sourced from earlier years should be inflated to the analytical base year using a GDP inflation index, though it is discouraged, when it can be avoided, to use data before 2016. Additionally, **forecasts** of costs and benefits only need to account for real growth and should ignore inflation. Lastly, researchers are strongly encouraged to refer to the GLSS 7 for their estimations.

h. Political considerations

All political costs regarding *the decision to implement* should be ignored, while political fall-out *in actual implementation* should be considered. In other words, all cost-benefit analyses should take as a starting point the hypothetical scenario where the decision is already made to implement the intervention. Costs associated with advocacy, campaigning, etc. to encourage implementation should be ignored. However, if the completed decision may make politicians decide to cheat or skim the process, this simply means a smaller benefit or a larger cost and should be included (along with all other risks, and challenges in implementation).

i. Implementation failure

To the extent that the data allows, commissioned economists should account for implementation failures such as corruption and incompetence. The most straightforward way to account for this is to adopt parameter estimates from studies with high quality methods (e.g. randomized-controlled trial, difference-in-difference, regression discontinuity) which should theoretically embed all the vagaries of implementation into the effect size. In disciplines where these studies are not possible or uncommon, we suggest carefully

[4] That is not meant to imply that individuals do not take multiple years of insurance. However, modeling multiple years of crop insurance will not lead to materially different BCRs than a one year model, since the costs (premiums) and effects (insurance benefits) occur within a one year time frame.

[5] Referring back to the examples above: one might feel it is more appropriate to compare a 20 year road project to 20 years of crop insurance. However, 20 years of crop insurance will have approximately the same BCR as one year of crop insurance, since 20 years of crop insurance is just one year of insurance repeated 20 times i.e. BCR = 20 x benefits / 20 x costs = 1 x benefits / 1 x costs.

[6] Reporting in USD or Int $ is ok, but not required.

considering to what extent the evidence represents ideal or non-realistic scenarios with respect to the actual local context and adjust accordingly. Indeed, even the recent literature around RCTs documents divergence between small-scale pilots and real world implementation.

j. Equity weights

As with most CBAs, as traditionally adopted, Copenhagen Consensus assigns an equal weighting to all costs and benefits regardless of who obtains or pays them. The one exception is for individuals who illegally obtained assets via corruption or theft, which we assign a weight of zero. So for example, in an intervention which reduces corruption, the loss of corrupted funds does not count as a cost in the societal cost-benefit calculation.

k. Jobs vs. output

Cost-benefit analysis, as is traditionally adopted, does **not** count the creation of jobs as a benefit. Instead the focus should be on the flow on effects of job creation – either output, income or consumption. The primary reason, is that job creation is likely to be similar across the different uses of capital – in other words all new uses of resources are likely to create jobs which can be assumed to be non-significantly different in each case, or at least not different enough to matter for our aim of identifying outliers of effectiveness (which as noted above are typically 1-3 orders of magnitude more cost-effective than the typical intervention). Secondly, the value of jobs differs depending on the state of the labor market in question, and this is better determined by examining flow-on effects (the increase in output or the increase in incomes) rather than the monetary value of the number of jobs created. Specifically, in full employment markets, new jobs merely represent a movement of individuals in a broader general equilibrium framework, rather than new welfare per se (and potentially could reduce societal welfare). In this case counting the value of jobs leads to an overestimate of benefits.

In contrast, when labor market distortions are present, job creation might lead to welfare gains. For example, careful studies of India's rural employment guarantee suggest that areas where the scheme is implemented better, households have higher incomes relative to areas where the scheme is implemented worse (Muralidharan, Neihaus and Sukhtankar, 2018). The researchers suggest this could be due to curtailing oligopsonistic power by rural employers. In this case, valuing only the jobs underestimates the value of the welfare gain. Indeed, Muralidharan, Neihaus and Sukhtankar, 2018 identify that, of the total income gains to households, only 10% are due to the wages of the guarantee employment scheme *per se*, with the remainder coming from flow on effects.

Therefore, we suggest that economists ignore job creation per se as a general rule, and instead focus on flow-on effects to output, income or consumption. If the intervention under analysis specifically targets job creation – such as a workfare program like India's rural

guarantee scheme – economists need to examine the broader general equilibrium effects to understand the impact in a cost-benefit framework.

6. Important common assumptions and approaches for Ghana Priorities

a. Economic growth forecasts

Since analyses undertaken in Ghana Priorities are prospective, forecasts of real economic growth are required for cost benefit analysis. The Copenhagen Consensus calculates the GDP growth forecasts using the GDP estimates in the IIASA database as discussed in Riahi et al. (2017). We use the SSP2 scenario and median estimate by OECD and IIASA. GDP estimates are only provided every 5 years, so we assume a constant growth rate figure per 5-year period. We then apply these growth rates to the government estimated GDP in 2018 GHS to estimate a stream of GDP figures (2018 GHS) up to 2080. Often, it is the case that the CBA requires a projection of GDP per capita. In this case, we use population estimates from the SSP2 scenario. As this is also only provided in 5-year increments, we use linear interpolation to estimate population in the "between" years. Thus, GDP per capita (for any given year within the 5-year period) is essentially the GDP forecast (for the 5-year period) divided by each "between" year's population projection.

b. Wages and wage forecasts

Similar to GDP per capita, wages and wage forecasts are required for estimating productivity and education benefits as well as time costs / benefits. Income is estimated by the following equation, relying on a conversion based on GDP per capita forecasts where:

Income = GDP per capita * labor force participation as **a % of total population** * labor share of income

In this case we estimate labor force participation as a % of total population is 43%. This is based on a labor force participation rate of 67.5% for the population aged 15 and above (World Bank, 2018) and a share of population under 15 of 37% as estimated by IIASA.

Labor share of income is assumed to be 50% (NB This may be updated if better information comes to light). The time series of income is included under the projections tab in the spreadsheet template.

Additionally we estimate the average income in urban and rural areas. This is estimated by drawing on wage differentials between rural and urban from the GLSS7 (the urban wage is estimated to be approximately 1.5x average rural wage), and expected share of population in urban areas from IIASA.

c. Discount rates

We acknowledge there is considerable debate around the appropriate discount rate to use in economics. Therefore, Copenhagen Consensus applies a range. For Ghana Priorities the discount rates are 5%, 8% and 14%.

Five percent is commonly used in development economics, for example in a study of a package of nutrition interventions for pregnant women and children (Hoddinott et al. 2013) and six country randomized evaluation of a poverty 'graduation' program (Banerjee et al. 2015). An older review of health economics evaluations showed that 5% was the most common discount rate adopted (67 out of 147; Smith and Gravelle, 2001).

Eight percent is motivated by Robinson et al. 2019 which suggests that a discount rate two times the short term per capita growth rate is used. In the case of Ghana, the short term GDP per capita growth rate is around 4% and therefore suggests 8% is appropriate.

Fourteen percent is the discount rate applied by the Ghanaian Ministry of Finance and reflects the financial discount rate implied by T-bills.

d. Value of mortality risk reduction (deaths avoided)

The value of mortality risk reduction follows the recommendations of Robinson, Hammitt and O'Keeffe (2019) who suggest valuing mortality risk reduction using a range of approaches. The first is to value each death avoided using a value of statistical life year (VSL) of $9.4m USD (2015 dollars) – representing approximately 160 times income as measured by income per capita PPP - transferred to Ghana using an income elasticity of 1.5.

To estimate these values, we take the GDP per capita figure in 2017 Int$ for both Ghana and the USA, and estimate the VSL, in time t=0, 2017.

$$VSL_t = \left(\frac{GDP\ pc_{Ghanat}}{GDP\ pc_{USAt}}\right)^{0.5} * 160\ * GDP\ pc_{Ghanat} \qquad \text{(Eq. 1)}$$

Following Cropper et al. (2019) we estimate each subsequent VSL in the time series according to the following formula:

$$VSL_{t+1} = VSL_t * [(1 + g_t)]^e \qquad \text{(Eq. 2)}$$

Where g_t is the GDP per capita growth rate between period t and t+1 (estimated using IIASA projections, discussed above) and e=1.5. The benefit of a case of avoided mortality is simply the VSL.

Robinson, Hammitt and O'Keeffe (2019) suggest that when the beneficiaries of health interventions are likely to be the very old or the very young, analysts should also include an

approach that values each life year lost from an avoided death. This time series of value of statistical life year (VSLY) across years *t* is calculated by:

$$VSLY_t = \frac{VSL_t}{LE_t(average\ adult\ age_t)} \qquad \text{(Eq. 3)}$$

where the numerator, VSL is given by the equation 1, and the denominator LE (average adult age) is the life expectancy of the average adult age, where adult is defined as anyone aged 15 and above. Age profiles to estimate average age are sourced from Riahi et al. 2017 (SP2 medium term scenario) while the life table for Ghana is sourced from WHO (2019). The benefit of avoided mortality is VSLY * avoided years of life lost from each avoided death.

We acknowledge that there is insufficient empirical evidence to conclusively assert that one should value life years using a constant VSLY over valuing lives using a constant VSL (and vice-versa). **Copenhagen Consensus has a preference for applying VSLY approach in its analyses.** This is because many of the health analyses conducted by us, tend to focus on the very young or adults several decades above the average adult age. Therefore, we are hesitant to apply a constant VSL which i) has its empirical support mostly from surveys and behavior of adults of average age and ii) means outcomes that save relatively few years of life are valued the same as outcomes that save many years of life, which appears intuitively untenable. Additionally, Robinson, Hammitt and O'Keeffe, 2019 suggest adopting VSLY for policies which impact individuals at the ends of the age distribution. To ensure comparability across papers, Copenhagen Consensus therefore needs to adopt VSLY approach **across all studies**.

The net effect of valuing life years using a constant VSLY is that avoiding the deaths of children are valued more than avoiding the deaths of adults, since children have more life years left.

We acknowledge there may be some valid concerns with a constant VSLY approach. Jamison et al. (2013) suggest that the value of mortality risk reduction for adults of working age may be higher than for children in developing country contexts. Additionally, given the uncertainties in the shape of the VSL over the life cycle, parsimony supports a constant VSL. Additionally, there is much we do not know about how individuals in developing countries value mortality risk reductions (Robinson, Hammitt and O'Keeffe, 2019). As such, we encourage all authors to report the results using a constant VSL approach, perhaps in an appendix. Additional sensitivity analyses suggested by Robinson, Hammitt and O'Keeffe (2019) include using a constant VSL equal to 100x income per capita and 160x income per capita. These should also be reported in an appendix table.

Nevertheless, whether using a constant VSLY or VSL, the value of mortality risk reductions should be the same across regardless of the beneficiary population in question. In other words, an economist should **not** value mortality risk reductions from a wealthier part of the country more than a less wealthy part of the country.

Still-births are a special case of mortality risk reduction. We suggest that the valuation of avoided stillbirths is very likely to be higher than zero but less than the value of losing a newborn. We await developments in the literature before offering a definitive position.

e. Value of avoided morbidity

Avoided morbidity valuation follows Robinson and Hammitt (2018), who suggest valuing each case of avoided illness using willingness-to-pay estimates relevant to the beneficiary population. Since this is very rarely available, Robinson and Hammitt (2018) suggest as substitutes valuing i) each case of avoided illness using a cost-of-illness approach, recognizing this understates the likely benefit since it does not include intangibles such as pain and suffering ii) each year lost to disability (YLD) at the VSLY calculated above adding third party costs that might not be captured in the willingness-to-pay metrics upon which VSLY is based. These third party costs include value of caregiver time or costs not typically covered by individuals (e.g. public health costs).

Inpatient and outpatient direct costs (consultation, diagnostics and drugs) and the indirect costs of transportation have been taken from the GLSS 7 and may be found on the Assumptions sheet of the Reporting template workbook.

f. Value of time

Following Whittington and Cook (2019), we assess the value of time which can be put to use for productive purposes at 100% of wages, while time that cannot be applied to productive purposes is valued at 50% wages for the population in question. Analysts should be careful to include the cost of time required to access the services provided by interventions, particularly for health programs.

In some instances, economists will have to value time of children. While there appears to be no agreed consensus on appropriate valuation, it seems reasonable that i) the value should be lower than productive adult's time and ii) very young children probably have a zero or even negative value of time (e.g. if children are not at school, adult caregivers are required). So we suggest applying a value of zero for the time of children less than 10 years old. This is consistent with the returns to education literature (e.g. Psacharopolous and Patrinos, 2018), which does not apply an opportunity cost of attending primary school before grade 5. For children aged 11 to 15, a value somewhere between children's and adult's time should be applied depending on the context, and potentially reflecting the value that children might contribute to agricultural activities. Individuals 16 and above should be considered adults.

g. Value of carbon emissions avoided

The value of carbon emissions avoided is drawn from a recent review of the social cost of carbon literature (Tol, 2018). According to this review, the marginal value of a ton of CO_2-eq avoided varies by discount rate. For a 3% discount rate the value is USD 25.30 / ton while for a 5% discount rate it is USD 7.60 / ton. Both figures are denominated in 2010 USD. For much higher discount rates, the effective value of carbon emissions avoided at USD 0 / ton.

To estimate the value of carbon emissions reduction also requires a growth factor in the social cost of carbon emissions, since the social cost grows over time as more CO_2-eq is released into the atmosphere. The growth factor should be set at 2% as per year (Tol, 2018). The equation for calculating the benefit of avoided carbon emissions is therefore:

$$Benefit = \sum_{t=0}^{n} \left[\frac{SCC_t(1\times g)^n}{(1+r)^n}\right]$$

where *t=0* represents the year 2015, SCC is the social cost of carbon above in 2010 USD (note in Tol (2018) the emissions year and the currency year are different), g = 2%, r = discount rate.

h. Treatment of costs of raising funds

In some CBAs, analysts explicitly include the cost of raising funds or the cost of taxation. This is usually assessed as a fixed cost per dollar of investment. We recommend ignoring this in CBA since it affects all analyses approximately equally. The inclusion of this cost would add complexity without improving precision or our ability to identify outliers.

7. Research outputs

Each researcher will produce three main outputs, and in the following order: (1) the calculations worksheet and literature review, and a (2) first and (3) final draft of the narrative report.

The calculations are to be undertaken in an Excel template provided by the Copenhagen Consensus Center. Included in this workbook are common research assumptions, which relate to all sectors (e.g. exchange rate and population characteristics), the format to assist the research in the calculation of the BCR, a table to help the researcher to assess the quality of evidence, and a final results table. The Copenhagen Consensus Center has already undertaken the GDP projections and, hence, GDP per capita, as well as calculation of the VSL; all of which may be found in the template.

The calculations and literature review will be reviewed by the Chief Economist and his team. Upon approval, the researcher will submit a first draft, to be subjected to two external

reviews. The researcher will then make the necessary modifications to produce a final report.

Principal researchers will be invited to Accra to present his/her work to a committee of eminent economists, tentatively scheduled for May 2020. All reports will be included in an academic book to be published shortly thereafter.

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