Institute of Health Policy, Management and Evaluation
UNIVERSITY OF TORONTO

Advanced Health Economics and Policy
HAD5760H

# EQUITY CONSIDERATION IN ECONOMIC EVALUATION OF POPULATION HEALTH INTERVENTIONS AND RESEARCH


*Author*

Eric Opoku

*Lecturer*

Dr. Audrey Laporte

Student Number: 1007617651


December 20, 2021

**Abstract**

*Background*: Traditional economic evaluation techniques such as cost-effectiveness analysis (CEA) can be used to test whether a program will improve total health, but it ignores the evaluation of key inputs such as non-health benefits (i.e., Financial Risk Protection (FRP) and Financial consequences) and the social distribution of the impacts of population health interventions (both health and non-health) stratified by equity-relevant variables (such as income quintile, sex, the severity of illness or region).
*Objective*: The study aimed at investigating economic methods and strategies that take equity, health, and non-health benefits into consideration in the evaluation of population health interventions and research.
*Methods*: The Distributional cost-effectiveness analysis (DCEA) and the Extended cost-effectiveness analysis (ECEA) methodological frameworks were employed, explained and applied conceptually to the integrated community case management (iCCM) strategy for malaria treatment in Ghana.
*Results*: The DCEA method uses social welfare indices (such as Atkinson and Kolm indices) to assess the overall health and health inequality impact of population health interventions and the potential trade-off between them. The ECEA approach assesses population health interventions based on their health and non-health impacts.
*Conclusion*: The DCEA method affords decision-makers the tools to decide on the trade-off between health maximization and health inequality reduction associated with the formulation and implementation of population health interventions. The ECEA approach assists policy-makers on how they might formulate policies and/or implement interventions as the health and financial needs of populations evolve, which is especially relevant in the context of moving toward UHC. Population Health Intervention research should take health, non-health benefits and equity into consideration in evaluating UPF programs. The study recommends that an important pathway to attaining UHC is to consider equity and non-health impact considerations in policy-making, implementation of health interventions and research.

Keywords: Extended cost-effectiveness, Distributional cost-effectiveness, Financial Risk Protection.

# 1 Historical Background

Engineers in France primarily introduced Cost-Benefit Analysis (CBA) based on the works of two French engineers, Auguste Cournot and Jules Dupuit in the mid-19th century (Zerbe, 2018). It was initially used in the U.S. in the 1930s when the Flood Control Act of 1936 required the U.S. Army Corps of Engineers to conduct cost-benefit analysis (CBA) for flood control and harbor deepening projects (Boardman et al., 1996). The academic works of John Krutilla, Otto Eckstein and the Bureau of Budget's Circular $A-47$ of 1952 popularized its use. It was further popularized by Barbara Castle when she was Minister of Transport in the UK (Boardman et al., 1996). Even though they had been previous discussions on CBA, the theoretical underpinnings of CBA were provided by British economists' writings in the late 1930s (Zerbe, 2018) under what was called Welfare Economics. The foundations of CBA was agreed by economists and based on scientific objectivity without value judgments until the Great Depression in 1930 where a discussion on depression and prosperity began. It was realized that economists made value judgments if they advocated for prosperity and full-employment policies as they imply that the gain of those millions who benefit by prosperity is in some sense greater or more important than the loss of real income suffered by those few whose money incomes are fixed (Scitovsky, 1951). Clearly, depression or prosperity affect different population sub-groups differently. So around 1932, Professor Lionel Robbins added that if economics was to have the objectivity of a science then economists may not be able to argue for or against any policy or change of policy that would make some people better and others worse off than they were before. To maintain his usefulness as an adviser and policy-maker, Sir Henry Roy Forbes Harrod was willing to relinquish the economists' claim to scientific objectivity but assume equality of man (Scitovsky, 1951). However, such assumption was very costly; hence two schools of thought in Welfare Economics emerged, each independently of the other, to restore the economist to his/her position of policy-maker without the necessity of assuming the equal ability of different people to enjoy life as advocated by Harrod. The two schools of thought were: The New

Welfare Economics (NWE) and the Social Welfare Function (SWF). The NWE was associated with Nicholas Kaldor, John Hicks, and Harod Hotelling and SWF was associated with Abram Bergson, Paul Samuelson, and Gerhard Tintner. The two schools of thought were divided among the conditions of optimum welfare or as to whether economists should be part of decisions concerning equity or not.

The two schools of thought adopted A. C. Pigou's procedure of dividing Welfare economics into production and distribution or the conditions of optimum welfare were divided into efficiency and equity. The first theorem of welfare economics states that "Given certain assumptions, competitive markets produce (Pareto) efficient outcomes", and it was based on Adams Smith's 'invisible hand.' Vilfredo Pareto introduced a welfare criterion, the "Pareto optimum", as a state of affairs in which no one can be made better off without making someone else worse off (Zerbe, 2018). The second theorem of welfare economics highlights that there may exist multiple competitive equilibria, and some may be more equitable or desirable or fairer than others, and any equilibrium can be reached through the 'right' adjustment. The Pareto improvement became the foundational concept in welfare economics and theory. Thus, a change in the economy is said to represent a Pareto improvement if at least one person benefits as a result of the change and no person is made worse-off, as was implicit in the argument of the economists who advocated for prosperity and full-employment policies after the Great Depression. However, the Pareto improvement criterion was impractical as actual compensation may be costly.

So Nicholas Kaldor (New welfare economist) used the Pareto criterion differently, called the Potential Pareto Improvement (PPI), where actual compensation does not take place. Kaldor proposed that (Zerbe, 2018) "Only if the increase in total income is sufficient to compensate for such losses, and still leave something left over to the rest of the community, can the project be said to be 'justified' without resort to interpersonal comparisons of utility." Kaldor further suggested that a project is desirable if the money measure of gains exceeds the money measure of

losses. John Hicks also believed that policy recommendations should be based on efficiency considerations alone, and Nicholas Kaldor added that "whether actual compensation should take place is a political question on which the economist, qua economist, could hardly pronounce an opinion (Kaldor, 1939; Scitovsky, 1951). These concepts resulted in the Kaldor-Hicks compensation principle upon which traditional economic evaluation methods such as CBA and Cost-effectiveness analysis (CEA) thrive. The principle, based on Potential Pareto improvement, highlights that the test of increased efficiency is that the gainers from a (policy) change can more than compensate the losers. The NWE school of thought believes that economists should focus on efficiency and not address moral sentiments regarding equity (Zerbe, 2018).

According to Scitovsky (1951), the SWF can be viewed as a collective utility function of each individual's welfare, and it expresses every individual's personal preferences relating to his personal satisfaction, the state of the entire community and the distribution of welfare among the members of the community. The SWF school of thought highlights the need for both efficiency and equity. They believe that economists cannot effectively influence policy if they do not engage in equity decisions. It is against this background that, over the last 15 years, economists have attempted to incorporate the postulates of SWF such as equity consideration into the traditional economic evaluation techniques (i.e., CBA and CEA).

# 2 Introduction

Traditional economic evaluation techniques include CBA, benefit-cost analysis (BCA), CEA, cost-utility Analysis (CUA), cost-minimization analysis (CMA) and cost-consequences analysis (CCA)[1]. CBA uses money as the 'numeraire' to measure the

[1]CUA is like CEA in that it compares interventions in terms of their cost per unit of effect (i.e., 'years in full health' which combines the length of life with Health-related Quality of Life). BCA, unlike CBA, recognizes rights, distributional, and other moral sentiments/equity considerations as values insofar as they reflect the willingness to pay (WTP) and willingness to accept (WTA) of projects (Zerbe, 2018). CMA examines the intervention with the minimum cost (relative to other interventions). With CCA, also known as soft 'CBA', the decision-maker is left with the task of weighing up the costs and the multiple outcomes (i.e., profile of possible outcomes) in a disaggregated form (Brazier et al., 1999).

costs and benefits of an intervention and deems it as worthwhile if the monetary valuation of all the benefits exceed the costs (Brazier et al., 1999). With regards to valuing human life in the CBA framework, Trumbull (1990) noted that an individual's life cannot be valued. He stated that there is no amount that individuals will be willing to accept for the loss of their lives and most individuals will be willing to pay all they have to continue to live. The CEA, however, is a technique that is used to compare interventions (Brazier et al., 1999) based on their cost per unit of effect such as natural/unvalued units (e.g., life-years saved) and it is mostly employed in health research. It does not place monetary value on life.

CEA measures the maximization of total health such that a health program is cost-effective if it generates a positive net health impact or its total health gains outweigh the net losses, and the converse is true. CEA has focused on the cost of intervention per health gains (i.e., quality-adjusted life years or QALYs) or deaths averted or disability-adjusted life-years (DALYs) averted of one policy option compared with others, based on the assumption that opportunity cost is equally distributed. Public health interventions may generate both health and non-health benefits such as FRP and Financial consequences. Financial consequences are estimated as the direct medical and non-medical out-of-pocket (OOP) expenditures averted, indirect costs averted, government savings/costs, or productivity losses/gains from an intervention. FRP is estimated as the number of poverty cases or catastrophic health expenditures (CHE)[2] averted or the money-metric value of insurance provided by the intervention. Kruk et al. (2009) surveyed households in 40 Lower-Middle Income Countries (LMICs) and found that about 25 percent of those households borrowed money or sold assets to pay for medical care. CEA can be used to test whether a program will improve total health (Cookson et al., 2017), but it ignores the evaluation of key inputs such as non-health benefits (i.e., FRP and Financial consequences) and the social distribution of impacts of population health interventions

[2]CHE is defined as expenditures exceeding a particular fraction of total household expenditures (Verguet et al., 2016).

(both health and non-health) stratified by equity-relevant variables (such as income quintile, sex, the severity of illness or region).

The SDG Goal 3 (8) targets the attainment of Universal Health Coverage (UHC), including FRP, and access to quality essential healthcare services for all. The need to ensure health equity and the provision of FRP (or non-health benefits) to all populations is inherent in this SDG goal. The popularity of the need for UHC has thrown more light on equity and non-health benefits (i.e., FRP and Financial consequences). It is worth noting that both health and non-health impacts of population interventions may be unequally stratified across population sub-groups. Essue et al. (2020) found a pro-rich health distribution and a pro-poor non-health distribution associated with eliminating the OOP expenditures of cataract surgery in Vietnam. Their study also revealed that more CHE cases, poverty cases, and DALYs were averted among females relative to males. According to Verguet et al. (2016), FRP is emerging as a relevant component of national health strategies in LMICs. Eliminating financial barriers to access would position Universal Public Finance (UPF) as a crucial policy device for attaining UHC (Verguet et al., 2016), which is necessary for reducing morbidity and mortality across populations and countries, especially in LMICs. Against this backdrop, this study attempts to answer the research question: what economic strategies and methods take equity, health and non-health benefits into consideration in the evaluation of population health interventions and research?.

## 2.1 Research Objective

In general, this study intends to investigate the economic evaluation of health policy interventions and the social distribution of their outcomes focusing on equity, health, and non-health benefits (i.e., FRP and Financial consequences). Its objectives are relevant for attaining the SDG Goal 3 (8). Specifically, the study:

1. attempts to conceptualize the estimation of the effect of a health intervention

(i.e., iCCM) on the overall health and health inequality of a population.

2. intends to conceptualize the methods of estimating the health and non-health benefits associated with a population health intervention (i.e., iCCM) and how they are stratified by income quintile.

# 3 Literature Review

In the quest of incorporating equity, health, and non-health benefits into the economic evaluation of population health interventions, myriad studies have employed the following techniques.

Olsen et al. (2021) initially estimated the sub-national cost-effectiveness and the inter-individual inequality impacts of scaling up community-based treatment of childhood pneumonia (CCM) coverage to 90 percent in each region in Ethiopia. Their second objective was to explore three different scale-up strategies: 1) maximizing health by prioritizing the regions where the intervention was the most cost-effective, 2) reducing geographical inequalities by prioritizing the regions with high baseline under-five mortality rate (U5MR), and 3) universal up-scaling to 90 percent coverage in all the regions. They employed Markov modelling, the DCEA and used the GINI index to measure inter-individual and geographical inequality impacts. They found that, in total, scaling up CCM coverage to 90 percent in all regions would decrease the Ethiopian Under-five mortality rate (health benefits) from 67 to 57 deaths per 1000 live births, translating as increased life expectancy (from 63.18 to 64.73 years, a 1.55 years gain) and decreased inter-individual inequalities in all regions. Only the targeted strategy to increase treatment coverage in the regions with the highest under-five mortality rate decreased regional inequalities in life expectancy. The other two strategies, health maximization and universal scale-up, both increased regional inequalities in life expectancy. Quan et al. (2021) used similar method (i.e., DCEA) to estimate the cost-effectiveness and epidemiological impact of equity and

proportional services approach[3] of increasing existing HIV service levels to identify the approach that best meets the dual objectives of improving population health and reducing racial or ethnic health disparities in the U.S. They employed three summary measures of health inequality: between-group variance, the index of disparity and the Theil index. They found that the equity approach resulted in lower levels of health inequality across racial or ethnic groups for all three measures of inequality in all cities (except Los Angeles), achieved incidence reductions that almost met the 'Ending the HIV Epidemic' targets in Baltimore and increased population health in four (out of the six) cities over the 20-year period. They concluded that approaches driven by equity principles have the potential to reduce racial or ethnic disparities both in HIV and overall health, and to increase total population health at expected lower overall costs compared with a strategy that remains agnostic to inequities in access to health services.

Assebe et al. (2020) employed the ECEA to estimate the health gains and non-health benefits of increasing the coverage of selected malaria interventions in Ethiopia by 10 percent. It was revealed that the averted deaths and FRP benefits of the strategy would accrue mainly to the poorest income quintiles as they face higher malaria prevalence and associated risk factors. About 50 percent of deaths averted by artemisinin-based combination therapy (ACT), long-lasting insecticide-treated bed nets (LLIN), and indoor residual spraying (IRS) and 52 percent by the malaria vaccine (hypothetical) accrued to the poorest and poorer quintiles. Essue et al. (2020) also used the ECEA to evaluate the health and non-health impact of eliminating medical and non-medical out-of-pocket payments of cataract surgery in Vietnam, across sex and income quintiles. They found that more DALYs were averted among females and the rich relative to their counterparts. They also found that most cases

[3]The proportional services approach included a proportional scale-up of services to the baseline/existing service levels across racial or ethnic groups, implying a higher scale of delivery for groups receiving greater service levels at baseline. The equity approach was grounded in the equity principle of proportionate universalism, which suggests that all groups receive care, with the amount of additional care being proportional to need or disparity or the distribution of new HIV diagnoses in 2018.

of CHE were averted among the poor. Saxena et al. (2019a) and Saxena et al. (2019b) used ECEA to examine the impact of a tax on sugar-sweetened beverages on premature deaths associated with non-communicable diseases such as type 2 diabetes mellitus, ischemic heart disease and stroke, across income quintiles in the Philippines and South Africa, respectively. Only 10 percent and 16 percent of deaths averted were accrued to the poor (bottom two income quintiles) in Philippines and South Africa, respectively. They associated the results with lower consumption of sugar-sweetened beverages by the poor. Wu et al. (2020) and Postolovska et al. (2018) examined the health and non-health impact of an increased excise tax on tobacco in four Indian states and Armenia, respectively using ECEA. It was revealed in both studies that poorer individuals were more responsive to the relative change in cigarette prices (from the tax), quitting in large numbers and facing less tobacco-related disease OOP treatment costs. Verguet et al. (2017) and Salti et al. (2016) found similar results when they used ECEA to evaluate the impacts of an increase in excise tax on tobacco products in China and Lebanon, respectively, across income quintiles. Dawkins et al. (2018) used the DCEA to examine a hypothetical re-designed vaccination program, which invests additional resources into vaccine delivery in rural areas, and compared it with the standard program currently implemented in Ethiopia. They analyzed the trade-off between cost-effectiveness and equity using the Atkinson inequality aversion parameter, $\varepsilon$, representing the decision-maker's strength of concern for reducing health inequality. They found that the more equitable, pro-poor program would be considered worthwhile by a decision-maker whose inequality concern is greater than $\varepsilon = 5.66$, which at current levels of health inequality in Ethiopia implies that health gains would need to be weighted approximately 4 times more highly in the poorest compared with the richest wealth quintile group. The DCEA of the re-designed vaccination program revealed that such a program would not be cost-effective relative to the standard program but would reduce both inequality in coverage, and in health. Johansson et al. (2016) employed the ECEA to estimate the health gains and non-health impacts of a National Mental Health Strategy in

Ethiopia for depression, bipolar affective disorder, schizophrenia, and epilepsy. It was revealed that the health and non-health benefits favored the richest income quintiles for all interventions owing to variation of disease prevalence and income levels.

Robson et al. (2016) used data from an online survey of the general public in England to elicit health inequality aversion parameters by numerically solving Atkinson and Kolm social welfare functions. They elicited median inequality aversion parameters of 10.95 for Atkinson and 0.15 for Kolm. These values suggested significant concern for or aversion to health inequality among the English general public which, at the levels of quality-adjusted life expectancy at that time, implies that marginal health gains to the 'poorest fifth' should be given between 6 and 7 times the weight of health gains of the 'richest fifth'. Asaria (2015) presented an application of a new methodological framework for undertaking DCEA to combine the objectives of maximizing health and minimizing unfair variation in health when evaluating population health interventions and how these two objectives can be traded off against each other. Screening plus a basic universal reminder letter (i.e., sending a General Practitioner-endorsed reminder letter to all eligible patients) was aimed at increasing UK bowel cancer screening uptake across the whole population. Screening plus an enhanced targeted reminder letter (i.e., personal General Practitioner-signed letter and tailored information package) was sent only to those living in the most income deprived 40 percent of small areas (index of multiple deprivation (IMD) 4 and IMD5) and to those living in areas with the highest proportion of inhabitants from the Indian sub-continent (IS5) aimed at increasing screening uptake in deprived and ethnically diverse neighborhoods. These strategies were compared with 'no screening' and the 'bowel cancer screening program' (the standard screening) introduced in 2006 in England. Compared with the 'standard screening', they found that the universal reminder is health-improving across the distribution but further exacerbates absolute health inequality. Meanwhile, the targeted reminder compared with 'standard screening' reduces absolute health inequality by focusing additional benefits on the least healthy. The study depicted that where there is little or no concern for inequality, the universal reminder is the

preferred strategy however, as inequality aversion increases, the targeted reminder becomes the preferred strategy. It was revealed that when all opportunity costs are borne by the least healthy subgroup, no screening and standard screening are no longer dominated. At the intermediate inequality aversion ($\varepsilon = 7$), the preferred screening strategy changes from standard screening (when all the opportunity cost is borne by the least healthy group) to universal reminder (when opportunity cost is equally distributed), to targeted reminder (where all the opportunity cost is borne by the healthiest group). Verguet et al. (2013) used the ECEA to examine the health and non-health benefits of a hypothetical rotavirus vaccination in India and Ethiopia. The poor benefited the most in both countries relative to the rich.

In conclusion, most studies have employed DCEA to estimate the health maximization and health inequality trade-off. Others have employed ECEA to estimate health and non-health benefits and the social distribution of their outcomes by equity-relevant variables.

# 4 Theoretical Framework

Based on the objectives of the study, an equity-efficiency trade-off model is employed below. It explains the potential trade-off between population health maximization and health inequality reduction, which is estimated using the DCEA. A dynamic stochastic general equilibrium (DSGE) model which highlights the non-health benefits (i.e., FRP) of health policy interventions is developed somewhere (See Awawda and Abu-Zaineh, 2019). I did not review the DSGE model in this study because of lack of space.

## 4.1 Equity-Efficiency trade-off model

Welfare economists have proposed the employment of a social welfare function (SWF) as a means to incorporate equity considerations into economic evaluation of population health interventions. The SWF would be defined not over utility levels

but over inter alia the health of the population. This SWF would be constructed so as to reflect an aversion to inequality, but would permit some trade-off between inequality and efficiency (Wagstaff, 1991). The SWF would then be maximized subject to resource and other constraints. Equality of health in the model depicts that any reduction (increase) in inequality is to be regarded as a good (bad) thing.

Following Wagstaff (1991), an equity-efficiency trade-off model is developed as follows. The axis of figure 1 or $h_A$ and $h_B$ indicate the health, measured in terms of expected QALYs remaining before death, of two individuals, or groups of similar individuals, A and B. The location and shape of the bowed-out curve in figure 1, termed as the health frontier[4], depends on the resources available, the initial distribution of health, the capacity of A and B to benefit from health care and the costs to society of that health care[5]. Assume that the resource and technological constraints would allow treatment to be administered which would improve the health (i.e., increase the number of QALYs remaining) of both A and B. Wagstaff (1991) developed an isoelastic SWF as follows:

$$W = (\tau - 1)^{-1}[(\alpha h_A)^{1-\tau} + (\beta h_B)^{1-\tau}], \tau \neq 1$$

Where, $W$ represents the level of social welfare associated with the health distribution $[h_A, h_B]$. The model captures equity considerations by weighting QALYs or health states associated with A and B. The parameter $\alpha$ denotes the weight to be attached to $A's$ health and $\beta$ is the weight to be attached to $B's$ health. For instance, the health of women and men, or the poor and the rich or the responsible person and those who lead reckless health behaviour/life such as smoking or the young and the

[4]The slope of the frontier indicates the marginal cost of a QALY to A in terms of QALYs denied to B. It is concave to the origin based on the assumption that health care is subject to a diminishing marginal product. This can be interpreted either at an individual level (an individual's capacity to benefit at the margin diminishes as more treatment is administered) or at a group level (if the cases are treated in order of capacity to benefit from treatment, the first cases will enjoy a bigger health improvement than the last). The asymmetrical nature of the frontier in figure 1 implies that B can be treated at lower cost than A and/or that B has a greater capacity to benefit from treatment than A.

[5]The costs to society include time and money costs incurred by patients, their family and friends, as well as the costs incurred by the health service.

old may not be valued the same by the society. Hence, $\alpha$ and $\beta$ may not be the same in contrast to the CEA literature, namely that the identity of the person receiving the QALY is irrelevant to the social value of that QALY, resulting in setting $\alpha$ and $\beta$ at the same value. In the CEA literature, $\tau = 0$ and $\alpha = \beta = 1$. The $\tau$ denotes the degree of aversion to inequality in health outcomes by the society. If $\tau > 0$, some aversion to inequality is indicated[6].

The CEA leads to the rule that resources ought to be deployed so that the marginal cost per QALY is the same across all types of health care activity. However, the social welfare maximization modifies this rule as the slope of the frontier (the ratio of marginal costs) is to be equated to the slope of the SWF contour$(i.e., h_A/h_B)^{-\tau}$, where $h_A$ and $h_B$ denote the final health levels of $A$ and $B$ (i.e., their health levels after receipt of any extra QALYs). The slope of the SWF contour is the sum of (i) the expected number of QALYs remaining in the absence of treatment (the shaded area in figure 2) and (ii) the QALYs that would be gained as a result of treatment (the cross-hatched area in figure 2). In the absence of treatment both $A$ and $B$ would enjoy the same number of QALYs, $\overline{h_A}$ and $\overline{h_B}$. Hence, $\overline{h_A}$ corresponds to the shaded area under the no-treatment profile in figure 2. Point $m$ in figure 1 can be thought of as an *endowment point*. It is worth noting that the movement from point $m$ to point $p$ involves, let's say, *'A'* receiving an additional number of QALYs equal to $h*$ - $h_A$ where $h_A$ denotes the cross-hatched area lying between the treatment and no-treatment profiles in figure 2, while $h*$ denotes the sum of the shaded and cross-hatched areas. Since (i) is given, the decision variable in each case depends on (ii), which affects both the slope of the SWF contour (via its effect on final health) and the slope of the frontier (via its effect on marginal costs). Note that when $\tau = 0$, i.e., when there is no concern about inequality, the rule reverts to the original rule

[6]With $\tau < \infty$ the contours of the welfare function are convex to the origin and as $\tau \to \infty$, the welfare contour becomes $L$-shaped with its corner on the 45° line - the so-called 'Rawlsian SWF', since it implies a concern solely with the health of the least healthy person (Rawls, 1972; Atkinson and Stiglitz, 1987). This is represented by Figure 1, which shows the implications of aversion to inequality for the choice of point on the health frontier. Any movement away from the 45° line in figure 1 increases the degree of inequality and is to be regarded as inequitable. The opposite is true of any movement towards the 45° line.

that the marginal cost per QALY is to be equalized across programs. In this case the pre- and post-treatment levels of health are irrelevant to resource allocation decisions. In the case where there is some concern about inequality, ($\tau > 0$) and $(h_A/h_B)^{-\tau}$ are different from one. With social welfare maximization rule, resource allocation decisions cannot be made simply by examining the marginal cost of additional QALYs (as in CEA or health maximization rule) however, consideration must also be given to (i) the expected health of A and B in the absence of treatment and (ii) the degree to which society is averse to inequality.

In conclusion, the implication of the model is that, when allocating resources between health care programs and between individuals within a given program, attention needs to be paid both to the degree of inequality implied by each decision and to the importance society attaches to that inequality. Thus, the community's health (defined as the sum of $h_A$, and $h_B$) is maximized in figure 1 at point $p$, where the cost of a QALY is the same at the margin (i.e., MC) for A and B (i.e., health maximization or efficient distribution of health). However, the equitable distribution with the highest attainable per capita level of health is at point $q$ (the 'equality of health' objective). Health maximization requires that $B$ receive more QALYs than $A$. The 'equality of health' objective, by contrast, requires that A and B receive the same number of QALYs. A price has to be paid for the pursuit of equality: the sum of QALYs would be clearly lower than the case under health maximization. Thus, the non-linear SWF (the trade-off), by contrast, chooses point s: here, there is less inequality than at $p$, but more inequality than at $q$. It is evident that the sum of health statuses is lower at $s$ than at $p$. This is the acceptable price (or trade-off) that the society will be willing to pay for some level of equality in health (Wagstaff, 1991). The DCEA can be used to model and estimate the trade-off between health maximization and health inequality reduction associated with population health interventions and research.

# 5 Methodology and Data sources

Data for DCEA and ECEA are mostly collected from Ministries or departments of Health in countries, World Development Indicators (WDI), Global Burden of Disease study's DisMod-MR output, the WHO-CHOICE costing database, Demographic Health Surveys (DHS) and the empirical literature. Wolfram Mathematica software, R statistical package and PopMod developed by WHO-CHOICE can be employed to conduct the analysis. Equity concerns in health are addressed using two main methods: (1) equity trade-off analysis and (2) equity impact analysis.

## 5.1 Equity Trade-off Analysis (ETA)

The ETA employs the health equity trade-off technique and it includes Equity Constraint Analysis, and Equity-Weighting Analysis. ETA highlights the trade-off between potential cost-effectiveness and an alternative health equity objective, such as reducing inequality in lifetime health or giving priority to those who are currently severely ill (Cookson et al., 2017). The Equity Constraint Analysis is also termed as counting the cost of equity. It counts the cost of selecting fairer but less cost-effective options (Cookson et al., 2017). Equity-Weighting Analysis helps decision-makers to measure the concern for equity required to select cost-effective options that improve or harms equity in case a policy intervention falls in the "win-lose" or "lose-win" quadrant of the health equity impact plane (See Figure 3).

## 5.2 Equity Impact Analysis (EIA)

The EIA employs the net equity impacts techniques and it is sub-divided into ECEA and DCEA. The net equity impacts technique highlights the importance of the distribution of both benefits and opportunity costs. For instance, a UPF policy intervention may divert money from other public programs that benefits or could have benefited the poor. Hence the opportunity cost in terms of losses in health and welbeing may be disproportionately borne by the poor (See Case 2 of Figure 4). Also,

even though opportunity cost in terms of losses in health and welbeing may be same for the poor and the rich, the cost of a policy intervention financed through general, progressive taxation would be disproportionately borne by the rich (Cookson, 2017). In Case 1 (see Figure 4), as in the case of traditional CEA, health opportunity costs are assumed to be equally distributed. In conclusion, the method of funding a policy intervention could determine the distribution of opportunity costs.

ECEA is mostly used in LMICs to assess health policies on four domains: Health Benefit Gain, Financial consequences, FRP, and Equity or distributional consequences based on socioeconomic status (e.g income quintile), sex, ethnicity, severity of disease and/or geographical location (e.g. county, state, province, region). Unlike ECEA, the DCEA does not estimate non-health benefits such as FRP. The DCEA measures the trade-off between total health maximization and health inequality. The DCEA is able to measure net health equity impact and plot it against net total health impact on the health equity impact plane (See Figure 3). This study will explain the DCEA and ECEA techniques for evaluating health policy interventions.

### 5.2.1 Distributional Cost-effectiveness Analysis

Population health interventions have two main objectives, improving health and reducing health inequality. When these two objectives conflict, Health-Related Social Welfare Functions (HRSWFs) can be used to articulate the trade-off between them. Economists have explored the properties of several SWFs which aim to capture these trade-offs in the form of a single inequality aversion parameter. The Atkinson Index (Atkinson, 1970) and Kolm Index (Kolm, 1976) are two such forms, concerned with relative and absolute concepts of inequality widely used in the income inequalities literature, respectively. A range of two person HRSWFs have also been proposed (Wagstaff, 1991, Abásolo and Tsuchiya, 2004), and there have been various attempts to elicit health inequality aversion parameters for some of these functions from interview data of members of the public in England (Dolan and Tsuchiya, 2011, Edlin et al., 2012; Robson et al., 2016) and Spain (Abásolo and Tsuchiya, 2013).

Unlike the traditional CEA which focuses on improving only total population health, DCEA focuses on both total health maximization and health inequality reduction.

## The Model

Yang et al. (2020) and Asaria et al. (2015) explained the methodological framework of DCEA as follows. Assume an economic evaluation of the increase in the coverage of the integrated community case management (iCCM), a community-based health strategy, for the treatment of malaria in Ghana to 90 percent versus 'no intervention' using DCEA. According to the ministry of health, the iCCM is mostly funded by the Global Fund to Fight AIDS, Tuberculosis and Malaria, partners and the Government of Ghana and all services are at no cost to the client (Ofosu, 2016). The iCCM or the Home-Based Care (HBC) is a strategy where community-based agents are given basic skills to provide care for children, aged 6-59 months, sick from malaria (and other diseases such as Diarrhea, and Acute Respiratory Infections), manage the situation, counsel and/or refer them to hospitals as quickly as possible to prevent deaths in their communities. In 2005, Ghana adopted the revised anti-malaria policy and Artesunate-Amodiaquine became the first line drug (Ofosu, 2016). Assume further that analysis was conducted from the health system perspective and a 3.5 percent annual discount rate was applied to both benefits and costs in accordance with the National Institute for Health and Care Excellence (NICE) guidance.

1. Extract the incremental direct health benefits[7] (a) and the incremental health care costs (b) of the iCCM intervention versus 'no intervention' for each income quintile (W) in Ghana.

2. Sum the incremental costs (c) and then convert to health opportunity costs at a rate of let's say the NICE cost-effectiveness threshold per QALY (d). Total health opportunity cost is:

$$d = \frac{c}{threshold}$$

[7]Health benefits could be expressed as quality-adjusted life-years (QALYs) and costs in Canadian Dollars (CAD, 2018 price year)

3. Search the literature to find data on the proportion of the health opportunity costs borne by each income quintile (e) and use it to calculate the size of the health opportunity costs in each income quintile (f). For example, assuming the proportion of the health opportunity costs borne by income quintile one (W1) or the poorest quintile group is 0.26, then the health opportunity costs for W1 ($f_1$) will be:

$$f_1 = d * e_1 = d * 0.26$$

4. Calculate the incremental Net Health Benefit (iNHB) for each income quintile (g) by subtracting health opportunity costs from the incremental direct health benefits. Example, the iNHB for W1 is:

$$g_1 = a_1 - f_1 = a_1 - (d * e_1) = a_1 - (d * 0.26)$$

5. Calculate the iNHB per capita by income quintile (i) using the distribution of the population of Ghana (h). The individual iNHB (i) for W1 is:

$$i_1 = \frac{g_1}{h_1}$$

   Data on the population of Ghana can be retrieved from the Ghana Statistical Service (GSS).

6. Add the individual incremental NHB (i) to the baseline QALE (j) to calculate the QALE with the iCCM intervention by income quintile (k). Thus, $k = i + j$. Baseline QALE (no intervention) is denoted by the $j$. QALE with iCCM is denoted by the $k$. For W1, we have $k_1 = i_1 + j_1$.

7. Calculate the equally distributed equivalent (EDE) health[8] for the baseline

[8]If several strategies were considered in this study, dominated strategies would be eliminated when estimated health distributions are compared using the generalized Lorenz dominance (Shorrocks, 1983). To compare the remaining, non-dominated strategies, we turn to more restricted social welfare indices that explicitly trade-off increases in the mean health against greater equality in the distribution of health (Wagstaff, 2002). These indices are calibrated on the same scale by

QALE distribution (l) and the QALE distribution with the iCCM intervention (m) using the Atkinson social welfare index with an inequality aversion parameter, $\varepsilon$ as follows (Asaria et al. 2015):

$$h_{EDE} = \left[\frac{1}{N}\sum_{i=1}^{N}[h_i]^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

or by using the Kolm's social welfare index with an inequality aversion parameter, $\alpha$ as follows (Asaria et al. 2015):

$$h_{EDE} = -(\frac{1}{\alpha})log(\frac{1}{N}\sum_{i=1}^{N}e^{-\alpha h_i})$$

where $h_i$ represents individual QALE for a person in income quintile $i$, and $N$ denotes total population size. According to Yang et al. (2020) and Asaria et al. (2015), a recent work on eliciting these inequality aversion parameters from members of the general public in England estimates an Atkinson $\varepsilon$ parameter of about 10.95 (95 percent confidence interval [CI]: 9.23–13.54) and a Kolm $\alpha$ parameter of about 0.15 (95 percent CI: 0.13–0.19).

8. Calculate the population incremental EDE (iEDE) with the iCCM intervention (n), i.e., the difference of population EDE with the iCCM intervention (m) and the population baseline EDE(l), where the population EDE is multiplying EDE by total population size. Thus, we have: n = (m * sum of h) – (l * sum of h). Sum of $h$ is the total sum of the population of each income quintile.

9. Calculate the population incremental NHB (iNHB) with the iCCM intervention (o), i.e., sum the iNHB across all quintiles. The impact on overall health is the population incremental NHB (iNHB). If it is positive, then the iCCM intervention had a positive impact or increased overall health.

calculating an 'equally distributed equivalent' (EDE) level of health for the health distribution: the level of health each person in the population would receive in a hypothetically perfectly equal health distribution such that society would be indifferent between that equal distribution of health and the actual unequal distribution of health.

10. Calculate how the intervention changes health inequality (iEDE - iNHB) (p). Thus, the difference between the population incremental EDE and the population incremental NHB. A positive difference or value shows that the iCCM intervention reduces health inequality.

In conclusion, a positive iNHB (cost-effective) and a positive difference between iEDE and iNHB (improves equity) falls in the "win-win" quadrant and it falls in the "win-lose" quadrant if the difference between iEDE and iNHB (harms equity) was rather negative (See Figure 3). A negative iNHB (cost-ineffective) and a positive difference between iEDE and iNHB (improves equity) falls in the "lose-win" quadrant and it falls in the "lose-lose" quadrant if the difference between iEDE and iNHB (harms equity) was rather negative (See Figure 3). Unlike the ECEA, the above model does not take non-health benefits of population health interventions into consideration.

### 5.2.2 Extended Cost-effectiveness Analysis

ECEA assesses Health policy instruments such as public financing interventions based on four domains, namely Health Benefit Gains (HBG), Financial Consequences/impact (FC), Financial Risk Protection (FRP) and Equity (Verguet et al., 2016). Assume population is segmented by income quintiles and the iCCM strategy for malaria treatment in Ghana is being considered. ECEA is explained below.

#### (A) Health Benefit Gain (HBG)

ECEA is used to measure HBG based on health gains (Deaths averted or Death-adjusted life years (DALYs) averted or Health-adjusted life years (HALYs) gained) of a population intervention. Following Verguet (2016), ECEA is used to assess the iCCM for malaria treatment in Ghana as follows. The untreated disease (or malaria) has a case fatality rate $d_0$. The probability of dying from the malaria (before the introduction of the UPF for the iCCM), conditional on having the disease is denoted

by $d_a$ as:

$$d_a(y) = u(y)(1-s)d_0 + (1-u(y))d_0$$

where the cost of the treatment for malaria and the cure rate corresponding to that treatment (from the iCCM) is represented by $c$ and $s$, respectively. Let $y$ be the annual income of an individual and $y_l$ and $y_h$ be the lowest and highest incomes, respectively. The probability of obtaining treatment (pre-existing treatment coverage) and the probability of privately purchasing the treatment for malaria at cost $c$, conditional on having the disease, before the introduction of the UPF program is denoted by $u$ and $b_c$. Assume that $u$ and $b_c$ depend on income $y$, that is, $u(y)$ and $b_c(y)$. Death results from (i) the probability of obtaining treatment (from the iCCM) but not cured $u(y)(1-s)d_0$ and (ii) the probability of not obtaining treatment (from the iCCM) $(1-u(y))d_0$.

Malaria is assumed to have an annual incidence of probability $p$, and that $p$ varies with income $y$, that is, $p(y)$. After the introduction of the UPF (for the iCCM), everyone is assumed to have obtained treatment ($u(y) = 1$) and hence the probability of dying from malaria conditional on having it (and not been cured by the treatment from the iCCM), $d_p$, is:

$$d_p = u(y)(1-s)d_0 = 1(1-s)d_0 = (1-s)d_0$$

The differential of deaths between ante-UPF and post-UPF introduction follows as $(d_a - d_p)(p(y))$. The aggregate number of lives saved (per capita), $H$, is:

$$H = \int_{y_l}^{y_h} (d_a - d_p)p(y)f(y)\,dy$$

where $f(y)$ is the income distribution in the population[9].

[9]It can be proxied by a Gamma density based on the GDP per capita and Gini index.

**(B) Financial Consequences**

Financial burden can include the direct payment of medical care and non-medical costs (e.g. transportation cost) out-of-pocket (OOP), and time and productivity losses, which could be translated into wages and income forgone (Verguet et al., 2016). Such costs may differ based on the specific health facility an individual attends. Implementation of UPF programs (such as the iCCM in Ghana) eliminates such costs. For one individual, the private expenditures (before the UPF program), conditional on having malaria is:

$$e(y) = cu(y)b_c(y)$$

where the cost of the treatment for malaria is represented by $c$. When an UPF program is implemented, $e(y)$, becomes the private expenditures averted (by the UPF program).

Malaria is assumed to have an annual incidence of probability $p$, and that $p$ varies with income $y$, that is, $p(y)$. Hence, the aggregate amount of private expenditures averted, $E$, is:

$$E = \int_{y_l}^{y_h} p(y)e(y)f(y)dy$$

where $f(y)$ is the income distribution in the population. The aggregate treatment cost to the government are:

$$TC = \int_{y_l}^{y_h} cp(y)f(y)dy$$

where $f(y)$ is the income distribution in the population and the cost of the treatment for malaria is represented by $c$. $TC$ could be financed with a tax, of constant rate $t$, insurance premiums and/or global funds or grants as in the case of the iCCM in Ghana.

### (C) Financial Risk Protection (FRP)

FRP measures the extent that individuals are protected from medical impoverishment and catastrophic health expenditures. Three metrics can be used to measure FRP: (1) a money-metric value of insurance provided by the iCCM intervention (2) number of poverty cases averted (3) number of catastrophic health expenditures cases averted.

#### (i) Money-metric value of insurance provided

A standard utility-based model is applied to quantify what may be seen as a 'fair' societal risk premium, where a UPF program/policy is considered a social insurance program. The insurance value of the UPF program/policy is calculated by using a money-metric-value of insurance as the outcome unit of FRP (McClellan and Skinner, 2006; Verguet et al., 2016). This value represents how much the society is willing to pay for eliminating the financial risk individuals currently face due to malaria infection. A UPF program delivers FRP benefits to patients by averting the existing OOP expenditures associated with malaria.

The expected value of the gamble associated with the eventuality of the malaria treatment (in the iCCM strategy) is estimated with the overall probability of receiving care for it, $P$ (calculated as, coverage * prevalence rates per quintile) and treatment cost $c$ (the OOP expenditures to treat malaria) at the individual level. *Prevalence* is incidence or the probability of getting malaria. *Coverage* denotes the current treatment coverage. This study focuses on the OOP cost of treatment and excludes the cost of earnings or productivity reduced by malaria[10].

A constant relative risk aversion utility function is utilized:

$$w(y) = \frac{y^{1-r}}{1-r}$$

for $r > 0$ and $r \neq 1$. $y$ is income and $r$ is the Arrow-Pratt coefficient of relative risk

[10]Other forms of social insurance (e.g. disability insurance, sick leave, and unemployment insurance) are intended to provide protection against these risks (Verguet et al., 2016)

aversion[11].

In the uncertain scenario, the expected value of income to an individual of the gamble concerning treatment cost of malaria before UPF (of the iCCM intervention) is estimated by a function based on (McClellan and Skinner, 2006):

$$y_p = (1 - P)y + P(y - c),$$

where $P(y) = p(y)u(y)b_c(y)$. Malaria is assumed to have an annual incidence of probability $p$, and that $p$ varies with income $y$, that is, $p(y)$. $P(y-c)$ is the expected value of income when there is treatment probability at cost, $c$. $(1 - P)y$ is the expected value of income of 'no treatment' probability.

In the certain scenario, the 'certainty equivalent' for the same individual is estimated by assigning individuals a utility function, $w$, that specifies their risk aversion. This is equivalent to calculating their willingness to pay for insurance against the risk of medical expenditure. The certainty equivalent, assuming a coefficient of relative risk aversion $r$, for the same individual, estimates the amount of money the individual is willing to have in order to obtain certainty in the expected OOP expenditures averted from UPF is denoted as:

$$y^* = w^{-1}[(1 - P)w(y) + Pw(y - c)]$$

$$= \left[(1 - P)y^{1-r} + P(y - c)^{1-r}\right]^{\frac{1}{1-r}}$$

The money-metric value of insurance (risk premium) at the individual level $v(P, y, c)$ is then:

$$v(P, y, c) = y_p - y^*$$

$$= (1 - P)y + P(y - c) - \left[(1 - P)y^{1-r} + (y - c)^{1-r}\right]^{\frac{1}{1-r}}$$

[11] When $r \to 1$, $w(y) \to ln(y)$

Hence, the aggregate money-metric value of insurance (population level), $V$, is:

$$V = \int_{y_l}^{y_h} v(P, y, c) f(y) dy$$

where $f(y)$ is the income distribution in the population. The insurance value, $V$, is simply the difference between the expected value of income before UPF and the certainty equivalent. The value of 3 is considered to be an appropriate, conservative level of risk aversion, $r$.

**(ii) Catastrophic health expenditures (CHE) averted**

This estimates the number of individuals who no longer crosses a 'catastrophic' threshold of income as a result of the costs faced. A case of catastrophic health cost is counted when, given a specific income threshold ($Th$) and at the individual level, we realize that:

$$c_{DM,k} + c_{DNM,k} > y * Th$$

where $y$ denotes disposable income. Direct payment of medical care out of pocket is denoted by $C_{DM}$, and direct non-medical costs (most importantly transportation costs to seek care) out of pocket is denoted by $C_{DNM}$. Hence, FRP is captured by counting the number of cases of Catastrophic Health Expenditures averted owing to the UPF program.

**(iii) Number of poverty cases averted**

This estimates the number of individuals who no longer crosses a given 'poverty line'. A case of poverty is counted when, given a specific income poverty line ($Pl$) and at the individual level, we realize that:

(i) $y > Pl$ and (ii) $y - (c_{DM,k} + c_{DNM,k}) < Pl$.

Hence, FRP is captured by counting the number of cases of poverty averted owing to the UPF program (from the iCCM intervention).

It is worth noting here that, in terms of equity, both the health and non-health benefits of population health interventions can vary by equity-relevant variables such as income quintiles, sex, severity of illness, or region.

**(iv) ICER FRP**

Financial protection incremental cost-effectiveness ratio (i.e., $ICER_{FRP}$) is calculated as follows:

$$ICER_{FRP} = \frac{C}{B_{FRP}}$$

where $C$ is the total net cost of implementing the iCCM to the government (which vary by population sub-group). $B_{FRP}$ represents the FRP afforded by the iCCM intervention. In this respect, ECEA can compare a range of policies and interventions along the two following efficiency criteria: (1) health benefits and (2) FRP. In doing so, ECEA enables the inclusion of multiple criteria into the decision-making process.

# 6 Results, Conclusion and Recommendation

The DCEA method uses social welfare indices (such as Atkinson and Kolm indices) to assess the overall health and health inequality impact of population interventions. It affords decision-makers the tools to decide on the trade-off between health maximization and health inequality reduction associated with the formulation and implementation of population health interventions. The ECEA approach assesses population interventions based on their health and non-health impacts (i.e., FRP). It assists policy-makers on how they might formulate policies and/or implement interventions as the health and financial needs of populations evolve, which is especially relevant in the context of moving toward UHC. Population Health Intervention research should take health, non-health benefits, and equity into consideration in evaluating UPF programs or national strategies/interventions. The study recommends that an important pathway to attaining UHC is to consider equity considerations in health interventions and research.

# 7 References

Abásolo, I. and Tsuchiya, A. (2004). Exploring social welfare functions and violation of monotonicity: An example from inequalities in health - a reply to Jan Abel Olsen. Journal of Health Economics, 23, 333- 334.

Abásolo, I. and Tsuchiya, A. (2013). Is more health always better for society? Exploring public preferences that violate monotonicity. Theory and Decision, 74, 539-563.

Asaria, M., Griffin, S., Cookson, R., Whyte, S., and Tappenden, P. (2015). Distributional cost-effectiveness analysis of health care programmes–a methodological case study of the UK bowel cancer screening programme. Health economics, 24(6), 742-754.

Assebe, L. F., Kwete, X. J., Wang, D., Liu, L., Norheim, O. F., Jbaily, A., Verguet, S., Johansson, K. A., and Tolla, M. T. (2020). Health gains and financial risk protection afforded by public financing of selected malaria interventions in Ethiopia: An extended cost-effectiveness analysis. Malaria Journal, 19(1), 1–10.

Atkinson A. B. (1970). On the measurement of inequality. Journal of economic theory 2(3): 244–263.

Atkinson, A. B. and Stiglitz, J. E. (1987). Lectures on public economics (McGraw-Hill, London).

Awawda, S., and Abu-Zaineh, M. (2019). An operationalizing theoretical framework for the analysis of universal health coverage reforms: first test on an archetype developing economy.

Boardman, A. E., Greenberg, D. H., Vining, A. R., and Weimer, D. L. (1996). Cost-Benefit Analysis: Concepts and practice.

Brazier, J., Deverill, M., and Green, C. (1999). A review of the use of health status

measures in economic evaluation. Journal of health services research and policy, 4(3), 174-184.

Cookson, R., Mirelman, A. J., Griffin, S., Asaria, M., Dawkins, B., Norheim, O. F., Verguet, S., and J. Culyer, A. (2017). Using Cost-Effectiveness Analysis to Address Health Equity Concerns. Value in Health, 20(2), 206–212.

Dawkins, B. R., Mirelman, A. J., Asaria, M., Johansson, K. A., and Cookson, R. A. (2018). Distributional cost-effectiveness analysis in low-and middle-income countries: illustrative example of rotavirus vaccination in Ethiopia. Health policy and planning, 33(3), 456-463.

Dolan, P. and Tsuchiya, A. (2011). Determining the parameters in a social welfare function using stated preference data: an application to health. Applied Economics, 43, 2241-2250.

Edlin, R., Tsuchiya, A. and Dolan, P. (2012). Public preferences for responsibility versus public preferences for reducing inequalities. Health Economics, 21, 1416-1426.

Essue, B. M., Jan, S., Phuc, H. T., Dodson, S., Armstrong, K., and Laba, T. L. (2020). Who benefits most from extending financial protection for cataract surgery in Vietnam? An extended cost-effectiveness analysis of small incision surgery. Health Policy and Planning, 35(4), 399–407.

Johansson, K. A., Strand, K. B., Fekadu, A., and Chisholm, D. (2016). Health Gains and Financial Protection Provided by the Ethiopian Mental Health Strategy: An Extended Cost-Effectiveness Analysis. Health Policy and Planning, 32(3), 376–383.

Kaldor, N. (1939). Welfare propositions of economics and interpersonal comparisons of utility. The economic journal, 549-552.

Kolm S. C. (1976). Unequal inequalities. I. Journal of Economic Theory 12(3): 416–442.

Kruk M. E., and Goldmann E., and Galea, S. (2009). Borrowing and selling to pay for health care in low- and middle-income countries. Health Affairs, 28(4), 1056–1066.

McClellan M. and Skinner J. (2006). The incidence of Medicare. Journal of Public Economics 90:257–76

Ofosu, W. K. (2016). National iCCM implementation plan for Ghana: Key components, Strategies and Challenges.

Olsen, M., Norheim, O. F., and Memirie, S. T. (2021). Reducing regional health inequality: a sub-national distributional cost-effectiveness analysis of community-based treatment of childhood pneumonia in Ethiopia. International Journal for Equity in Health, 20(1), 1-10.

Postolovska, I., Lavado, R., Tarr, G., Verguet, S., Iryna, F., Postolovska, I., Lavado, R., and Tarr, G. (2018). The Health Gains , Financial Risk Protection Benefits , and Distributional Impact of Increased Tobacco Taxes in Armenia The Health Gains , Financial Risk Protection Benefits , and Distributional Impact of Increased Tobacco Taxes in Armenia.

Quan, A. M. L., Mah, C., Krebs, E., Zang, X., Chen, S., Althoff, K., Armstrong, W., Behrends, C. N., Dombrowski, J. C., Enns, E., Feaster, D. J., Gebo, K. A., Goedel, W. C., Golden, M., Marshall, B. D. L., Mehta, S. H., Pandya, A., Schackman, B. R., Strathdee, S. A., Sullivan, P., Tookes, H., Nosyk B. (2021). Improving health equity and ending the HIV epidemic in the United States: A distributional cost-effectiveness analysis in six cities. Journal of the International AIDS Society, 24(S4), 51-53.

Rawls, J. (1972). A theory of Justice. (Oxford University Press, Oxford).

Robson, M., Asaria, M., Tsuchiya, A., Ali, S., and Cookson, R. (2016). Eliciting the level of Health Inequality Aversion in England.

Salti, N., Brouwer, E., and Verguet, S. (2016). The health, financial and distributional

consequences of increases in the tobacco excise tax among smokers in Lebanon. Social Science and Medicine, 170, 161–169.

Saxena, A., Koon, A. D., Lagrada-Rombaua, L., Angeles-Agdeppa, I., Johns, B., and Capanzana, M. (2019a). Modelling the impact of a tax on sweetened beverages in the Philippines: An extended cost–effectiveness analysis. Bulletin of the World Health Organization, 97(2), 97–107.

Saxena, A., Stacey, N., Puech, P. D. R., Mudara, C., Hofman, K., and Verguet, S. (2019b). The distributional impact of taxing sugar-sweetened beverages: Findings from an extended cost-effectiveness analysis in South Africa. BMJ Global Health, 4(4).

Scitovsky, T. (1951). The State of Welfare Economics. The American Economic Review, 41, 3, pp. 303-315.

Shorrocks A. F. (1983). Ranking income distributions. Economica. 1983;50(197):3.

Trumbull, W. N. (1990). Who has standing in cost-benefit analysis?. Journal of Policy Analysis and Management, 9(2), 201-218.

Verguet, S., Kim, J. J., and Jamison, D. T. (2016). Extended cost-effectiveness analysis for health policy assessment: A tutorial. Pharmacoeconomics, 34(9), 913-923.

Verguet, S., Murphy, S., Anderson, B., Arne, K., Glass, R., and Rheingans, R. (2013). Public finance of rotavirus vaccination in India and Ethiopia: An extended cost-effectiveness analysis. Vaccine, 31(42), 4902–4910.

Verguet, S., Tarr, G., Gauvreau, C. L., Mishra, S., Jha, P., Liu, L., Xiao, Y., Qiu, Y., and Zhao, K. (2017). Distributional benefits of tobacco tax and smoke-free workplaces in China: A modeling study. Journal of Global Health, 7(2), 1–13.

Wagstaff, A. (1991). QALYs and the equity-efficiency trade-off. Journal of health economics, 10(1), 21-41.

Wagstaff A. (2002). Inequality aversion, health inequalities and health achievement. Journal of health economics 21(4): 627–641

Wu, D. C., Sheel, V., Gupta, P., Essue, B. M., Luong, L., and Jha, P. (2020). Impact of cigarette tax increase on health and financing outcomes in four Indian states. Gates Open Research, 4.

Yang, F., Angus, C., Duarte, A., Gillespie, D., Walker, S. and Griffin, S. (2020). Impact of Socioeconomic Differences on Distributional Cost-effectiveness Analysis. Medical Decision Making. Vol. 40(5) 606–618.

Zerbe, R. O. (2018). A Distinction between Benefit-Cost Analysis and Cost Benefit Analysis Moral Reasoning and a Justification for Benefit Cost Analysis.

# 8 Appendix

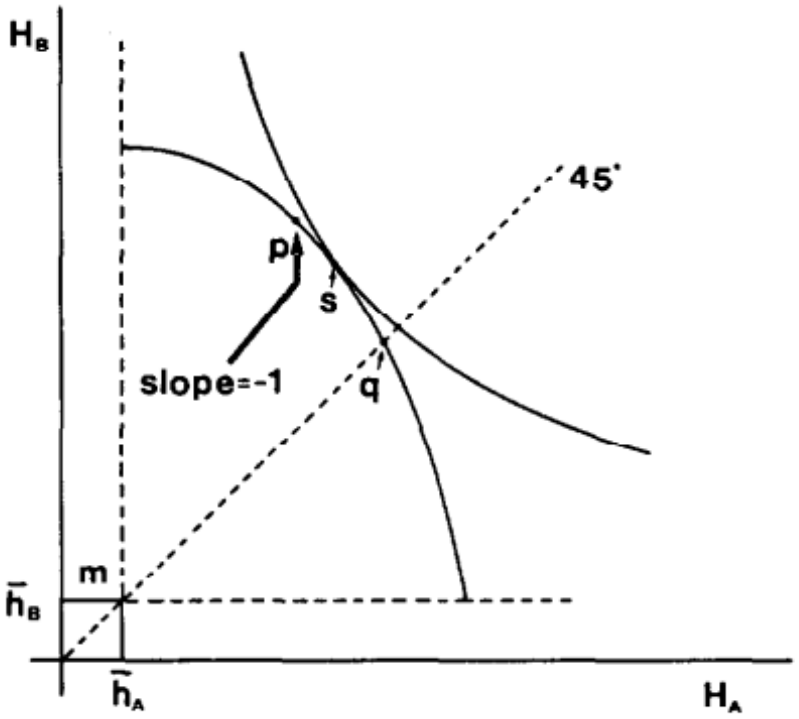


Figure 1: Equity-efficiency trade-off. Source: Wagstaff (1991)

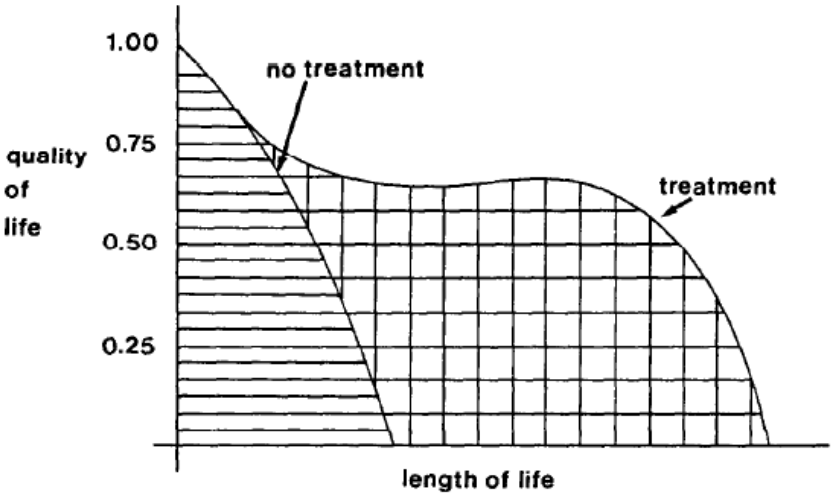


Figure 2: No treatment profile. Source: Wagstaff (1991)

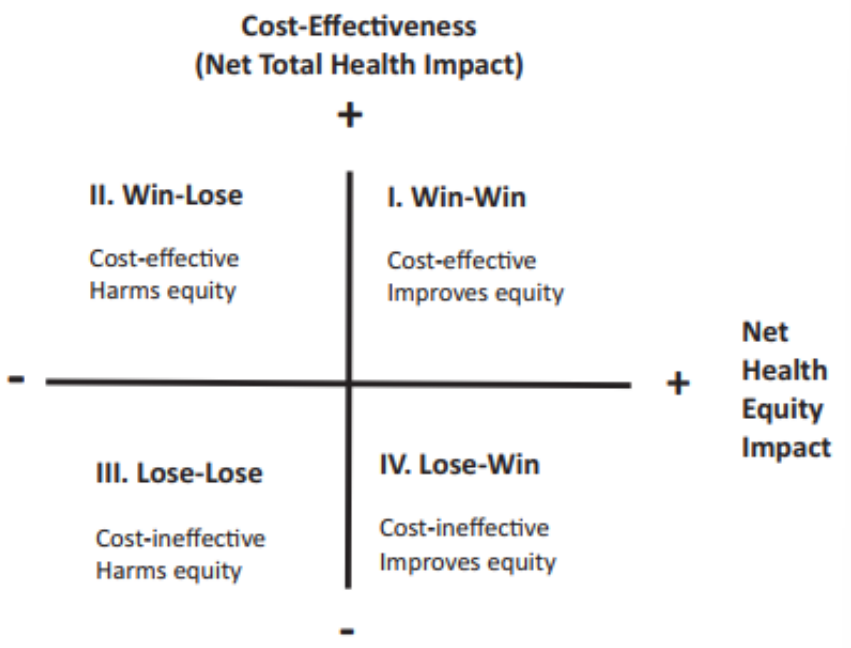


Figure 3: Health Equity Impact plane. Source: Cookson et al. (2017)

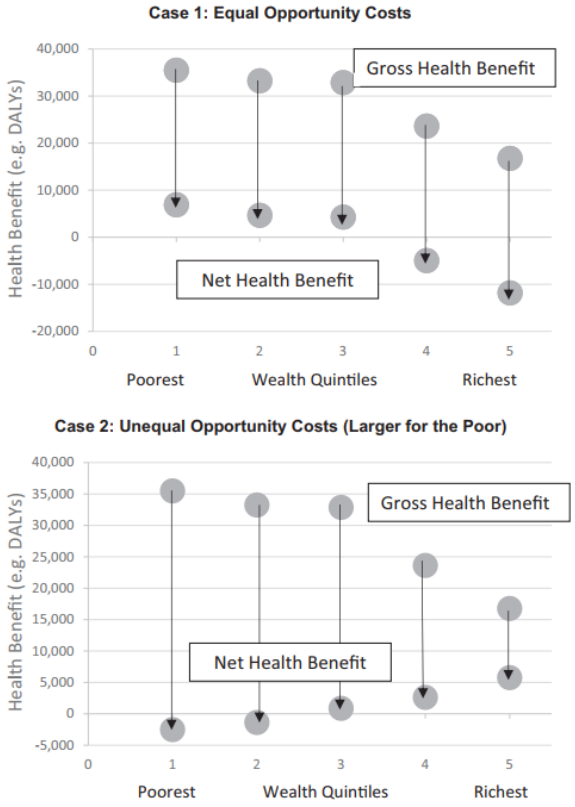


Figure 4: Health Equity Implications. Source: Cookson et al. (2017)