Chapter 8

Health Policy Analysis: Applications of Extended Cost-Effectiveness Analysis Methodology in *Disease Control Priorities*, Third Edition

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INTRODUCTION

Multiple criteria are involved in making decisions and prioritizing health policies (Baltussen and Niessen 2006). Potential trade-offs between efficiency and equity are among these criteria and have long been emphasized in the treatment and prevention of human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) (for example, Cleary 2010; Kaplan and Merson 2002; Verguet 2013). Notably, several mathematical frameworks, including mathematical programming, have proposed incorporating equity into resource allocation decisions in the public sector (Birch and Gafni 1992; Bleichrodt, Diecidue, and Quiggin 2004; Epstein and others 2007; Segall 1989; Stinnett and Paltiel 1996). The worldwide application of benefit-cost analysis provided for "distributional weights" as early as the 1970s.

Protection from financial risks associated with health care expenses is emerging as a critical component of national health strategies in many low- and middle-income countries (LMICs). The World Health Organization's *World Health Reports* of 1999 and 2000 included the provision of financial risk protection (FRP) as one criterion of good performance for health systems (WHO 1999, 2000). Reducing these financial risks is one objective of health policy instruments such as universal public finance (UPF), that is, full public finance irrespective of whether services are provided privately or publicly. Indeed, out-of-pocket (OOP) medical payments can lead to impoverishment in many countries, with households choosing from among many coping strategies (borrowing from friends and relatives, selling assets) to manage health-related expenses (Kruk, Goldmann, and Galea 2009; van Doorslaer and others 2006; Xu and others 2003). Absent other financing mechanisms, household medical expenditures can often be *catastrophic* (Wagstaff 2010; Wagstaff and van Doorslaer 2003), defined as exceeding a certain fraction of total household expenditures. A large literature documents the significance of medical impoverishment, but far less is known about the medical conditions responsible for it. Essue and others (2017), in chapter 6 of this volume, review and extend that literature, and Verguet, Memirie, and Norheim (2016) provide a framework for assessing the global burden of medical impoverishment by cause, applying it to a case study of a systematic categorization by disease in Ethiopia. In the literature on medical impoverishment, attenuating such impoverishment is considered a significant objective of health policy, but surprisingly little analysis has been

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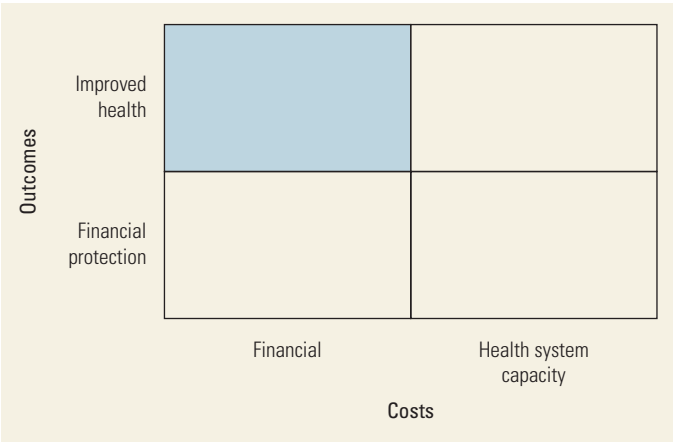
performed of efficient ways to address the problem. The method of Extended cost-effectiveness analysis (ECEA) was initially developed for *DCP3* by Verguet, Laxminarayan, and Jamison (2015).

Traditionally, economic evaluations of health interventions (cost-effectiveness analyses [CEAs]) have focused on improvements in health and estimated an intervention cost per health gain in dollar per death averted or dollar per disability-adjusted life year (DALY) averted (Jamison and others 2006). However, arguments have been developed for some time that CEA in health should be extended to explicitly consider the multiple dimensions of outcome. Jamison (2009), for example, argued that CEAs can be extended to include FRP on the outcome side and use of scarce health system capacity on the cost side (figure 8.1). Specific methods for advancing this agenda were first proposed and applied in assessments of the consequences of two alternative policies—public finance and improved access to credit—for extending coverage of tuberculosis treatment in India (Verguet, Laxminarayan, and Jamison 2015). That study and other early ECEAs (Verguet 2013; Verguet, Gauvreau, and others 2015; Verguet, Olson, and others 2015) supplemented traditional economic evaluation with evaluation of nonhealth benefits (such as FRP and equity), with the broad objective of providing valuable guidance in the design of health policies.[1]

ECEA in this respect builds on the existing frameworks of cost-benefit analysis and cost-consequence analysis that tabulate disaggregated results (Mauskopf and others 1998) and on analytical frameworks that incorporate equity and FRP concerns into economic evaluations (Asaria and others 2015; Brown and Finkelstein 2008; Cookson, Drummond, and Weatherly 2009; Finkelstein and McKnight 2008; Fleurbaey and others 2013; McClellan and Skinner 2006; Sassi, Archard, and Le Grand 2001; Smith 2007, 2013). It enables the design of benefits packages that quantify both health and nonhealth benefits for a given expenditure on specific health policies, based on the quantitative inclusion of how much nonhealth benefits are being bought as well as how much health benefits are being bought with a given investment in an intervention or policy. In this respect, ECEA can answer some of the policy questions raised by the *World Health Reports* for 2010 and 2013 (WHO 2010, 2013) regarding how to select and sequence the health services to be provided on the path toward universal health coverage. This chapter first describes the ECEA approach and then summarizes findings of ECEAs undertaken in the context of the third edition of *Disease Control Priorities* (*DCP3*; http://www.dcp-3.org).

Figure 8.1 Intervention Costs and Effects: A More General View



Source: Jamison 2009, by permission of Oxford University Press.
Note: The shaded box represents the domain of traditional cost-effectiveness analysis.

APPROACH

Consider the implementation of a given health policy (*HP*) in a given population (*P*). Policy examples include public finance for a package of vaccines, taxation on tobacco products, legislation to enforce the mandatory use of helmets, and so forth. *P* can be divided into subgroups, which can be denoted P_k (with $1 \leq k \leq n$) per socioeconomic status according to five income quintiles, per region according to geographic location (state, region, county), and per gender.

HP entails a given coverage (*Cov*) and given effectiveness (*Eff*) for preventing disease burden (*D*) in the population as well as a net cost (*C*). The ECEA methodology quantifies both health benefits (B_H) and nonhealth benefits (B_{NH}) in *P* for a given increment in public (or private) expenditure (figure 8.2).

Health Benefits

With the introduction of *HP*, health benefits (B_H) are procured—for example, quantified by the sum of the burden of disease averted in each subgroup (P_k)—with a specific effectiveness of the policy (Eff_k) assumed to be constant per subgroup.

In this respect, ECEA estimates the distributional health consequences—in particular, benefits (mortality, morbidity averted, disability-adjusted life years averted, quality-adjusted life years gained)—per population strata, whether socioeconomic group or geographic setting (figure 8.3).

Nonhealth Benefits

With *HP*, nonhealth benefits ($B_{NH,j}$) are procured, with $1 \leq j \leq m$, where *j* indicates the type of nonhealth benefits (FRP, number of school days gained). For example, if

we consider FRP, given a preexisting burden of illness-related impoverishment due to medical expenses, direct nonmedical costs such as transportation costs, and indirect costs such as wages lost, the related nonhealth benefits could be expressed by the sum of the burden of illness-related impoverishment averted in each population subgroup.

Specifically, the ECEA approach goes beyond the societal perspective in traditional economic evaluations (Drummond and others 2015) to examine the perspective of households in estimating the amount of OOP expenditures (direct medical costs, direct nonmedical costs, indirect costs) that could be affected by a specific policy (figure 8.4).

Subsequently, once the amount of OOP private expenditures borne by households that may be "crowded out" has been estimated, ECEA can be used to scale the amount of OOP household expenditures by households' disposable income to estimate FRP—in other words, to account for the fact that a household with annual income of US$100,000 and OOP expenditures of US$10 is much less severely affected than a household with annual income of US$100. The crowding out of private health expenditures will often be an objective as well as a consequence of health policy.

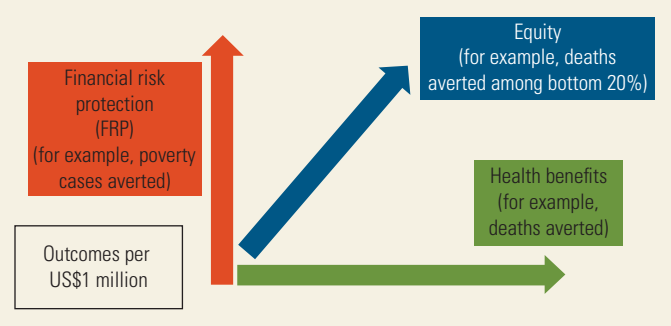
Several metrics can be used to estimate FRP (Flores and others 2008; Wagstaff 2010; Verguet, Laxminarayan, and Jamison 2015), including the following:

- Number of catastrophic health expenditures averted, estimating the number of households no longer crossing a catastrophic threshold (for example, 10 percent, 20 percent, 40 percent of income or capacity to pay) from OOP expenditures
- Number of poverty cases averted, estimating the number of households no longer crossing a poverty line (for example, US$1.25 per day) because of OOP expenditures
- Number of instances of forced asset sales or forced borrowing averted
- A money-metric value of insurance provided, quantifying the willingness to pay or risk premium associated with the policy (figure 8.5).

Equity Benefits

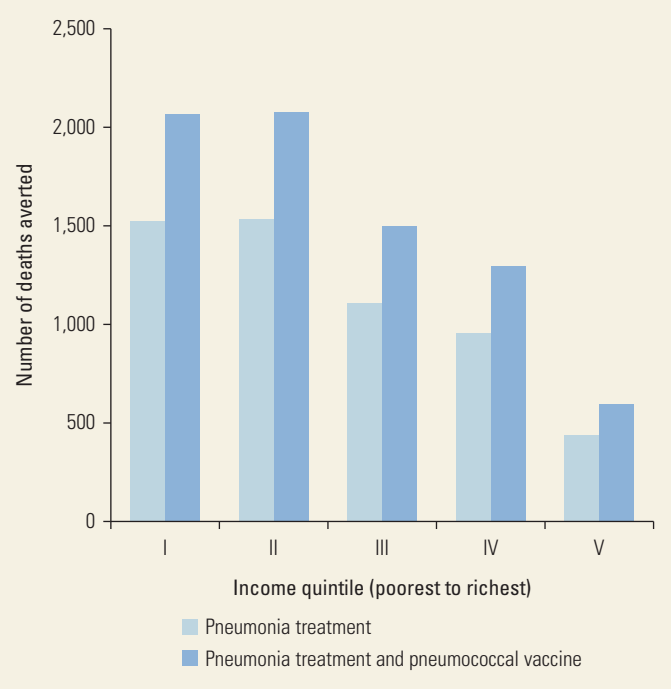
With *HP*, equity benefits (B_{Eq}), estimated here in terms of health distribution, can be procured. For example, if *HP* provides more health benefits to poorer than to richer segments of the population, the policy could be deemed equity enhancing (figure 8.3). There are several ways to quantify B_{Eq}, including $\frac{B_{H,w}}{B_H}$, where $B_{H,w}$ and B_H are the health benefits procured by *HP* among the worst-off group and the total sum of health benefits in all groups, respectively.

Figure 8.2 Objective of Extended Cost-Effectiveness Analysis: Efficient Purchase of Health and Nonhealth Benefits



Note: Similar to CEA measures in, say, US$ per death averted, estimate the efficient purchase of FRP in, say, US$ per FRP provided. CEA = cost-effectiveness analysis; FRP = financial risk protection.

Figure 8.3 Distribution of Under-Five Deaths Averted with Universal Public Finance (UPF) of Pneumonia Treatment at a Coverage Level 20 Percent Higher Than the Current Level and UPF of Combined Pneumonia Treatment and Pneumococcal Vaccination at 20 Percent Coverage Level in Ethiopia

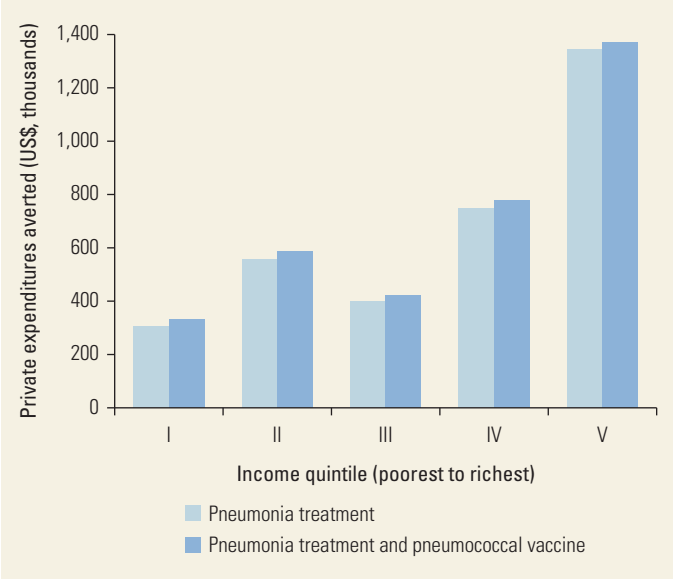


Source: Verguet and others 2016.

"Efficient Purchase" of Health and Nonhealth Benefits

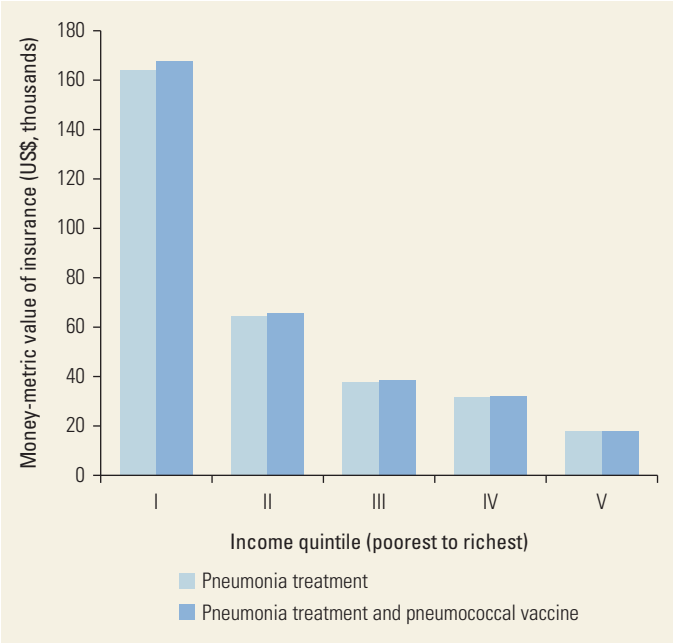
The net cost of the policy is *C*. For that net cost, *HP* "efficiently" purchases health benefits (B_H) but also nonhealth benefits (B_{NH})—for example, B_{FRP}. As in CEA, we can then define a usual incremental cost-effectiveness ratio (ICER)—ICER = C/B_H—but we can also define an ICER for each of the nonhealth benefits: for FRP, $ICER_{FRP} = C/B_{FRP}$. In this respect, ECEA can help quantify the efficient purchase of

Figure 8.4 Distribution of Household Private Expenditures Averted with Universal Public Finance (UPF) of Pneumonia Treatment at a Coverage Level 20 Percent Higher Than the Current Level and UPF of Combined Pneumonia Treatment and Pneumococcal Vaccination at 20 Percent Coverage Level in Ethiopia



Source: Verguet and others 2016.

Figure 8.5 Distribution of Financial Risk Protection (Measured by a Money-Metric Value of Insurance Provided) with Universal Public Finance (UPF) of Pneumonia Treatment at a Coverage Level 20 Percent Higher Than the Current Level and UPF of Combined Pneumonia Treatment and Pneumococcal Vaccination at 20 Percent Coverage Level in Ethiopia



Source: Verguet and others 2016.

both equity and FRP in addition to health. It also can help generate the evidence base to support informed trade-offs among the partially competing objectives of improved health, improved FRP, and improved equity. Figure 8.6 provides an illustration from Ethiopia.

APPLICATIONS

ECEAs Completed to Date

ECEA was developed for *DCP3* and has been used in health policy assessments for a variety of both policies and settings (table 8.1). The policies include public finance, excise taxes, legislation, regulation, conditional cash transfers, task shifting, and education.

ECEAs are context specific and depend substantially on the epidemiology of the setting (endemicity, distribution of specific diseases), local health system infrastructure (presence and distribution of health facilities), wealth of the location (low-income, lower-middle-income, upper-middle-income country), and financial arrangements (presence of social health insurance, community-based insurance). In total, more than 20 ECEAs have been published (or accepted for publication) as of May 2017. Of these, nine are included in one of *DCP3*'s nine volumes.

Example: Use of Dashboard

We now illustrate ECEA in considering the example of UPF for tuberculosis treatment in India in a population composed of five income quintiles totaling 1 million people (200,000 people per income quintile), drawing on the first completed ECEA (Verguet, Laxminarayan, and Jamison 2015).

Notably, we assume an average incidence of tuberculosis of $p_0 = 100$ per 100,000 per year, with incidence highest in the lowest income quintile. The cost of tuberculosis treatment (that is, directly observed treatment, short course) is US$100 per person. We also assume income in the population is distributed following a Gamma distribution based on a mean income of US$1,500 and a Gini coefficient of 0.33, as produced by an algorithm given by Salem and Mount (1974; see also Kemp-Benedict 2001).

The total number of deaths averted would be about 80 a year. The health benefits would be concentrated among the bottom income quintile (50 percent) because tuberculosis has a higher incidence among this subgroup. The total amount of private OOP expenditures averted by universal public funding would be about US$29,000. The bottom income quintile would benefit from about 20 percent of the private expenditures averted. The total incremental treatment costs incurred by the public sector would be about US$65,000. The total FRP afforded by UPF, estimated here using a money-metric value of insurance,

would be about US$9,000, 60 percent of which would be among the bottom quintile (table 8.2).

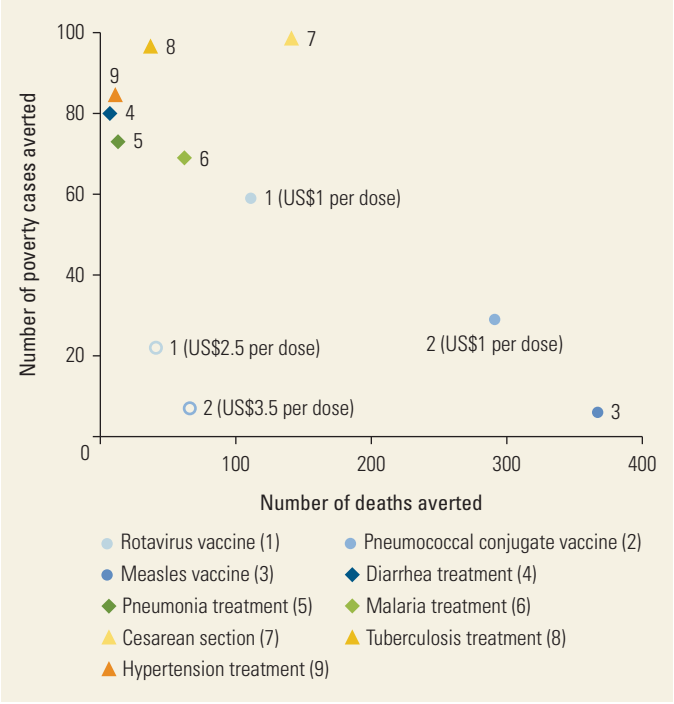
Examining the efficient purchase of health and non-health benefits, we find the following: ICER = US$800 per death averted, and $ICER_{FRP}$ = US$7 per dollar of insurance value provided. For each US$1 million spent, about 1,200 deaths are averted, 600 of which are in the bottom income quintile, and the money-metric value of insurance is US$140,000, of which 60 percent is in the bottom income quintile.

In addition to examining UPF, the ECEA study for India examined the consequences of improving access to borrowing to cover treatment costs. It found that it was plausible that such policies substantially reduce TB mortality among the poor but—relative to UPF—it would generate high burdens of lingering debt.

Poverty Reduction Benefits of Health Policies and Design of the Benefits Package

ECEA stresses the potential poverty reduction benefits of health policies. Specifically, ECEA explicitly quantifies the FRP benefits or the poverty reduction benefits of policies. In this respect, it fulfills two major objectives. First, it provides a quantitative tool that enables intersectoral comparison of health policies with other sectors (education and transport), which is of particular relevance for

Figure 8.6 Financial Risk Protection Afforded (Poverty Cases Averted) Versus Health Gains (Deaths Averted) per US$100,000 Spent (in 2011 U.S. Dollars) for Interventions Provided through Universal Public Finance in Ethiopia



Source: Verguet, Olson, and others 2015.

Table 8.1 Extended Cost-Effectiveness Analyses for *Disease Control Priorities*

a. ECEAs in DCP3

DCP3 Volume	Chapter and topic	Policy instrument	Country	Authors and other relevant publications (if any)
1	19. Expanding surgical access	Task sharing, public finance	Ethiopia	Shrime and others 2015; Shrime and others 2016
2	18. Universal home-based neonatal care package in rural India	Public finance	India	Ashok, Nandi, and Laxminarayan 2015; Nandi, Colson, and others 2016
	19. Diarrhea and pneumonia treatment	Public finance	Ethiopia	Verguet, Pecenka, and others 2016; Johansson, Pecenka, and others 2015; Pecenka and others 2015; Verguet, Murphy, and others 2013
3	18. Human papillomavirus vaccination to prevent cervical cancer	Public finance	China	Levin and others 2015a; Levin and others 2015b
4	13. Universal coverage for mental, neurological, and substance use disorders	Public finance	Ethiopia, India	Chisholm and others 2015; Johansson, Bjerkreim Strand, and others 2016; Megiddo and others 2016; Raykar and others 2016

table continues next page

Table 8.1 Extended Cost-Effectiveness Analyses for *Disease Control Priorities* (continued)

DCP3 Volume	Chapter and topic	Policy instrument	Country	Authors and other relevant publications (if any)
5	20. Selected ECEAs for cardiovascular diseases	Public finance of interventions, tobacco taxation, regulation of salt	China, Ethiopia, South Africa	Watkins, Nugent, and Verguet 2017; Verguet, Gauvreau, and others 2015; Verguet, Olson, and others 2015; Watkins and others 2015
7	11. Motorcycle helmet laws	Regulation	Vietnam	Olson and others 2016; Olson and others 2017
	12. Use of liquefied petroleum gas and other clean energy sources in household	Commodity subsidy	India	Pillarisetti, Jamison, and Smith 2017
8	28. Postponing adolescent parity	Education	India, Niger	Verguet, Nandi, and Bundy 2016; Verguet, Nandi, and others 2017

b. Other published ECEAs (including those accepted for publication)

Topic	Policy instrument	Country	Reference
Tuberculosis treatment	Universal public finance; policies to improve ease of borrowing for treatment costs	India	Verguet, Laxminarayan, and Jamison 2015
Measles vaccine	Conditional cash transfers	Ethiopia	Driessen and others 2015
Universal immunization	Public finance	India	Megiddo and others 2014
Water and sanitation	Clean piped water and improved sanitation	India	Nandi, Megiddo, and others 2016
Tobacco	Taxation	Lebanon/Armenia	Verguet, Gauvreau, and others 2015; Salti, Brouwer, and Verguet 2016; Postolovska and others 2017
Palliative care	Public finance	Vietnam	Krakauer and others 2017
Tutorial		Not applicable	Verguet, Kim, and Jamison 2016
Rotavirus vaccine	Public finance	Malaysia	Loganathan and others 2016
Malaria vaccine	Public finance	Zambia	Liu, True, and others, forthcoming

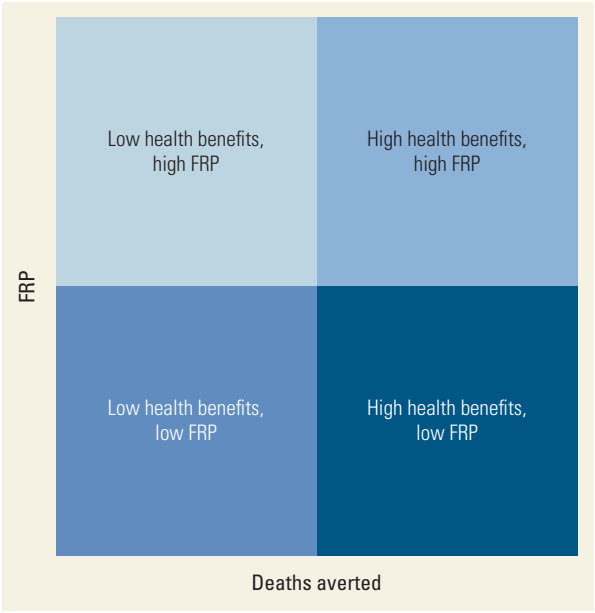
Note: ECEA = extended cost-effectiveness analysis. These two papers reference the same study.

Table 8.2 Extended Cost-Effectiveness Analysis Results for Universal Public Finance of Tuberculosis Treatment in India to 90 Percent Current Coverage (per Million Population)

		Income Quintile				
Outcome	Total	I	II	III	IV	V
Tuberculosis deaths averted	80	40	25	12	3	0
Private expenditures averted (US$)	29,000	6,000	6,000	7,000	6,000	4,000
Insurance value (US$)	9,000	5,000	2,000	1,000	1,000	0

Source: Reproduced from table III of Verguet, Laxminarayan, and Jamison 2015.
Note: Financial risk protection is measured as a money-metric value of insurance.

Figure 8.7 Use of Extended Cost-Effectiveness Analysis in Decision Making with the Inclusion of One Health Domain (Deaths Averted by Policy) and One Nonhealth Domain (Financial Risk Protection Provided by Policy) per Dollar Expenditure



Note: FRP = financial risk protection. As a simplification, the decision-making space can be divided into four quadrants: high health benefits and high FRP, high health benefits and low FRP, low health benefits and high FRP, and low health benefits and low FRP.

ministries of finance in LMICs (figure 8.7). In this context, ECEAs may yield surprising results. Salti and others (2016) found that tobacco taxation not only differentially benefited the health of the poor, but it protected them from financial consequences of illness and thereby constituted a progressive tax. Second, it enables policy makers to assemble a basic benefits package that takes into account how much health and how much FRP they can buy when designing the package. Depending on the preferences of policy makers and users, they can directly choose and optimize the benefits packages.

DISCUSSION

This chapter presents detailed methods for the broader economic evaluation of health policies. ECEAs build on CEAs by assessing consequences in both the health and nonhealth domains.

The ECEA approach is novel in that it includes equity and nonhealth benefits (FRP) in the economic evaluation of health policies, which enables multiple criteria to be included in the decision-making process. More important, the ECEA approach enables the design of benefits packages, such as essential universal health coverage and the highest-priority package discussed in chapter 3 in this volume (Watkins and others 2018), based on the quantitative inclusion of information about how much nonhealth benefits can be bought, in addition to how much health can be bought, per dollar expenditure on health care (figures 8.6 and 8.7).

Some health policies will rank higher on one metric relative to another. ECEA allows policy makers to take both health and nonhealth outcomes into account when making decisions and thus to target scarce health care resources more effectively toward specific policy objectives.

NOTES

Large parts of this chapter have been reproduced and adapted from the following *PharmacoEconomics* publication: Verguet, S., J. J. Kim, and D. T. Jamison. 2016. "Extended Cost-Effectiveness Analysis for Health Policy Assessment: A Tutorial." *PharmacoEconomics* 34 (9): 913–23. Licensed under Creative Commons Attribution (CC BY 4.0) available at: https://creativecommons.org/licenses/by/4.0/

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  (a) lower-middle-income = US$1,046 to US$4,125
  (b) upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

1. Kim and others (2006) analyzed the effects of health system constraints on optimal resource allocation, and Rheingans, Atherly, and Anderson (2012) examined the distributional impact of rotavirus immunization.

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