An Implicit Price of a DALY for Use in a Cost-Benefit Analysis of ARVs

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Abstract

This paper uses the revealed preference approach to estimate the price for a Disability Adjusted Life Year (DALY) implied by grant decisions by the Global Fund for AIDS, Tuberculosis and Malaria (GFATM). A Cost-Benefit criterion is used that requires the DALY price exceed the Cost-Effectiveness ratio. The estimated price was $6,300 for a DALY saved from any disease, but it was $11,900 from a DALY saved specifically from HIV/AIDS. Estimates of the Cost-Effectiveness ratios of Antiretroviral Drug Therapies (ARVs) in the literature were examined. At the DALY prices implicit by GFATM decisions, ARVs would be socially worthwhile.
I Introduction

In countries with widespread HIV/AIDS epidemics, there is an ongoing debate as to whether preventative interventions, such as mass media and school education, condom provision for sex workers and others, and voluntary counseling and testing services, are preferable to treatment, in the form of antiretroviral therapies (ARVs) – see for example, Creese et al. (2002), Hogan et al. (2005), and Canning (2006). This debate continues even though it is well known that the prevention/treatment choice, firstly, excludes a third option, mitigation, as with caring for AIDS orphans and, secondly, this choice is not mutually exclusive, seeing that people often get involved with prevention only when treatment is possible and available.

This preoccupation with the prevention/treatment choice is somewhat understandable in the context of a fixed budget constraint. In these circumstances what to do first needed to be decided and Cost-Effectiveness Analysis (CEA) was used to help identify the priorities. However, with the increased flow of funds now being allocated to HIV/AIDS interventions which includes, among others, the President’s Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund (to fight AIDS, tuberculosis and malaria), the emphasis should now switch to deciding whether any particular intervention is worthwhile or not. For this task, Cost-Benefit Analysis (CBA) is necessary to establish what is socially worthwhile. So CEA is not a viable alternative notwithstanding its widespread and preponderant use in the healthcare and development evaluation fields.
The reason why the literature turned to CEA in the first place was because there were perceived to be major problems in assigning monetary values to outcomes to form the benefits that are to be compared with the costs in a CBA. Best practice to measure project effects in CBA is to use the Willingness To Pay (WTP) approach. This fits in well with the welfare economics base that is used to evaluate and guide public policy decisions. The human capital approach is not consistent with WTP and this is why its use is thought problematical even though it is the main way of evaluating benefits in CBA practice in the health field. WTP crucially requires that individuals be the best judges of their own welfare. With this requirement, WTP records intensity of preference. When the loss of life is at stake, WTP is directed at measuring how much an individual is willing to accept in monetary compensation, typically in terms of the wages that people are paid in a hazardous occupation, to accept the increased risk of death. In this context of risk of death, WTP is called the Value of a Statistical Life (VSL) approach. The extent to which workers are actually informed about, and can perceive, small changes in risk is not clear. A more recent criticism of VSL is by Haacker (2006) who argues that the value of an extra year of life is not constant across individuals and countries because life expectancies can vary and, as we all know, life expectancies have greatly been shortened, especially in Africa, due to the HIV/AIDS epidemic.

Although there are applications of human capital, WTP and VSL methods to interventions for HIV/AIDS – see Brent (2008a, 2008b and 2008c) – the health care field is not yet comfortable with any of these three methods of monetizing the outcomes to form the benefits in a CBA of interventions. In part this is because some of the weaknesses of WTP are viewed as fatal. But, in large part this seems to be because equity in the health care field is
considered to be just as important as efficiency as reflected by WTP. WTP is not only affected by intensity of preferences; it is also affected by a person’s ability to pay. If the distribution of income is not optimal (and it is not) then the fact that some groups may not be able to access health care because they cannot afford to pay for services is a major social concern. In principle one can weight the WTP of a person or group by the social marginal utility of income (i.e., use distributional weights). But this is not going to be an acceptable solution if one does not recognize WTP in the first place.

In this context, where we are thinking about using CBA in the health care field, where CEA is the norm, that it may be useful to consider a fourth method of deriving estimates of the monetary benefits. CBA uses a money metric for both inputs and outputs. CEA uses costs for inputs, but uses “effects” as its output. In order for CEA to have a comprehensive outcome measure, evaluators have turned to a Disability Adjusted Life Year (DALY), or its inverse the quality Adjusted Life Year (QALY), which combines both mortality and morbidity into a single index for the effect. One could stick with the philosophy of CEA based on DALYs, yet undertake a CBA, if only one had available a price to attach to the DALYs. For then the cost of a DALY could be compared with the value of a DALY to see whether any intervention was worthwhile. The purpose of this paper is to present, and apply, a revealed preference methodology to derive an estimate for the price of a DALY to be used to convert a CEA into a CBA. DALYs are more and more being used in the development field to evaluate outcomes for policy changes at the national level and for individual projects. We will use our estimate of the price of a DALY to form the benefits of ARVs in order to carry out a CBA of this intervention. Finding worthwhile interventions for combating HIV/AIDS is essential since, as Barnett and
Whiteside (2006, p25) emphasize, there can be no ‘development’ in Africa – it is “virtually impossible” –unless HIV/AIDS is contained.

In the next section we present the CBA criterion and express this in terms of the number of DALYs and its price. Then we present our method for estimating the price of a DALY and proceed to apply the method to Global Fund grant decisions. From there we return to the prevention/treatment debate to examine how the case for ARVs is affected by the ability to now undertake a CBA. We close with the summary and conclusions.

2. The CBA Criterion in Cost-Effectiveness Terms

A CBA judges an intervention, say prevention, to be worthwhile if the present value of all benefits $B$ exceed the present value of all costs $C$:

$$B > C$$ (1a)

Instead of a myriad of outputs that make up the benefits, led us assume there is a single effect $E$ for each intervention. Let $P$ be the price for this effect. In this framework a benefit is the product of the price of an effect times the number of effects: $B \equiv PE$. Equation (1a) therefore becomes:

$$PE > C$$ (1b)

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1 To see how a calculated DALY can be converted to a QALY, and vice versa, see Arensen and Nord (1999).
Equivalently, we can divide both sides of equation (1b) by $E$ to form:

$$P > C/E$$  \hspace{2cm} (1c)$$

The CBA criterion requires that the price of the effect must be greater than the cost-effectiveness ratio. Note that unless we know $P$, the ratio $C/E$ for one intervention may be the lowest, but not worthwhile (it is less than $P$), and the ratio $C/E$ for another intervention may be the highest, yet worthwhile (it is greater than $P$). So knowing $P$ is essential to judge the desirability of interventions. Knowledge of the cost-effectiveness ratio is not sufficient to make the decisions.

To reinforce the idea that it is a DALY that is the common effect, we can denote the common price by $P_D$ and require that it exceed the cost per DALY generated by an intervention. Equation (1c) can be rewritten as:

$$P_D > C/DALY$$  \hspace{2cm} (1d)$$

This is the version of the CBA criterion that we will be using to evaluate ARVs.

3. The Revealed Preference Method to be Used to Estimate $P_D$

3.1 Basic Concepts

The revealed preference methodology and its role in CBA generally are covered in Brent (2006) and its role in health care evaluations in Brent (2003). For choices by individuals related to their
utility functions, the revealed preference method leads to the need to estimate demand curves and use them to form the benefits. On this basis Brent (2008a) evaluated a condom social marketing program, which is one way of preventing HIV. For cases where choices have been made by a social decision-maker on the basis of a social utility function, the reveal preference approach has been used to estimate income distribution weights, Brent (1979, 1980), the social discount rate, Brent (1989), and the benefits of alcohol treatment programs, Brent (1998). Here we explain just enough to make understandable how we are applying the revealed preference methodology in this article.

The revealed preference approach is based on the idea that behavior reveals preferences. People will therefore spend more on items that give greater utility and spend less on goods and services that give lower levels of utility. To use the approach one has to postulate what are the variables in the utility function, obtain data on them, and see if they are statistically related to past expenditure decisions. The importance of any one factor is given by the size (and sign) of its coefficient in the estimation equation. Thus a comparison of two factors’ coefficients will reveal the marginal rate of substitution, the “trade-off”, of one factor in terms of the other. When one of the factors is measured in monetary terms, and the other is in physical terms, then the ratio of coefficients express units of the physical factor in monetary units. In this way one is “pricing” the physical unit.

The physical unit we are attempting to price in this article is a DALY. The question arises as to why one should try to find its implicit price rather than estimating its value directly by extracting people’s willingness to pay for it in the same way that one tries to value items in other
applications in CBA. The problem is that people have experience purchasing most final goods and services, such as transportation, housing, clothing and even paying admission to go to an art museum, but have no experience in purchasing a DALY. The implicit price revealed by behavior is not automatically the correct shadow / social valuation. But it is a value based on experience that helps one formulate the right price. Thus if one thinks that past spending behavior has been insufficient, then the estimated revealed price needs to be adjusted upwards. While if one thinks that past behavior has been too generous, then one would want to adjust downward the estimated revealed price. In the context of HIV/AIDS where millions have died and will die in the future, and stigma has been a major constraining force, there is a strong public presumption that we are not doing enough to prevent and treat the disease. So any preferences revealed by past behavior would be likely to understate the value of a HIV DALY avoided.

3.1 Estimation Framework

Whether for an individual, or for a country $i$ that we are now considering, one can assume that utility $U_i$ depends on health and on income. We will measure health by the burden of disease as reflected by DALYs lost due to disease ($D_i$) and income by per capita Gross National Product ($Y_i$). The social utility function then is represented by:

$$U_i = U_i(D_i, Y_i)$$

(2)
The definition of the price of a DALY is the impact of a marginal increase in \( D_i \) in terms of income \( Y_i \):

\[
P_D \equiv \frac{dY_i}{dD_i} = (-) \frac{\partial U_i / \partial D_i}{\partial U_i / \partial Y_i}
\]

For simplicity we will assume that the two marginal effects are constant:

\[
\frac{\partial U_i}{\partial D_i} = \beta_D ; \quad \frac{dU_i}{dY_i} = \beta_Y,
\]

in which case the price of a DALY is to be determined by the ratio:

\[
P_D = \beta_D / \beta_Y \quad (3)
\]

Expenditure decisions or grants \((G_i)\) are a function of the utility variables and a third factor (or set of factors) denoted by the variable \(Z_i\). If these expenditure decisions are additively separable in \(U_i\) and \(Z_i\), then we can write them as:

\[
G_i = G_i(U_i(D_i, Y_i), Z_i) = \Gamma_1[U_i(D_i, Y_i)] + \Gamma_2[Z_i] \quad (4)
\]

We will assume that the expenditure decisions are linear, so that when we consider marginal changes in expenditures they will simply be proportionally related to changes in the three factors:

\[
dG_i = \Gamma_1 [dU_i] + \Gamma_2 [dZ_i] = \Gamma_1 [(\frac{\partial U_i}{\partial D_i}) dD_i + (\frac{\partial U_i}{\partial Y_i}) dY_i] + \Gamma_2 [dZ_i]
\]

\[
= \Gamma_1 \beta_D \ dD_i + \Gamma_1 \beta_Y \ dY_i + \Gamma_2 \ dZ_i
\]

Or:

\[
dG_i = \gamma_D \ dD_i + \gamma_Y \ dY_i + \gamma_Z \ dZ_i \quad (5)
\]
where: $\gamma_D = \Gamma_1 \beta_D$; $\gamma_Y = \Gamma_1 \beta_Y$; $\gamma_Z = \Gamma_2$.

Because of the linear structure, we can rewrite equation (5) as a regression equation with a constant term $\gamma_0$ and a random error term $\epsilon_i$ to form:

$$G_i = \gamma_0 + \gamma_D D_i + \gamma_Y Y_i + \gamma_Z Z_i + \epsilon_i$$  \hspace{1cm} (6)

The price of a DALY as expressed in equation (3) can be determined from this regression equation using:

$$P_D = \frac{\gamma_D}{\gamma_Y}.$$ \hspace{1cm} (7)

4. The Global Fund’s Implicit Price for a DALY

Here we give some details of how the Global Fund operates, specify the variables that will be used in the estimation, and present the results.

4.1 Background.

The largest source of multilateral funds for HIV/AIDS is the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM).\(^2\) This Fund was set up to finance projects for the three

\(^2\) Much of the information detailed in this section is drawn from UNAIDS (2006, 240-242).
diseases so that others, mainly nationally organized entities, can carry out interventions. The GFATM was established in January 2002 and guided by the “additionality principle” that its grants should have no negative impacts on other programs targeting the three diseases. Up to 2004, the Fund depended on ad hoc contributions from 45 countries and from philanthropic foundations, corporations and individuals. In 2005, in order to make its resources more sustainable, the UN set up the Voluntary Replenishment Mechanism and there were three meetings during the year. At the last of these, 29 international donors pledged a total of US$ 3.7 billion for 2006 and 2007. By the end of December 2005, which is the end date of the period that we will be analyzing, the GFATM received contributions and pledges that would bring a cumulative total of US$ 8.6 billion through 2008. There were five rounds of grants (April 2002, January 2003, October 2003, June 2004 and September 2005) which produced a total of 350 grants to recipients in 128 countries. By the end of 2005 the total amount approved was US$ 9.6 billion. But note that, of the US$ 9.6 billion approved, only US$ 1.9 billion was actually dispersed, with US$ 1.1 billion dispersed in 2005 alone.

The share of the grants going to HIV was 56%, with 17% going to TB and 26% to malaria. Around 60% of commitments went to Sub-Saharan Africa. It is this region’s grants that we will be analyzing in detail, which is home to almost two-thirds of the world’s population living with HIV/AIDS, except that we will be adding also North African countries to the mix (seeing that their data was available on the same basis as for those in Sub-Saharan Africa and included together). So the GFATM grants that we will be attempting to explain consists of
rounds 1-5 going to countries in Africa, numbering 48 in total (44 in Sub-Saharan Africa and 4 in North Africa).³

It is important to fully understand the utility maximizing process that underlies GFATM grant allocations. In general, to make economic decisions, there has to be two ingredients: a statement of preferences (e.g., a utility function) and a statement of the constraints (e.g., a production function). So for GFATM decisions one might expect that it is not just the neediest countries that obtain the greatest monetary grants; one might also suspect that countries that could make the best use of the funds would be the most favored. However, there is a two-step procedure that the GFATM employs. The first is to allocate funds according to need (the utility function part). Then, once the amounts have been assigned to a particular country, there is a Technical Review Panel, consisting of scientists, who review applications from specific groups who make detailed plans as to how to spend the funds (the production function part). Thus, in the special case of GFATM country grant allocation decisions that we will be analyzing, this is primarily the first stage of the two-step utility maximizing procedure. The need variables are going to come to the fore and not the variables that indicate how best to use the funds.

4.2 Specifying the Estimation Equation.

We now specify in detail the variables that we will be using to correspond to equation (6).

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³ The grant data that will be analyzing was downloaded from the Global Fund website: www.globalfund.org. We refer to this data as the Global Fund (2005). Of the 48 countries in Sub-Saharan Africa, our sample excludes the Republic of the Congo, Cape Verdi, Mauritius and Seychelles. The 4 North African counties included are Algeria, Egypt, Jordan and Morocco.
The Dependent Variable

The Fund divides proposals into two phases, phase 1 covering the first two years and phase 2 usually covering three additional years. We take the “grand total” amounts for each country over 5 years as the dependent variable. Note that these totals are for the three diseases, except for Malawi and Rwanda, where the amounts also include funds for Health System Strengthening (HSS). The amounts are what have been committed and not just what have been disbursed.

The Independent Variables

Obviously, in order to obtain an estimate of the price of a DALY in terms of income, both DALYs and income must appear as independent variables in the estimation equation. In turns out that in the criteria to determine the eligibility of proposals for the GFATM, both these variables are referred to explicitly. In the mission statement for the Global Fund (undated) they state that: “the highest priority should be given to those proposals from countries and regions in greatest need, based on the highest burden of disease and the least ability to bring financial resources to address these health problems.”

In terms of identifying those with the greatest burden of the three diseases, the Fund states that one “would rely on accepted international standards”. A suitable international source would be the World Health Organization’s (2004) Global Burden of Disease (GBD) DALY figures. Table 2 is headed: “Estimated Total DALYs by Cause and WHO Member State, 2002”. This gives the DALYs for all causes (GBD code W000), DALYs for TB (GBD code W003),
DALYs for HIV/AIDS (GBD code W009) and DALYs for Malaria (GBD code W020). In our estimation we utilize this information to derive four specifications for $D_i$: DALYs for All Diseases, DALYs for Three Diseases (HIV, TB and Malaria), DALYs for Two Diseases (HIV and TB) and DALYs for HIV. All specifications are in per capita terms to be on the same basis as the other independent variables. UNAIDS (2006) had country profiles and the population numbers given there were used to produce the per capita DALY figures.

To identify countries and regions with the least ability to finance interventions, the mission statement writes that: “Relevant indicators of the poverty situation, such as GNP per capita” can be used. The UNAIDS (2006) country profiles also included data on “Per Capita Gross National Income”. This was measured in purchasing power parity (ppp) international dollar rates. So our specification for $Y_i$ was this measure expressed in a common currency unit for all countries.

To complete the specifications of the independent variables in equation (6) we need a measure and data source for $Z_i$. As explained in the previous section, since we are focusing primarily on the utility/need part of the two-step decision-making procedure, we will be extremely parsimonious in our specification of $Z_i$. The mission statement listed as an additional eligibility requirement “political commitment” and this could be measured by “public spending on health”. UNAIDS (2006) in their country profiles had data on the “Amount of National Funds Spent By Governments From Domestic Sources On AIDS.” UNAIDS called this a “Generalized Epidemic Indicator” and this follows closely the added Global Fund’s eligibility requirement. The data reflect the best estimates of actual expenditures for the period 2001 – 2005.
and attempted to net out international funds to isolate countries’ own expenditures. These own expenditures are thus treated as a proxy for determining whether a country is committed domestically to dealing with the HIV/AIDS epidemic.

A summary of the data on $D$, $Y$ and $Z$ is given in table 1. We have added also information on disability adjusted life expectancy because sometimes CEA outcomes are expressed as lives averted and one would like to know how many years these lives saved are going to generate. We will use this information on disability life years expected to convert DALYs into the value of lives saved which is often used as the outcome measure in CBA.\footnote{The data on disability life years expected at birth in 1999 come from Mathers et al. (2001).}

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>DALYs for all diseases</td>
<td>0.4840</td>
<td>0.1764</td>
<td>0.1478</td>
<td>0.8176</td>
</tr>
<tr>
<td>DALYs for three diseases</td>
<td>0.1455</td>
<td>0.1279</td>
<td>0.0002</td>
<td>0.5530</td>
</tr>
<tr>
<td>DALYs for two diseases</td>
<td>0.1104</td>
<td>0.1325</td>
<td>0.0025</td>
<td>0.5496</td>
</tr>
<tr>
<td>DALYs for HIV</td>
<td>0.0986</td>
<td>0.1305</td>
<td>0</td>
<td>0.5405</td>
</tr>
<tr>
<td>Income per capita</td>
<td>2414.7</td>
<td>2325.0</td>
<td>620</td>
<td>10960</td>
</tr>
<tr>
<td>Health expenditures per capita</td>
<td>53.681</td>
<td>67.451</td>
<td>3</td>
<td>258</td>
</tr>
<tr>
<td>Disability adjusted life expectancy</td>
<td>39.831</td>
<td>8.1462</td>
<td>25.9</td>
<td>61.6</td>
</tr>
</tbody>
</table>

Note: The numbers in the table were based on 48 observations for all four DALY specifications, on 45 for income, on 47 for health expenditures and on 48 for disability adjusted life expectancy.

### 4.3 Estimating the DALY Price.

We noted earlier that of the US$ 9.6 billion that the GFATM approved by the end of 2005, only US$ 1.9 billion was actually dispersed, most of this just in 2005. This confirms the fact that our
specification of the dependent variable was in terms of commitments and not disbursements. Given that these commitments were for up to 5 years into the future from 2003 to 2005, and our data on all the independent variables are measured as at 2005 or earlier, we have our identification strategy. The independent variables can be regarded as predetermined relative to the dependent variable. This means that causation can only run from \( D, Y \) and \( Z \) to \( G \) and not vice-versa. Ordinary Least Squares (OLS) would then appear to be a suitable estimation technique.

| Table 2: OLS Regression Estimates with GFATM Grants as the Dependent Variable |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| | (I) DALYs for All Diseases | (II) DALYs for Three Diseases | (III) DALYs for Two Diseases | (IV) DALYs for HIV |
| Variable | (D) | (Y) | (Z) | (D) |
| DALYs (D) | 38.0853 | 72.3172 | 72.527 | 72.6735 |
| | (2.93) | (4.44) | (4.46) | (4.32) |
| Income (Y) | – 0.0061 | – 0.0067 | – 0.0067 | – 0.0068 |
| | (2.41) | (2.97) | (3.01) | (3.03) |
| Health Expenditures (Z) | 0.3076 | 0.2701 | 0.2592 | 0.2622 |
| | (3.63) | (3.48) | (3.32) | (3.33) |
| Constant | – 7.7662 | 3.0206 | 6.2934 | 7.2189 |
| | (1.06) | (3.11) | (1.99) | (2.31) |
| \( R^2 \) | 0.3834 | 0.4963 | 0.4983 | 0.4879 |

| Value of a DALY | $ 6,284 | $ 10,868 | $ 10,783 | $ 11,871 |
| Value of a Life | $ 250,286 | $ 432,869 | $ 429,501 | $ 422,957 |

\(^5\) Data on variable \( D \) was for 2002, on \( Y \) was for 2005, and on \( Z \) for anytime between 2000-2005. As most of the disbursements were made in 2005 there would not have had enough time for this to have impacted 2005 per capita income. In any case our dependent variable is planned spending and not actual spending.
Table 2 presents the OLS results for the four DALY specifications related to HIV. All regression coefficients (except the constant terms) were significant at the 1% level (using the T-test statistics) and all equations were significant at well below the 1% level (using the F-test statistics). The order of the equations is from the broadest (equation I has DALYS lost from HIV and all other causes) to the narrowest (equation IV has DALYs lost just due to HIV). Income per capita as a measure of need (poverty) had the expected negative sign (the higher the need the higher the grant). DALYs were measured in terms of healthy years lost, so the positive sign here also was as expected (the more years lost to disease, the higher the grant). Explaining between 40 to 50% of the variation in GFATM grants with our parsimonious specification (which just used the three variables we were testing) means that our statistical model gave a reasonably good fit to the data. The fit was much greater (over 10 percentage points higher) for the three diseases targeted by the Global Fund, i.e., equations (II) – (IV), than for the “generic” DALY equation (1)

The DALY prices given in table 2 were obtained by substituting the pair of coefficients for $D$ and $Y$ from each of the four regressions into equation (7). The price of a generic DALY from equation I was valued at around US $6,300 (in 2005 ppp dollars). For the three diseases covered by the GFATM, the DALY price was much higher. The DALY price for HIV on its own (at US $11,900 in equation IV) or combined with TB (at US $10,800 in equation III) was close to the HIV DALY price for all three GFATM diseases (at US $10,900 in equation II). Since the DALY prices are derived from the ratios of coefficients there is no simple statistical test for differences in the DALY price estimates. But, given the small differences in DALY price estimates among the three diseases and the large differences between the prices of any of the three specific diseases and the generic DALY price, and given the small sizes of the standard
errors, it is highly likely that the prices for the three diseases are not statistically significantly different from each other, while each of the three prices would be statistically significantly different from the generic DALY price.\(^6\)

All four of the DALY prices were multiplied by 39.8313, being the average disability adjusted life expectancy in the sample, to form the value of a life that appears in the last line of table 2. The value of life derived from a general DALY is around a quarter of a million US dollars. For a DALY covered by the three diseases in the GFATM, the value of a life was within the range US $430,000 to US $470,000.

5. **The Case for ARVs Revisited**

Now that we have an estimate of the price of DALY we can carry out a CBA in order to evaluate the case for ARVs. Recall that the CBA criterion expressed in equation (1d) was to declare an intervention worthwhile if the DALY price exceeded the cost-effectiveness ratio, i.e., \( P_D > C / \text{DALY} \). So what we require are some estimates of the cost-effectiveness ratios of ARVs existing in the literature. A number of surveys of CEAs of ARVs have been undertaken, see Marseille et al. (2002), Creese et al. (2002), Masaki et al. (2003), Canning (2006) and Hogan (2006), and we will take our estimates from these sources. As there is some cross-referencing in these sources, our summary in table 3 uses figures just from tables 3 and 4 of Canning and tables 1 and 3 of Hogan et al.

\(^6\) Note that using a pooled variance T-test of the difference between two means, the three diseases \( D \) coefficients were not significantly different from each other and any of them were statistically significantly different from the \( D \) coefficient for the generic DALY. The same set of results applies to the \( Y \) coefficients in table 2.
### Table 3: Cost-Effectiveness Ratios for Antiretroviral Therapy (US$ Cost per DALY)

<table>
<thead>
<tr>
<th>Type of ARV Intervention</th>
<th>Source</th>
<th>CE Ratio (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single Interventions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First line drugs only</td>
<td>Marseille et al. (2002)</td>
<td>350 – 2000</td>
</tr>
<tr>
<td></td>
<td>Creese et al. (2002)</td>
<td>1100 – 1800</td>
</tr>
<tr>
<td></td>
<td>Masaki et al. (2003)</td>
<td>1317 – 2029</td>
</tr>
<tr>
<td></td>
<td>Hogan et al. (2006)</td>
<td>556</td>
</tr>
<tr>
<td>First line drugs with intensive monitoring</td>
<td>Hogan et al. (2006)</td>
<td>596</td>
</tr>
<tr>
<td>First and second line drugs only</td>
<td>Hogan et al. (2006)</td>
<td>2010</td>
</tr>
<tr>
<td>First and second line drugs with intensive monitoring</td>
<td>Hogan et al. (2006)</td>
<td>1977</td>
</tr>
<tr>
<td><strong>Combined interventions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First line drugs only</td>
<td>Hogan et al. (2006)</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td>Canning (2006)</td>
<td>563</td>
</tr>
<tr>
<td>First line drugs with intensive monitoring</td>
<td>Hogan et al. (2006)</td>
<td>1144</td>
</tr>
<tr>
<td>First and second line drugs only</td>
<td>Canning (2006)</td>
<td>2011</td>
</tr>
<tr>
<td>First and second line drugs with intensive monitoring</td>
<td>Hogan et al. (2006)</td>
<td>5175</td>
</tr>
</tbody>
</table>

The single interventions are for ARVs assuming that no other interventions are taking place. The combined interventions are when ARVs are added to a package that includes prevention interventions first. For Hogan et al. the ratios are marginal cost-effectiveness ratios, while for Canning they are my calculations of what would be his average cost-effectiveness ratios.⁷

Whether we take the all disease DALY price of US $6,300 or the HIV-specific DALY price of US $11,900, and no matter the particular ARV intervention we consider in table 3, it is clear that the benefits of ARVs exceed the costs. This conclusion holds whether we consider preventative interventions or not. So it does not matter whether it is true that ARVs are less cost-

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⁷ That is, $563 is a total cost of $1,1350 million divided by total DALYs saved of 2.4 million, and $2,011 is a total cost of $6,434 million divided by total DALYs saved of 3.2 million.
effective than preventative programs. The only result that is important is that current ARVS have been found to be socially worthwhile if one accepts the preferences implicit in GFATM grant decisions.

6. Summary and Conclusions

The CEA literature has reached a sort of consensus that prevention is more cost-effective than treatment when it comes to interventions for HIV/AIDS in counties with widespread epidemics. The problem with this consensus is that it relies on CEA and not CBA. So it could still be true that: (a) prevention, even if it is more cost-effective than ARVs, is not worthwhile, and (b) ARV treatment, even if it is less cost-effective than prevention, is worthwhile. On the basis of one CBA methodology we have found that ARV treatment is in fact beneficial. This is despite the fact that one CEA survey judges that not only are ARVs less cost-effective than prevention, they are also not at all cost-effective.\footnote{See Evans et al. (2005).} For this conclusion the common CEA device of referring to a “bench-mark” figure for CEA acceptability took place, in this case equal to one year’s worth of GDP per capita ($1,576) for a Sub-Saharan African country for “highly cost-effective” and equal to three year’s worth of GPP per capita ($4,347) for “cost-effective”. These benchmarks make sense in Cost-Benefit terms if they are used as measures of the price of a DALY based on the human capital approach for the GDP figure (one year’s earnings) or for the price of a DALY using the Valuing of a Statistical Life approach (that often values a life three times that as for the human capital approach). But, as we have shown in this article, there are other CBA valuing methodologies, such as one based on revealed preferences, which would approve ARVs. The
CEA literature has to start to think of evaluating HIV interventions in Cost-Benefit terms and come up with a price of a DALY using a methodology that they are willing to endorse.

The CBA we undertook was based on the implicit price of a DALY revealed by the grants made by the Global Fund to 48 African countries in the first five rounds of its operation. The fact that the implicit price of US $11,900 given by the GFATM for a HIV-specific DALY was higher than the generic DALY price of US $6,300 makes sense if one believes that HIV/AIDS interventions have been underfinanced in the past relative to other disease interventions. One could regard the US $6,300 as the long-run price of a DALY and the US $11,900 as the short-run, constrained, DALY price for a HIV/AIDS intervention. A DALY price can be used to evaluate any type of HIV intervention.

But, is there any social significance in the DALY price we have estimated? We would argue yes for two main reasons. Firstly, the Global Fund in its mission statement stated that its allocation of grants was to be guided by social considerations, like need in terms of the burden of disease and the goal of reducing poverty in HIV/AIDS affected countries. And secondly, because it is just a financing agency and delegates the actual running of projects to others (this is the second stage of the two-step utility maximization process undertaken by the Technical Review Panel), there is little scope for vested interests to play a role in GFATM grant decisions. Any “rent seeking” that takes place would focus not on the Global Fund, but on the groups receiving the funds and deciding how the monies are to be spent and who gets the contacts.
The DALY price was converted into the value of a life saved by multiplying by 38.813 years, which is the average disability adjusted life expectancy of a person born in 1999 in our sample. The resulting value of a life lost from generic diseases was US $250,286 and it was US $472,837 for a life lost due to HIV/AIDS. Although a DALY is somewhat egalitarian in a CEA context,\(^9\) i.e., your DALY is measured the same as my DALY, when priced and converted to the value of a life in a CBA context, the DALY philosophy does have an interesting implication, i.e., your life may be valued differently from my life because our disability adjusted life expectancies may differ. Japan would multiply the DALY price by 74.5 years, US by 70 years, and in our sample of African countries we would use a high of 61.6 years for Algeria and a low of 25.9 years for Sierra Leone. So developed country lives saved from HIV/AIDS would be valued two to three times greater than those saved in Africa. However, these differences would be very much greater if we used the other CBA methods to value a life saved in Africa, as we now see.

The figure of US $472,837 can be compared with the amounts used to evaluate the benefits of interventions in Tanzania. US $7,500 was the value used to evaluate lives saved by expanding female primary education enrollments based on the human capital approach.\(^10\) Using the value of a statistical life (VSL) method produced a value about five times larger than for the human capital approach. So US $38,900 was the value of a life saved in an evaluation of providing VCT services.\(^11\) We now see that the revealed preference methodology valued lives saved even higher, around 11 times greater than for the VSL method. Policy evaluators for

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\(^9\) DALYs would be egalitarian if we ignored the age weighting that takes place.

\(^10\) See Brent (2008b). Note that even with such a low benefit estimate female education was worthwhile because the costs were even lower when measured in domestic terms

\(^11\) See Brent (2008c).
HIV/AIDS interventions have a wide array of alternative methodologies to choose from to carry out a CBA. They do not need to rely on CEA.

References


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