Disease burden, cost modelling and the AIDS funding debate – Towards clarity on whether the world is spending 'too much' on HIV/AIDS

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

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Abstract

There is currently considerable uncertainty surrounding the future of HIV/AIDS funding. With pressures from the recent financial crisis forcing donors to carefully review their spending priorities, some have claimed, firstly, that HIV/AIDS receives too much money relative to its disease burden and, secondly, that the future costs of treating those with the disease will become unmanageable. This paper seeks to clarify each of these two areas in the following ways. Firstly, it examines the proportionality of HIV/AIDS funding to its disease burden in the year 2008 by measuring that percentage of total health expenditure spent on HIV/AIDS against that percentage of total disease burden attributable to the disease. It pays particular attention to a recently raised issue; namely, whether using OECD or UNAIDS data has any significant effect on the number of countries spending above or below the level that is proportional to their HIV/AIDS disease burdens. This occupies the main part of the paper. Results indicate that the majority of countries in the dataset 'overspend' on HIV/AIDS relative to the most commonly employed measure of disease burden, the Disability Adjusted Life Year (DALY). This result, however, belies the fact that global 'underspending' is far more severe than 'overspending'; while most countries 'overspend', the total amount in surplus of proportionality in overspending countries is dwarfed by the total amount needed to reach proportionality in underspending ones. In other words, global HIV/AIDS resources are inadequate to bring all countries' spending on the disease in line with their disease burdens.

Secondly, the paper critiques the assumptions of a recently released AIDS costing model ('AIDSCost') and compares its outputs for South Africa to those of ASSA2003, South Africa's most highly developed AIDS modelling tool, for the period 2007-2016 as a test of the former's accuracy. Results indicate that, even when applying a number of different antiretroviral therapy (ART) coverage and costing scenarios, AIDSCost overestimates the future burden of ART by as much as 100%. Though the model's costing function is disputable, the most serious errors underlie the calculation of vital outputs on which costing depends, most notably AIDS death rates, the number of those on ART and HIV prevalence. Accordingly, it is argued that the model should be subjected to thorough refinement before it is used by anyone. Further, it is argued that AIDSCost co-author Mead Over, in employing the model to show that 'ballooning' ART burdens will overwhelm US aid budgets, generates unreliable figures which severely overestimate the future financial burden of global ART.

Acknowledgements

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Thanks must also go to members of the Centre for Social Science Research for their insight, commentary and candid critique

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List of commonly used acronyms and key terms

AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral Therapy
CRS	Creditor Reporting System [OECD official development assistance database]
DAC	Development Assistance Committee [of OECD]
DALY	Disability Adjusted Life Year [Measure of disease burden]
HIV	Human Immunodeficiency Virus
NASA	National AIDS Spending Assessment [UNAIDS data on AIDS spending]
NHA	National Health Accounts [WHO data on total health expenditure]
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
PEPFAR	President's Emergency Plan for AIDS Relief [USA]
TB	Tuberculosis
UNAIDS	Joint United Nations Program on HIV/AIDS
WHO	World Health Organisation

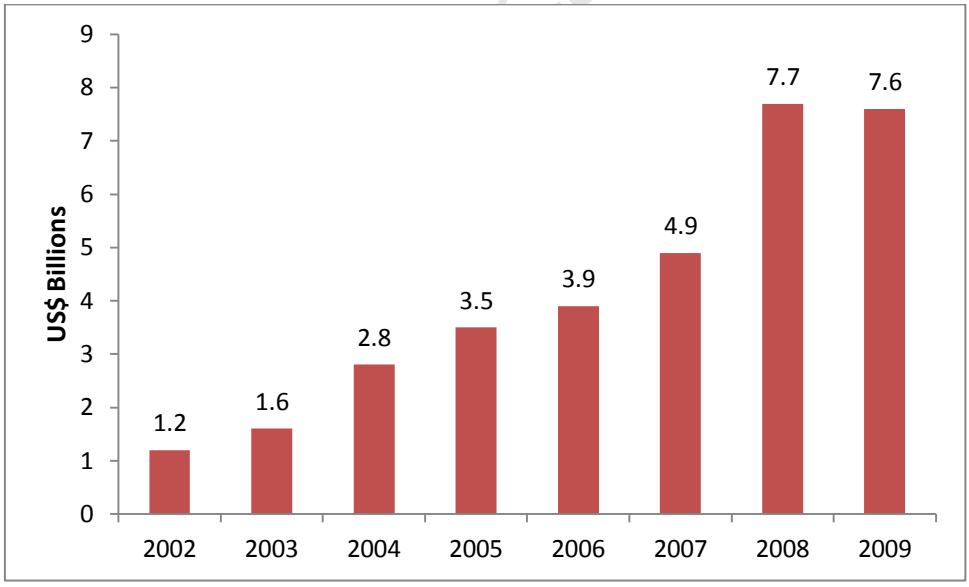
Proportionality	Refers to the share of total health expenditure spent on AIDS relative to the share of total disease burden accounted for by AIDS
AIDS sick	Refers to those individuals who require or are eligible for ART. In South Africa, these are individuals whose CD4 (a type of white blood cell that fights infection) counts are below 200
Disease burden	Broadly defined, the harm caused to human beings by disease. Measures of disease burden aim to quantify this harm and do so in various ways. Some consider only lives lost to a disease, while others (like the DALY) also consider the morbidity/disability associated with it
Disbursements	Funding actually available for spending (usually measured in a particular year)
Commitments	Funding guaranteed by donors (may be 'disbursed' over a number of years)
Overspending	Refers to an instance of spending on AIDS above the level implied by proportionality – in other words, where the proportion of total health

	expenditure spent on AIDS in a country exceeds the share of total DALYs attributable to AIDS. *This does not imply that a country is spending too much on AIDS, but rather indicates its spending relative to a particular measure*
Underspending	As above, but refers to an instance of spending on AIDS below the level implied by proportionality
Reallocation	Used to refer to those funds that would have to be transferred from AIDS (to other diseases) in order for strict proportionality to hold *within a given country*
Debate in *Science*	Refers to a 2010 debate between Nattrass & Gonsalves and Bongaarts & Over on the issue of proportionality (specifically regarding data sources) in the journal *Science* (volume 330, pages 174-178).
AIDS cost modeling	Using mathematical modeling techniques to project the future financial resource requirements of HIV/AIDS interventions (including prevention, treatment and healthcare infrastructure).
AIDSCost	An AIDS costing model developed by the Centre for Global Development and co-authored by Owen McCarthy and Mead Over. It has been designed to forecast the future financial burden of antiretroviral therapy, both globally and by country, up until the year 2050.
ASSA2003	An epidemiological model of the HIV/AIDS virus in South Africa developed by the Actuarial Society of South Africa. This model uses a wide variety of data applicable to South Africa and is calibrated to fit data on AIDS deaths according to gender, age and race.

Introduction

The global catastrophe that is HIV/AIDS (henceforth AIDS) has created a powerful and dedicated machinery of activism that, since the 1980s, has roused far-reaching international, multi-sectoral responses to the epidemic (see Fabj and Sobnosky, 1995; Epstein, 1998; Heywood and Altman, 2000 and Grebe, 2008). This machinery has been very good at mobilising resources – especially in the last decade or so. In 2009, disbursements (that is, actual resources available for spending) by donor governments totaled approximately $7.6 billion (Kates et al, 2009: 2). 77% of this was provided bilaterally (country to country), but a sizeable proportion (23%) found its way through multilateral agencies (UNAIDS, 2010a: 152). Moreover, a powerful and sustained surge in international funding took place between 2002 and 2008:

Figure I.1: International AIDS assistance (disbursements), 2002-2009 (billions of US$)



Source: Adapted from Kates et al, 2009: 4

The United States (US) has been the most powerful driving force behind the AIDS response. It first provided funding for global AIDS interventions in 1986, and since then its international efforts in this regard have been steadily expanding – both absolutely and as a share of the total US AIDS budget (Kaiser Family Foundation, 2010: 2). In 2009 the US accounted for 58% of total donor assistance and 26.9% of all available resources (including

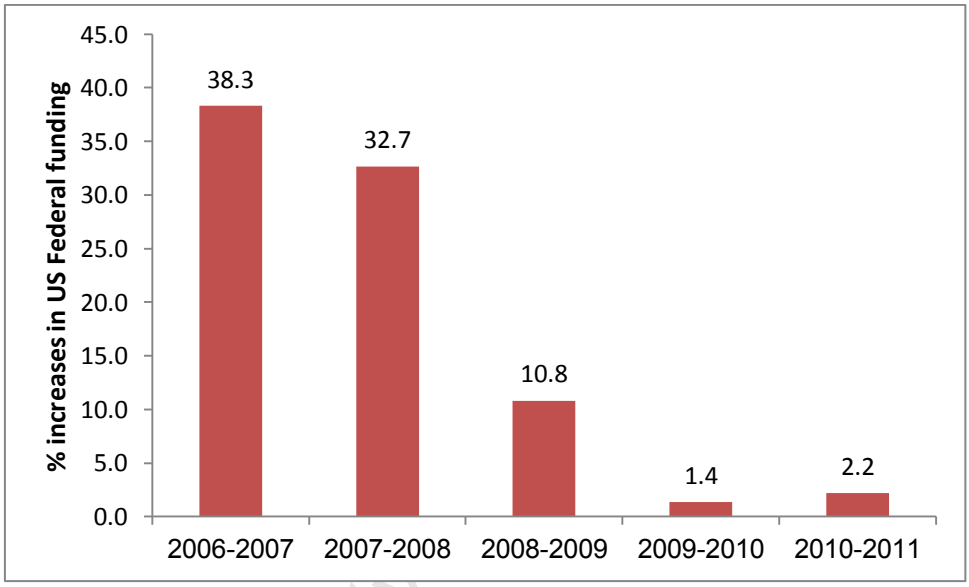
public sector spending, private sector spending and philanthropic contributions) for AIDS. It leads decisively: the next highest contributor was the United Kingdom, which contributed 10.2% and 4.7% respectively (Kates et al, 2010: 2). The US's PEPFAR (President's Emergency Plan for AIDS Relief) programme, created in 2003, pledged $15 billion over five years to combat AIDS, malaria and tuberculosis (Kates and Lief, 2006: 7). An additional $48 billion was authorized in 2008 for the period 2008-2013 (PEPFAR, 2011: online). The US, through PEPFAR, is also the heftiest contributor to the Global Fund to fight AIDS, Tuberculosis and Malaria (Kates et al, 2010: 7; Kaiser Family Foundation, 2010: 2).

Resources are, however, still inadequate. In many low and middle income countries, funding gaps show themselves daily in the empty spaces where drugs, doctors and testing centres should be. Even given massive injections of funding, and including all possible sources of funding, UNAIDS – together with the Kaiser Family Foundation - estimated that approximately $7.7 billion in *additional* funding was needed in 2009 for a comprehensive response (prevention, treatment, infrastructure and human resources) to the epidemic in low and middle income countries (Kates et al, 2010: 9). Approximately 33.3 million people were still living with the disease come the end of 2009, a 27% increase from the 1999 level of 26.2 million. Though this has partly to do with vastly expanded access to life-saving and life-prolonging antiretroviral therapy (ART), a large proportion of those urgently needing drugs are not getting them. In 2009 in Sub-Saharan Africa, only 37% of those eligible for treatment were able to access it, while this proportion was 42% in South and Central America and 19% in Eastern Europe and Central Asia (UNAIDS, 2010a: 96). Globally, approximately 9.8 million people did not have access to the treatment they needed in 2009. Many people dying of AIDS (1.8 million in 2009), thus, do so far from the threshold at which modern medicine can keep them alive (UNAIDS, 2010a: 19).

It is clear that the large international funding network that supports the AIDS response is not large enough to get help to all those that need it. Still, its scale has placed AIDS funding under the spotlight. Recently, a question has been put to the responders: 'are you not perhaps spending too much on this disease'? It seems a callous question to some, especially considering the many AIDS sufferers still awaiting treatment, but several factors have urged its asking. Firstly, the 2008 financial crisis has placed severe pressure on all governments, donors included, and spending priorities have been placed under close scrutiny (see UNAIDS, 2010c: 16, for example). As can be seen from the figure above, international

assistance for AIDS leveled off – even dropping slightly – between 2008 and 2009. The US Federal Budget for 2011 cut 5% in contributions to the Global Fund from 2010. While it called for a 2% increase in overall global contributions to AIDS relief, relative to previous year-on-year increases this is a near flat-lining of funds:

Figure I.2: Percentage increases in US Federal funding for global HIV/AIDS relief, Federal Years 2006-2011



Source: Calculated from Kaiser Family Foundation, 2010: 3

Elsewhere, strong concern has been voiced by AIDS relief workers, Non Governmental Organisations (NGOs) and various media commentators over the scaling back of funding commitments that will see many aid-dependant relief projects severely compromised (see, for example, Guardian, 2011: online; PULSE, 2011: online; Health Gap, 2011: online; and Heal Africa, 2011: online).

Secondly, the donor attention paid to AIDS has raised concerns over whether a zero-sum game exists among diseases, wherein high spending on AIDS, given finite resources, leads to the neglect of other illnesses (see, for example, England, 2007 and Bongaarts and Over, 2010). While AIDS is a vast and dangerous epidemic, so the argument goes, the funding it receives should be linked to its disease burden – in other words, what causes the most harm should get the most money. There are various other vast and dangerous conditions that, though less present in the public mind, should not be neglected. In particular, acute

respiratory conditions, malaria, pneumonia, diarrheal illnesses and various tropical diseases have been flagged as significant but underfunded conditions in low and middle income countries (Shiffman, 2006; Moran et al, 2009; Liese and Schubert, 2009). Such concern has motivated comparisons of that proportion of total health spending spent on AIDS (both globally and regionally) with that proportion of total disease burden accounted for by AIDS (see, for example, Amico et al, 2010 and Nattrass and Gonsalves, 2010). These 'proportionality' exercises aim for clarity on whether AIDS is unfairly favoured in terms of global health spending. Finally, alarm has been raised about the future costs of AIDS. While much has been done, much has still to be done, and a series of mathematical models have been created to gauge the future financial burden of the epidemic. Authors such as Over (2008) and Hecht et al (2009) have used such models to voice concerns that AIDS funding commitments will soon overwhelm global health budgets should the epidemic continue on its current path. In particular, Over (2008) has argued for a shift from treatment to prevention, partly on the basis that the former will become prohibitively expensive.

Both AIDS modeling and exercises in 'proportionality', however, remain very contentious. There is considerable debate about whether AIDS is, in fact, receiving too much or too little money relative to its disease burden. The issue came to the fore in a recent (2010) issue of the journal *Science.* Nattrass and Gonsalves (2010: 175) used 2007 UNAIDS data to argue that the proportion of total health spending spent on AIDS was greater than the disease's share of the disease burden (as given by Disability Adjusted Life Years [DALYs], a measure that shall be thoroughly discussed in Chapter 2) in a small minority of countries. Bongaarts and Over (2010: 177), however, argued that using data from the Organisation for Economic Cooperation and Development (OECD) would produce a more reliable and different conclusion. The issue has yet to be resolved. Further, AIDS modeling exercises produce impressively complex outputs relating to future costs, but many of these have yet to be tested against reliable alternative estimations based on real data. The numbers underlying our conception of the future costs of AIDS are accepted largely on faith that the modelers and their models are working.

Given the gravity of the issues at hand, there is a need for clarity within the two areas above, both of which have become considerably blurry and both of which, despite this blurriness, have played active parts in the debate about whether AIDS is receiving 'too much' money. This paper approaches this need for clarity through two separate exercises. Firstly, it

examines the proportionality of AIDS funding to its disease burden in the year 2008 (the most recent available data) by measuring that percentage of total health expenditure spent on HIV/AIDS against that percentage of total disease burden attributable to the disease. Particular attention is paid to the issue raised in *Science*; namely, whether using OECD or UNAIDS data has any significant effect on the number of countries spending above or below the level that is proportional to their AIDS disease burdens. Proportionality is the area of most complexity and controversy and constitutes the main focus of the paper. The paper then goes on to critique the assumptions of a recently released AIDS costing model ('AIDSCost') and compares its outputs for South Africa to those of the country's most sophisticated AIDS projection model, ASSA2003. The choice of model is motivated, as we shall see, by the fact that its chief creator has used (and continues to use) its outputs to make strong claims regarding policies focused on treatment, and also by the fact that the creators of the model have solicited critique of it for the purposes of improvement. As we shall see, the proven reliability of ASSA2003 (which uses a much wider range of inputs and has been calibrated to the South African epidemic) allows us to generate such critique by comparing its outputs with those of AIDSCost.

Chapter 1 summarises the main contributions to the literature and expands on the need for further research in each of the two areas (proportionality and AIDS costing). Chapter 2 explains the methodology, data sources and results of the exercise in measuring proportionality. Results indicate that the majority of countries in the dataset 'overspend' on HIV/AIDS relative to the most commonly employed measure of disease burden, the DALY. This result, however, belies the fact that 'underspending' is far more egregious than overspending – while most countries 'overspend', the total amount in surplus of proportionality in overspending countries is dwarfed by the total amount still needed to reach proportionality in underspending countries. Total global HIV/AIDS resources are still grossly inadequate to bring all countries' spending on the disease in line with their respective disease burdens. Interestingly, South Africa is the country that needs to increase its absolute AIDS spending the most in order to spend proportionately.

Chapter 3 interrogates the structure and assumptions of the AIDSCost model and compares its outputs with those of ASSA2003, South Africa's foremost epidemiological model of the HIV/AIDS virus. Since ASSA2003 utilises a large amount of country-specific data, and since it is calibrated to fit actual trends in AIDS deaths, it may be referred to as a kind of

benchmark. Results indicate that AIDSCost is based on various troubling assumptions that lead to serious problems of overestimation. AIDSCost produces cost estimates for South Africa that are approximately *double* those that correspond to ASSA2003's epidemiological outputs. To the extent that AIDSCost's country-specific outputs are a proxy for its overall quality, this suggests that the model is deeply flawed. Accordingly, it is argued that the model should be significantly overhauled before it is used by anyone to argue anything. Further, it is argued that one of the model's co-creators, in employing AIDSCost, uses unreliable estimates as a basis for arguing for a shift in donor focus from AIDS treatment to prevention. Chapter 4 concludes.

It is not the intention of this paper to answer the question of whether the world spends too much on AIDS. Rather, it seeks to contribute a measure of clarity to the debate on whether a 'disproportionate' amount is being spent on the disease. To spend 'disproportionately' on AIDS is not necessarily to be in error. In many cases it is appropriate to allocate spending in line with the marginal benefits of additional funding, and this may result in seemingly disproportionate allocations. However, as we shall see, measures of proportionality can provide a useful first step in deciding how to allocate what limited resources are available for health. This is especially so because data available for marginal cost effectiveness calculations at the global level are severely limited. Similarly, critiquing AIDSCost does not tell us how much more money AIDS will require in the years to come, but it does allow us to place 'danger, unstable ground' signs on at least one path available to those interested in the future costs of the disease. At bottom, both exercises are driven by the recognition that, however precise they at first appear to be, all numbers need to be interrogated before they can be trusted.

Chapter 1 - Literature review and the need for further research

1.1 - Proportionality

Interest in proportionality has been driven by the need to sensibly allocate extremely scarce global healthcare resources. Scarcities in global health spending have and do force health initiatives into competition with one another (Reich, 1995; Segall, 2003; Waddington, 2004; MacKellar, 2005; as quoted in Shiffman, 2006). The need to prioritise, thus, cannot be ignored. AIDS kills, but so do many other diseases. AIDS needs more money, but perhaps diarrhea needs it more. It would of course be most helpful if each additional dollar of healthcare could be allocated in such a way as to maximise its impact on disease burden. As Bongaarts and Over state in their contribution to the aforementioned *Science* debate:

> "regardless of data discrepancies, we believe that health spending should not be allocated in any strict proportion to disease burden, but rather in proportion to the marginal return in terms of reducing disease burden. We advocate allocating incremental resources to the interventions that save the most life-years per dollar spent" (2010: 176).

Unfortunately, such maximisation of marginal benefit is – currently, at least – very difficult to do, if not impossible. As we shall see, it is difficult to obtain accurate data on even aggregate allocations of healthcare resources. Calculating which interventions 'save the most life-years per dollar spent' requires a level of precision and coverage that is currently unavailable in the global data bank.

In the absence of certainty regarding where each dollar will have the most impact, scholars have been forced to consider a broader measure for which data are available – namely, the proportionality between that share of healthcare funding allocated to a specific disease and its share of the disease burden. Chapter 2 expands on specific measures of disease burden, but it is important to note here that all measures aim to quantify the harm to human life that a given condition causes. Linking funding to 'harm' through proportionality, even if loosely, merely

suggests that the most dangerous conditions should receive the most attention. As early as 1999, the Institute of Medicine in the United States, in order to allocate scarce funding resources, "proposed that the amount of disease-specific research funding provided by the National Institutes of Health be systematically and consistently compared with the burden of disease for society" (Gross et al, 1999: 1881). More recently and more relevantly, UNAIDS has accepted a measure of proportionality. Its recently created Domestic Investment Priority Index indicates what levels of country spending "might be expected given their disease burden and government resources" (UNAIDS, 2010a: 147). It is important to reiterate that proportionality does not tell us precisely how healthcare resources should be allocated. This is not least because measures of disease burden (as we shall see) depend on specific assumptions and cannot capture the true complexity of disease. Proportionality does, however, give us some idea of whether the most harmful conditions are being placed high on the funding agenda. In so doing, it provides a useful foundation for debate.

The question of whether AIDS spending is disproportionate to its disease burden is a relatively recent one. Still, important contributions have been made. MacKeller (2005) investigates aggregate official development assistance by all OECD donors to all countries for the years 1993 and 2003, and finds that AIDS received far greater donor attention than any other condition. In particular, she notes that it received more funding per DALY than all other infectious diseases, maternal and perinatal conditions and nutritional deficiencies. Shiffman (2006) examines funding for 20 communicable diseases that heavily affect developing countries from 42 major donors. He finds that AIDS is prioritized relative to other diseases, receiving 46% of donor funding in the period 1996-2003 but representing only 31% of developing country disease burden. England (2007) claims that AIDS constitutes 5% of the disease burden in low and middle income countries – "less than...respiratory infections, perinatal conditions, or ischaemic heart disease" (2007: 344) - but, in 2004, received 21% of international health aid. He does not, however, explain how he arrived at these figures.

Shiffman (2008) explicitly tackles the question of whether donor commitments to AIDS have displaced spending on other diseases. He finds that, during the period 1992 to 2005, both the level of aid directed towards AIDS and its increasing share in total health aid budgets implied a high prioritization of the disease relative to other conditions. He notes that "overall, the evidence indicates that displacement is likely occurring, but that aggregate increases in global health aid may have mitigated some of the crowding-out effects" (2008: 1). Ravishankar et al

(2009) conduct a detailed analysis of trends in international health aid between 1990 and 2007, and note that development assistance for AIDS has seen significantly greater increases than that for other conditions, and also that it receives the most aid per DALY. Moran et al (2009) examine key data from the first of five annual surveys - commissioned by the Bill and Melinda Gates Foundation – of global Research and Development investments into developing country diseases, their analysis aimed at ascertaining just which diseases qualify as 'neglected' in terms of funding. They find that in 2007 Tuberculosis, Malaria and AIDS received a significantly greater share of funding – with AIDS receiving the most out of these – than many other conditions with high disease burdens. They state that:

> "The predominance of research into new products for HIV/AIDS, malaria, and TB is understandable—and the generosity of funding in these areas is a credit to donors—however, other high-burden, high-mortality diseases remain badly under-funded: pneumonia and the diarrhoeal illnesses stand out in this regard...For instance, HIV, TB, and malaria accounted for 125 million DALYs in low- and middle-income countries in 2004 and received nearly 80% of total funding; while pneumonia and the diarrheal illnesses accounted for 165 million DALYs in the same year but received less than 6% of total funding" (Moran et al, 2009: 0145).

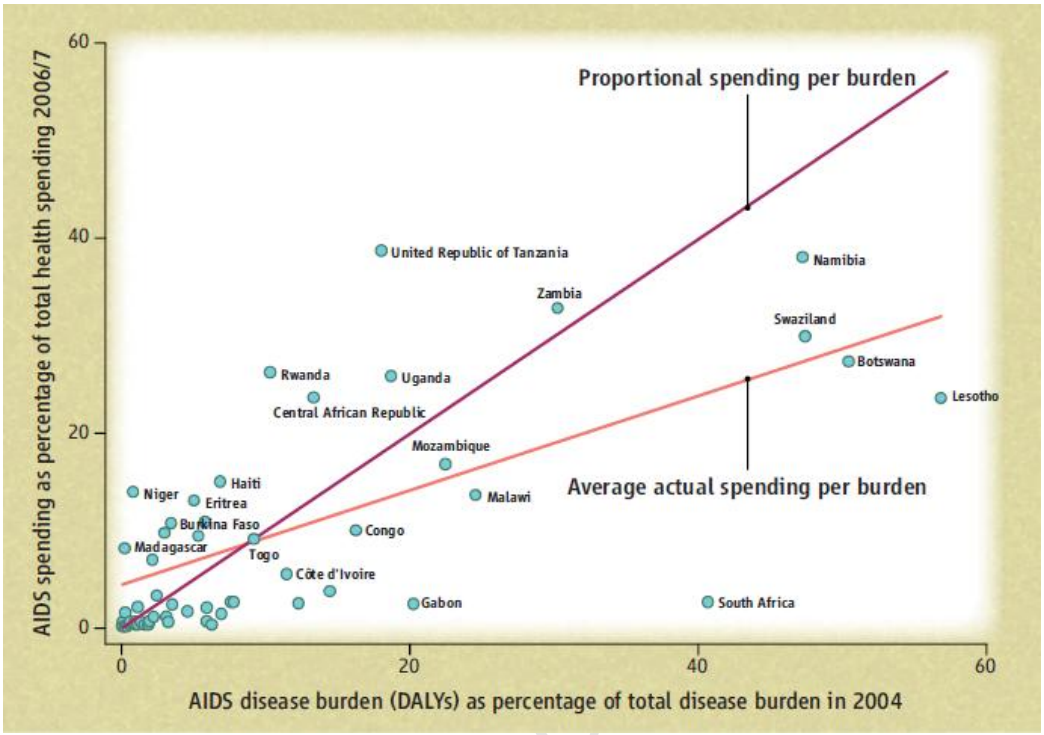
The above studies seem to indicate donor bias towards AIDS at the expense of other diseases, but suffer from important shortcomings. Firstly, where it is asserted that AIDS receives more per DALY than other diseases (proportionality implies equal funding per DALY), little information is given on where disproportionate spending is occurring. Aggregate statistics are interesting, but the analysis of trends misses country-specific results that may well be important to policymakers. If disproportionate spending is occurring, *where* is it occurring? How much spending must be redistributed from AIDS to other conditions in Ghana, say, for proportionality to be satisfied? Further, are there particular countries that are driving the trend? Is spending below proportionality (henceforth, 'underspending') the norm for most countries, with cases of spending above proportionality (henceforth, 'overspending') representing only powerful outliers? Secondly, the studies reviewed above, through no fault of their own, contain data only up until 2007. If one recalls that international aid for AIDS jumped from $4.9 billion to $7.7 billion between 2007 and 2008 – a near 60% increase – it is clear that a more recent analysis is required. Conclusions about under- or over-spending in

2007 (such as those drawn by Nattrass and Gonsalves, 2010), even if given at the country level, are largely obsolete.

Thirdly, and even if these first two issues were solved, the studies above – with the exception of Moran et al's - focus merely on donor assistance. There is no reason why donor assistance would – or should - follow DALYs in any given country. This is not because donor priorities may run counter to developing country need – Shiffman (2006: 412), for example, notes that issues such as national security and various other political factors may play a role in a 'provider interest' understanding of donor aid. Rather, it is because a proper understanding of proportionality within any given country, given developing country needs, implies inclusion of domestic government spending *as well as* international aid. If certain diseases are heavily prioritized by developing country governments at the expense of others, donor spending that follows disease burden will skew overall spending in favour of such diseases. Few meaningful conclusions, thus, can be made on the basis of donor spending alone.

The first and third concerns have been partially addressed by two very recent studies. Nattrass and Gonsalves (2010) use 2006 and 2007 UNAIDS and World Health Organization (WHO) National Health Accounts (NHA) data to compare country-level spending on AIDS – including domestic expenditure and international aid – as a proportion of overall health spending to the proportion of overall DALYs attributable to AIDS. Their results, shown in Figure 1.1, indicate a trend towards under-spending, and provide some country-level detail on which countries lie where.

Figure 1.1: AIDS spend (% overall health spend) vs. AIDS DALYs (% overall DALYs), 2006/07



Source: Nattrass and Gonsalves, 2010: 175

Amico et al (2010), meanwhile, also use UNAIDS and WHO data to conduct the same, though more systematically explained, exercise for 2007. They include 65 countries and, in addition to the proportionality exercise, analyse AIDS spending per capita, total AIDS spending and the statistical correlation between AIDS spending and HIV prevalence. Of primary relevance is their finding that Sub-Saharan Africa (SSA) is the only region where the share of AIDS spending exceeds the share of DALYs attributable to the disease. They state that "on the whole, most countries are spending rational amounts based on the impacts of HIV" and note that only a few select countries in SSA account for the region's overspending result (2010: 7).

There are still questions left unanswered by these contributions, however, and not just those that pertain to the potential differences between 2007 and 2008. Nattrass and Gonsalves use 2006 spending data for some countries and 2007 data for others, which makes things a little confusing. A static picture such as theirs (Figure 1.1), which plots one entry per country on the same graph regardless of data vintage, gives the impression of a snapshot of the situation

at a given point in time. But this is not the case. Further, the WHO data on total health expenditure that they use includes private expenditure. The UNAIDS data on AIDS spending they use, however, does not include private expenditure (UNAIDS and WHO, 2009a). This is likely to bias their vertical axis indicator (proportion of overall health expenditure spent on AIDS) downward or, in other words, underestimate the true proportion of total health funds spent on AIDS. This downward bias is likely to be more severe in middle income and rich countries because of higher levels of out of pocket expenditure. Amico et al, meanwhile, do not include data on South Africa – the country with the largest population of HIV positive people – in their study. Since they report results by region, this severely skews their findings for Sub-Saharan Africa. Further, they do not provide results on spending relative to DALYs that are disaggregated by country (though they do this for AIDS spending per capita, prevalence and other indicators).

Finally, and most significantly, Bongaarts and Over (2010: 177) – in direct reply to the Nattrass and Gonsalves exercise - raise an intriguing concern over the source of AIDS spending data. They contend that UNAIDS data underestimates AIDS spending by excluding a large portion of international AIDS assistance. They note large discrepancies between UNAIDS and OECD data for countries such as Botswana, Namibia, Senegal, South Africa and Nigeria. OECD data, they claim, provide more reliable estimates in this regard:

> "A key reason for this discrepancy is that a large part of foreign donor expenditures passes directly through contractors to AIDS patients without ever being reported to the government. If the donor-reported OECD data rather than the recipient-reported U.N. data are used, AIDS's share of total health spending is larger than AIDS's share of the disease burden in more countries than Nattrass *et al.*'s figure [Figure 1.1] suggests" (2010: 177).

It is true that the two data sources approach data collection from different angles. The OECD's Creditor Reporting System (CRS) contains data disaggregated according to two 'channels of delivery': NGOs and Civil Society and Public Sector (OECD, 2010a). An inspection of the recently declassified reporting directives for the OECD's Development Assistance Committee (DAC) confirms that each channel of delivery is "normally linked to the extending agency [donor providing funds] by a contract or other agreement, and is

directly accountable to it" (OECD, 2010b: 8). In other words, some funds are channelled directly to NGOs and other organisations without passing through government.

The National AIDS Spending Assessment exercises, from whence UNAIDS sources its spending data, do attempt to capture such funds (UNAIDS and WHO, 2009a). However, their data collection teams are organised by country governments. Health resource tracking is a vast and complex challenge. Indeed, agencies such as the WHO, UN and OECD have yet to properly align their systems of accounting for health expenditure (see Powell-Jackson and Mills, 2007). Given this complexity, it is inevitable that some funding will be missed as teams attempt to solicit information from the many agencies operating within their countries (the specifics of these various funding flows are explored more thoroughly in Chapter 2). CRS data may well provide a better picture of international assistance for AIDS – at least for the OECD member countries.

Considering the above, and taking into account the funding controversies unfolding even as this is written down, there are several pressing needs that need to be addressed. Firstly, regardless of methodological or data questions, the latest data need to be interrogated. It seems probable that anyone wishing to use existing evidence to argue, one way or the other, would like to avoid the retort: 'we don't believe you because it's just not like that anymore'. Secondly, it needs to be seen whether UNAIDS and OECD data do differ significantly, and whether such difference significantly affects overall findings. It is worth knowing if results that set a country on one side of a very contentious line are sensitive to the source of the data used. Finally, it would be extremely helpful to present a detailed breakdown of which countries spend disproportionately and by how much.

1.2 - Modelling the future costs of AIDS interventions

There exist relatively few models that researchers can use to estimate the future global costs of interventions related to the AIDS epidemic. Spectrum, a publicly available suite of modeling software available through the UNAIDS website, is perhaps the most widely known. It allows for projection of various types of costs – including laboratory costs, first- and second-line ART and nutritional supplements – associated with AIDS interventions (Stover, 2009). Stover et al, for example, used it to estimate that the global costs of averting

28 million new HIV infections between 2005 and 2015 would be approximately $3900 per infection (2006: 1474). Spectrum has been available since 2004 and has been updated and modified several times. Kumaranayake (2008) has reviewed the available empirical and mathematical modeling exercises aimed at gauging the costs of AIDS interventions and their scaling up. Though her summary (2008: S27) indicates that seven studies modeled the future (relative to their year of publication) costs of AIDS interventions, most of these are now outdated or involve ad hoc calculations (see Table 1.1 below).

Both Gutierrez et al (2004) and Schwartlander et al (2001) project various resource requirements related to sets of interventions for the year 2005, Broomberg et al (1996) base their hypothetical prevention strategies on data available in 1996, and two of the three projections generated by the World Health Organisation's Commission on Macroeconomics and Health (CMH) focused on the year 2007 (Kumaranayake et al, 2001). The third CMH projection is for the year 2015. Though not yet outdated, it involves a time- and intervention-specific projection and does not provide software that can be used in a range of different scenarios. Bertozzi et al (2004) include details of their modeling methodology that allow for its replication, but application to other settings requires the sourcing of new data and substantial software programming (see Table 1.1 below). The only other relevant paper mentioned by Kumaranayake is by Stover et al (2006) – which, as mentioned, made use of Spectrum. More recently, Hecht et al, in "modeling carried out for the AIDS 2031 project", estimated that if the AIDS epidemic continues on its current trajectory global resource requirements for the disease could triple – to $35 billion annually – by 2031 (2009: 1591). Their estimates cite 'author's calculations', however, and no modeling package is referred to.

It is this dearth of publically available models that McCarthy and Over (2009) sought to address. Their recently developed AIDSCost model provides open source software that can be used to make projections on global and country- and region-specific costs of AIDS treatment until the year 2050. This model shall be thoroughly discussed in Chapter 3, but it is important to note that Over (2008) has employed it to argue that funding AIDS treatment programmes will soon become untenable for the United States. If it continues to do so, he argues, it will face "reputational risk" (2008: 307). Since each person already on ART will die if funding for his/her treatment is removed, he argues, it will reflect very badly on the US if it reduces its treatment programme at any time. Thus, in order to avoid saddling itself with 'ballooning' commitments it can't get rid of, to put it crudely, he argues that the US should

shift focus away from treatment and toward prevention. More recently, Over (2011: online) has used the AIDSCost model to argue that recent findings (UNAIDS, 2011: online) confirming that ART prevents HIV transmission should not prompt a greater focus on treatment. "Modelling shows", he states, that even given this treatment-as-prevention finding, treatment costs will still become untenable and therefore "behavioural HIV prevention still deserves the highest priority" (Over, 2011: online).

McCarthy and Over (2009: 29) have solicited critique of their model, as well as its comparison with other modeling packages. Further, the model is being used to support strong positions regarding AIDS treatment at a time when funding for it is very much under threat. The controversy that unfolds in the comments following Over's article (2011: online) confirm its relevance to pressing issues. Finally, its ease of use, geographical versatility (it covers over 100 countries) and public availability mean that it has the potential to be used by many who may have real influence over public health policy. For these reasons, it is imperative that the reliability of AIDSCost be tested before it is used to leverage further positions or support decision-making. While it would be ideal to test all available models, including Spectrum, for their reliability, gauging the quality of even a single model (as we shall see in Chapter 3) is a considerably involved exercise.

Table 1.1: Summary of literature

Empirical findings on proportionality		
Author(s)(year)[period analysed]	**Methodology**	**Main findings**
MacKellar (2005)[1993 and 2003] Shiffman (2006)[1996-2003] England (2007)[2004] Shiffman (2008)[1992-2005] Ravishankar et al (2009)[1990-2007] Moran et al (2009)[2007]	Compare official development assistance for AIDS to assistance for other diseases heavily affecting low and middle income countries.	AIDS receives significantly more donor funding than other high burden diseases, including per DALY.
Nattrass & Gonsalves (2010)[2007] Amico et al (2010)[2007]	Compare proportion of total health expenditure (WHO data) allotted to AIDS spending (UNAIDS data) to proportion of total DALYs accounted for by the disease (WHO data for 2004)	Though some countries' AIDS spending is above the level of proportionality, there is a general trend towards spending that is below this level. Amico et al find that Sub-Saharan Africa is the only region that 'overspends'.
Bongaarts and Over (2010)[2007]	Analysis of selected OECD official development assistance data	There is a discrepancy between UNAIDS and OECD estimates of AIDS spending for some countries
Modelling the future costs of AIDS		
Author(s)(year)[projection period]	**Ad hoc / Can be used again for future projections**	
Broomberg et al (1996)[undefined]	Outlines method of calculating costs related to hypothetical programme design of a number of HIV prevention strategies.	
Gutierrez et al (2004)[2005]	Once-off series of projections that attempt to gauge the costs of the WHO and UNAIDS '3X5' initiative (3 million people on ART by end 2005)	
Kumaranayake et al (2001)[2007, 2015]	Once-off WHO Commission on Macroeconomics and Health projections. One 2007 projection focused on the costs of expanding lower levels of health systems such as outreach services and health posts. The other 2007 and 2015 projection focused on scaling up priority programmes with investments across all levels of the health system.	

Schwartlander et al (2001)[2005]	Once-off projections for 2005 of AIDS resource needs (prevention and care) in 135 low and middle income countries.
Bertozzi et al (2004)[2007]	Outlines methodology to allow for replication, but provides no software or data. Presents results of model projections for 2007 concerning scale-up of AIDS interventions (palliative care, diagnostic HIV testing, treatment of and prophylaxis for the prevention of opportunistic HIV infections, ART lab work and monitoring) in low and middle income countries.
Hecht e al (2009)[2031]	Once-off projections regarding AIDS resource requirements up until 2031 over a range of different prevention and treatment scenarios
McCarthy and Over (2009)[until 2050]	AIDSCost comes in the form of open-source software that can be used by anyone with the statistical program Stata. It allows for the projection of future global costs of ART as well as for region- and country-specific projections
Stover (2009)[undefined]	The Spectrum suite of software is able to accommodate both multi-country and country-specific projections regarding the future costs of AIDS interventions

Chapter 2 - Proportionality

This chapter proceeds as follows. Section 2.1 discusses data sources and choice of indicators. Section 2.2 summarises results. Section 2.3 discusses weaknesses in the analysis. Section 5 concludes.

2.1 - Indicators and Data Sources

Calculating proportionality, on the face of it, is not at all complicated. It merely involves the comparison of two ratios: (1) that proportion of the health budget spent on AIDS and (2) that proportion of total disease burden that is attributable to AIDS. Thus, the proportionality condition is satisfied if:

$$\frac{Spending\ on\ AIDS}{Total\ Health\ Spending} = \frac{AIDS\ disease\ burden}{Total\ disease\ burden}$$

Properly defining and measuring each indicator, however, is a complex ordeal involving multiple data sources and variables. Accordingly, the indicators used in this chapter's proportionality exercise will be explained in some detail. As the issues discussed are contentious, the greatest care has been taken to ensure minimal experimentation with the data. Further, care has been taken to ensure that the selected measures have been both widely and officially used. The approach is deliberately non-technical and can be followed by anyone with the necessary time and inclination to do so.

Disease burden – AIDS DALYs and Total DALYs

The Disability Adjusted Life Year (DALY) attempts to provide a single measure quantifying the mortality and morbidity associated with disease and various forms of injury. It improves upon simpler measures of disease burden, such as deaths attributable to a given condition, by including both losses due to premature death *and* the disability inflicted during life – both key

to any properly considered conception of true affliction. A simple summation of the indicator is given thus:

> "The disability-adjusted life year (DALY) extends the concept of potential years of life lost due to premature death to include equivalent years of "healthy" life lost by virtue of being in states of poor health or disability. One DALY can be thought of as one lost year of "healthy" life, and the burden of disease can be thought of as a measurement of the gap between current health status and an ideal situation where everyone lives into old age, free of disease and disability" (WHO, 2008a: 3).

The unweighted indicator comprises two measures: years of life lost due to premature death (YLL) and years of life lost due to disability (YLD). YLL for a particular condition considers the number of deaths at a given age and for a particular sex, multiplied by a global standard life expectancy (in number of years still to be lived) at that age and sex (WHO, 2011a: online). YLL is measured relative to the same 'ideal' standard life expectancy for all countries – 80 years at birth for men and 82.5 for women, as in the original 1990 DALY calculations (AbouZahr and Vaughan, 2000: 78). YLD, meanwhile, is calculated with reference to the 'disease weight' or relative severity of disease as measured on a scale between 0 and 1 (0 being perfectly healthy and 1 being dead). It can be calculated as the number of incidences of the disease multiplied by the disease weight and the average duration of disease from contraction to either remission or death (WHO, 2011a: online). Disease weight is the same for all countries, but varies according to age with regard to some conditions (see below) (WHO, 2008b).

'Social preferences' are applied to the simple calculus described above in two steps. First, future DALYs are discounted relative to present ones, which is meant to factor in the societal preference for disease alleviation today over disease alleviation tomorrow. Second, non-uniform age weights are applied so that years of life lost carry less weight in the elderly and the very young. This reflects an assumption of 'welfare interdependence', where those in infancy and old age are supported by others while those in adulthood support others (Robberstad, 2005: 186). In particular, and including both discounting and age weighting, an infant's death incurs a cost of 33 DALYs while the death of a person aged 5-20 incurs a cost of approximately 36 DALYs (WHO, 2008a: 3). Our basic definition above, then, can be qualified thus:

> "DALYs are the sum of the present value of future years of lifetime lost through premature mortality, and the present value of years of future life-time adjusted for the average severity (frequency and intensity) of any mental or physical disability caused by disease or injury" (Fox-Rushby and Hanson, 2001: 326).

DALYs (for 1990) were first introduced in the 1993 World Development Report, while updates were conducted for the years 2002 (in 2005) and 2004 (in 2008). A further update is currently underway (WHO, 2011a: online). The update conducted in 2008 for the year 2004 shall henceforth be referred to as 'the 2004 update'. The proportionality exercise in this paper uses the latest data available from the WHO, which are sourced mainly from the 2004 update but also include additional updates – also for the year 2004 - following consultation with WHO member states in late 2008 (WHO, 2009). The 2004 update uses non-uniform age weights as described above and a discount rate of 3% per annum (WHO, 2008a). Disease weights for HIV cases (0.135) vary according to age and are sourced from the original 1990 calculations. Those for AIDS cases not on ART (0.505) are uniform across age groups and, again, are identical to those in 1990. Disease weights for AIDS cases on ART (0.167) were revised in the 2004 update, though they too are uniform across age groups (WHO, 2008b: 2). 'Total DALYs' in a given country include all DALYs for all diseases, conditions and injuries. 'AIDS DALYs' include those DALYs attributable to AIDS, which are identified by the Global Burden of Disease code W009 in the WHO dataset (WHO, 2009).

It is important to note that there are other measures of disease burden, among them Quality Adjusted Life Years (QALYs), Life Years gained and Health Adjusted Life Expectancy. Their histories and methodological idiosyncrasies are summarized elsewhere (see, for example, Sassi, 2006; Robberstad, 2005; and Gold et al, 2002.) Further, some have raised objections, many of them ethical, about the way that DALYs are calculated and used (see Anand and Hanson, 1997, particularly with regard to the ethics of age weighting; as well as Arnesen and Nord, 1999; AbouZahr and Vaughan, 2000; and Gold et al, 2002). The DALY, like any metric, is an imperfect tool that does not capture the entire realm of disease. It is, however, widely used by the international community in general and by the WHO in particular. Further, by including consideration of morbidity, it provides a more complete picture of the harm caused by disease than measures (such as Life Years Gained) that consider only mortality. In addition, its assumptions and value choices are more explicit and

transparent than those used in the calculation of QALYs, which also include consideration of morbidity (Murray, 2004: 430). Finally, as we have seen, DALYs remain the standard measure of disease burden used by those seeking to measure AIDS proportionality.

Total Health Spending

The measure of total health spending employed here attempts to include all spending on health by the public sector and the international community. As in Amico et al (2010), private sector spending on health - as given by out of pocket expenditure and private health insurance – is excluded. This is done for two reasons. Firstly, neither UNAIDS nor OECD data on AIDS spending includes private expenditure. Including it in the denominator and not the numerator would thus skew the calculations. Secondly, even if private AIDS expenditure data were available, including it could still arguably be inappropriate. The idea of linking spending to disease burden implicitly appeals to the need to care for the public good (or reduce the public 'bad', one could say). Both international aid and government spending, at least ostensibly, also include consideration of this public good. There are philosophical grounds, then, to make a case for the redirection of government and aid resources in order to better serve the needy. Such grounds are harder to establish with regard to the private sphere. To say that all health expenditure, including private health expenditure, should be linked to burden of disease is akin to suggesting a global redistribution of private resources according to non-private preferences. This is both infeasible and unhelpful for current policy dialogue.

Data for total health spending is sourced from the WHO's National Health Accounts (NHA) database. The NHA represents a vast international effort – which includes cooperation between and assistance from the WHO, World Bank, the United States Agency for International Development and the OECD – to track the entire system of health expenditure within each country and "trace how much is being spent, where it is being spent, what it is being spent on and for whom" (WHO, 2003: XIII). The NHA methodology represents the current international standard for health resource tracking (Powell-Jackson and Mills, 2007: 353). The most recent data available are used, which include final estimates for the year 2008. There is, as yet, no unified database containing total health expenditure in absolute terms by country for the year 2008. A new database was thus constructed by the author from individual country reports, which provide detailed information on funds spent by the public

and private sectors. The country reports (WHO, 2011b) present figures in Local Currency Units (LCUs), but provide an indicator of average LCU per US Dollar for each year. The author divided nominal LCU amounts by the LCU per US dollar figure to produce health expenditure figures for each country in 2008 US Dollars.

Expenditures in each country report are separated according to 'financing agent'. Public expenditure agents include general government, the ministry of health and social security funds. Private health expenditure agents include out of pocket expenditure, private health insurance and non-profit institutions serving households. A careful reading of the NHA Guide to Producing National Health Accounts (WHO, 2003) indicates that funds are classified according to direct health spending by the financing agent *regardless of financing source*. In other words, general government health expenditure in the NHA includes not only domestic funds, but also funds received from international donors and spent by the government. Similarly, expenditure by non-profit institutions includes funding received from private sources (philanthropic foundations or businesses, for example), government agencies and international sources. The NHA guide provides an example of a survey soliciting spending information from an NGO which illustrates this (WHO, 2003: 136).

This creates a problem. A portion of both donor and government funding, which should be included in the chosen measure of total health spending, flows to non-profits. However, so too does some private funding. Since funding is presented according to financing agent and not financing source, there is no way to separate that part of non-profit expenditure financed by the private sector and that part financed by the public and international sectors. Though the country reports do include information on total funding from international sources, there is no indication of the relative shares going to each of the funding agents. There is thus no choice but to include non-profit institutions serving households for the purposes of this study. While this forces the inclusion of some invisible amount of private health expenditure – which biases the share of AIDS spending in total health spending downwards, as explained in Chapter 1 with reference to Nattrass and Gonsalves (2010) – excluding the non-profit sector produces total health expenditure figures for many countries that are smaller than total AIDS spending figures (discussed next). This is clearly impossible. It would seem that private expenditure represents a small portion of non-profit funding relative to combined government and international financing. Excluding the non-profit sector would pose a different but bigger problem than including it. As an aside, it is interesting to note that this same issue was faced

by Amico et al (2010), though they did not discuss it or consider the implications of including the non-profit sector for their analysis.

Spending on AIDS

AIDS spending data is provided from three alternative data sources in this study: UNAIDS, OECD and AidData. Each of these requires some explanation.

UNAIDS data

The National AIDS Spending Assessment (NASA), created by UNAIDS, represents "the most ambitious attempt to collect [AIDS] spending information at the national level and to monitor expenditures at the global level" (Amico et al, 2010: 2). The NASA framework attempts to account for all AIDS funding flows from all sources and to all projects in a given country. This includes both health and non-health related AIDS activities, such as social and prevention campaigns. One could say that it is to AIDS expenditure what the NHA is to health expenditure. Important overlaps exist between the NHA and NASA frameworks. Indeed, UNAIDS (together with the United States Agency for International Development and the WHO) has developed a comprehensive guide on linking the NHA implementation efforts with those of NASA:

> "While their [NASA's and NHA's] objectives are not identical, they have overlapping components and so NASA and NHA implementation can occur in a coordinated manner to avoid duplicative and redundant resource-tracking efforts. By doing so, the frameworks can meet the needs of both HIV/AIDS and general health care stakeholders, national and international" (UNAIDS and WHO, 2009a: XI).

These overlaps, which include adherence to similar norms of accounting and health resource tracking, make for a smooth pairing of NASA data with the NHA data on total health expenditure described above. As mentioned, NASA data do not include private expenditures on AIDS. As with the NHA data, NASA data (henceforth UNAIDS data) are for the year 2008 in 2008 US Dollars. All data, except for that on South Africa, were sourced from the AIDSinfo database for the purposes of this study (UNAIDS, 2010b). Data for South Africa were retrieved from its United Nations General Assembly Special Session on HIV/AIDS

(UNGASS) country report (Republic of South Africa, 2010**)**. It is unclear why this data was not included in the AIDSinfo database. Data for each country includes spending from both public and international sources.

OECD data

The OECD Creditor Reporting System contains official data from the 23 member countries of the Development Assistance Committee on commitments and disbursements of international development assistance (ODA). These members are as follows (OECD, 2011a):

Australia	France	Korea	Spain
Austria	Germany	Luxembourg	Sweden
Belgium	Greece	Netherlands	Switzerland
Canada	Ireland	New Zealand	United Kingdom
Denmark	Italy	Norway	United States
Finland	Japan	Portugal	(EU institutions)

International development assistance is defined thus:

> "those flows to countries and territories on the DAC List of ODA Recipients and to multilateral development institutions which are:
> i. *provided by official agencies*, including state and local governments, or by their executive agencies; and
> ii. each transaction of which: a) is administered with the promotion of the *economic development and welfare of developing countries* as its main objective; and b) is *concessional in character* and conveys a grant element of at least 25 per cent (calculated at a rate of discount of 10 per cent)" (OECD, 2011b: online)

A commitment is a "firm written obligation by a government or official agency, backed by the appropriation or availability of the necessary funds, to provide resources of a specified amount under specified financial terms and conditions and for specified purposes for the benefit of the recipient country". A disbursement, meanwhile, is "the placement of resources at the disposal of a recipient country or agency, or in the case of internal development-related expenditures, the outlay of funds by the official sector" (OECD, 2010b: 8).

The CRS includes both bilateral assistance flowing from DAC members to recipient countries as well as assistance channelled through multilateral institutions such as the World Bank and

the Global Fund. Donors self-report to the DAC and are guided by a set of detailed reporting directives that define how funding is to be classified and presented (Powell-Jackson and Mills, 2007: 357). The NHA framework builds upon the standards for health accounting set forth by the OECD (WHO, 2003: XIV) and, as a result, CRS data pair well with the chosen measures of total health expenditure. CRS data group projects funded under 'purpose codes', which reflect the main purpose for which funds are used. Two purpose codes pertain to spending on AIDS: 'STD [Sexually Transmitted Disease] control including HIV/AIDS' (13040) and 'Social mitigation of HIV/AIDS' (16040). Together, these two purpose codes attempt to capture all funds from the world's main donors, both health and non-health, directed towards the fight against AIDS. Data are grouped by recipient country, recipient region and donor country and agency. Data do not include funding from private donors such as the Bill and Melinda Gates foundation, and only consider public expenditure on ODA channelled through DAC member country governments.

For the purposes of this study, 2008 **disbursement** data for 'STD control including HIV/AIDS' and 'Social mitigation of HIV/AIDS' from all donors for the year 2008, measured in 2008 US Dollars (OECD, 2010a), were combined. This delivered a single international AIDS funding figure for each recipient country which can be thought of as a kind of CRS version of the UNAIDS data indicator 'domestic spending on HIV from international sources'. UNAIDS also provides data for AIDS spending from domestic sources alone – 'domestic HIV spending from public sources'. **UNAIDS** data on AIDS expenditure from public (or domestic) sources were combined with **CRS** data for expenditure from international sources. This produced the OECD estimate of AIDS spending used in this study. This combination should not be controversial. There is no double counting, as the UNAIDS data differentiates clearly between public and international financing. Further, the CRS contains no data on expenditure from domestic sources. Lastly, as has already been explained, it is important to consider AIDS expenditure in each country from both domestic and international sources if a meaningful contribution to the literature is to be made.

Just how much do UNAIDS and OECD data differ?

As a prelude to the main investigation, it is useful to interrogate the question of whether OECD and UNAIDS data differ significantly from country to country. Data from both

sources on AIDS spending from *international* sources were available for 87 countries (Appendix 1.1). Comparing the data yields interesting results:

Figure 2.1: 2008 AIDS spending from international sources, millions 2008 US$, UNAIDS vs. OECD data

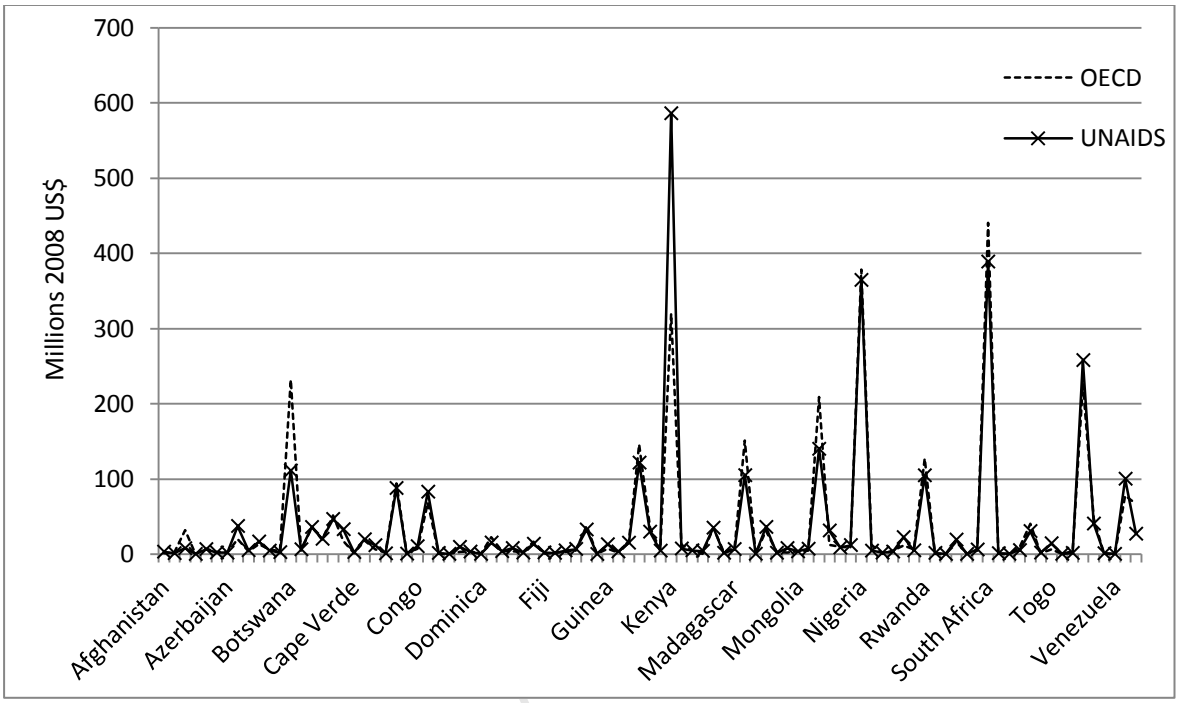


Figure 2.2: 2008 Absolute deviation of OECD from UNAIDS data, AIDS spending from international sources, millions 2008 USD

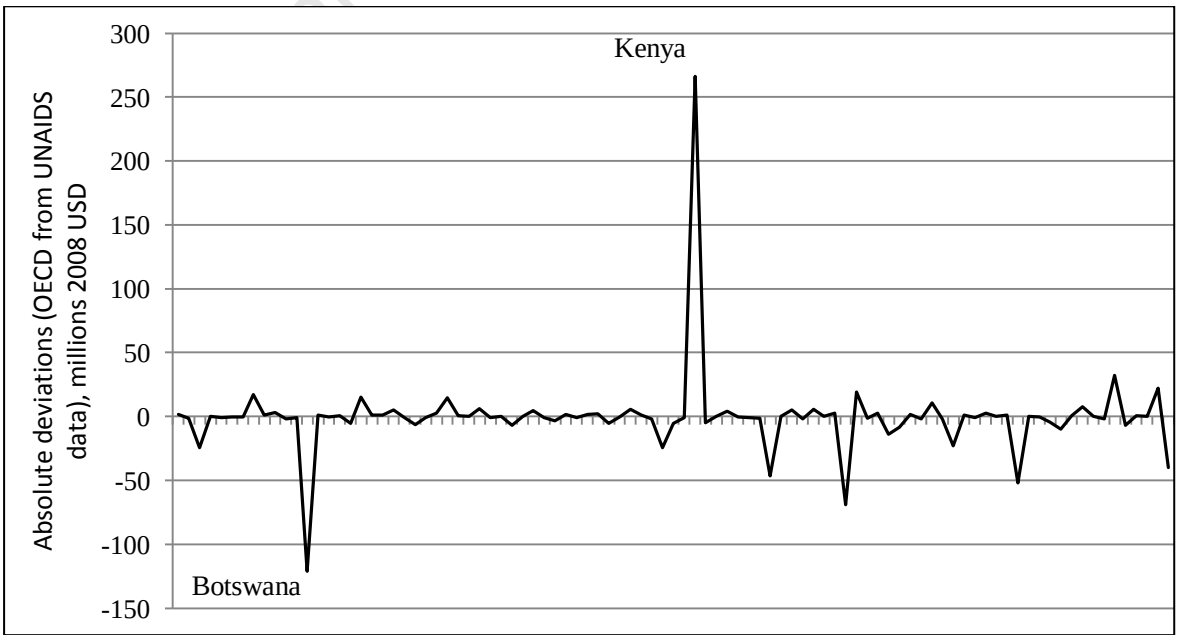
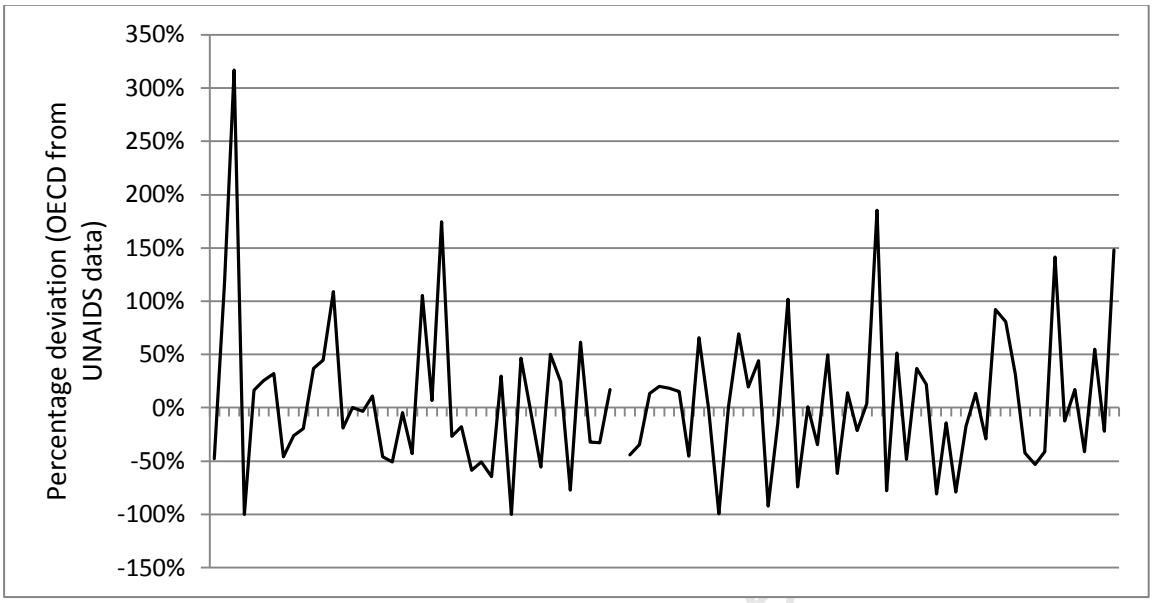


Figure 2.3: 2008 Percentage deviation of OECD from UNAIDS data, AIDS spending from international sources



*Line break is owing to a 0 international spending value for Grenada in UNAIDS data

One can see from Figure 2.1 and 2.2 that the OECD and UNAIDS data generally follow each other quite well. Indeed, their figures for total AIDS spending from international sources are very similar: $3.281 billion in OECD and $3.251 in UNAIDS. Figure 2.2, however, demonstrates that this similarity belies some extreme inter-country discrepancies. It shows that OECD data routinely deviate by over 100% from UNAIDS data, with figures for Angola showing a discrepancy of 316%. The data disagree most on Sao Tome and Principe, with a remarkable deviation of 1290% for this country ($700 000 in OECD and $50 000 in UNAIDS). For the sake of readability, the wayward island was removed from the deviations graph. Importantly, deviations show no regular pattern, implying that there is no routine under- or over-estimation of one data source vis a vis the other. Recall for a moment the aforementioned debate in *Science* involving Nattrass and Gonsalves (2010) and Bongaarts and Over (2010). It is clear from the above that Bongaarts and Over (2010: 177) use only selective evidence when they imply that UNAIDS data are likely to underestimate the number of countries overspending on AIDS relative to its disease burden. The data sources do disagree at times, but we have yet to see what the implications of this disagreement are for proportionality.

AIDDATA

Though it is not central to the data issue brought up by Bongaarts and Over (2010), it is prudent to include yet another source of AIDS spending to clear up some questions left unanswered by CRS data. Firstly, it is troubling that the most encompassing measure of AIDS spending in the CRS seems to include other forms of STD control than those directed towards AIDS ('STD Control including HIV/AIDS'). If a large number of STD spending unrelated to AIDS is being included, this will naturally bias AIDS spending figures upwards. Secondly, it would be useful to get an idea of how many projects classed under different purpose codes include AIDS components. This would provide a more complete picture of true AIDS spending. Thirdly, it would be useful to include funding from non-DAC donors not included in the CRS as well as funding not classified as Official Development Assistance. To investigate these issues, alternative data were sourced for the purposes of this study from a development finance portal named AidData.

AidData, formed in 2009, is the result of a collaboration between, firstly, the Project-Level Aid Database (PLAID) team at the College of William and Mary and Brigham Young University and, secondly, the aid information technology provider Development Gateway. It aims to provide comprehensive, project-by-project, easily-accessible data encompassing the entire universe of development aid. Building on a range of official sources from a range of multilateral and bilateral aid agencies - including the CRS, donor agency annual reports and project documents – it seeks to provide rigorous and transparent data that can be used for the effective management of development flows. Its data collection efforts are ambitious:

> "The core of the AidData project, the PLAID database, currently encompasses multilateral and bilateral donor activities spanning the years 1945-2009. It contains information from traditional aid sources such as the OECD's Creditor Reporting System (CRS) as well as donors not captured by the CRS and activities that do not fit the OECD definition of Official Development Assistance (ODA). In cooperation with the OECD CRS, PLAID augments existing data by publishing more complete project descriptions and more detailed aid project purpose codes. In particular, PLAID is dedicated to collecting project-level data from all multilateral donors and non-DAC bilateral donors (NDBs) to provide a more complete picture of development finance flows and activities" (Findley et al, 2010a: 4).

AidData only replaces CRS data on those projects for which more complete information is available – for example, from individual project reports. Further, it does not include private sector aid (AidData, 2011: online). Its database, thus, should include all and only donor-reported aid of the form that is required for the chosen exercise.

A key strength of the database is that it provides searchable project-level data that allows for the extraction of projects related to a specific purpose, donor, year or recipient country. Detail about project aims and scope is primarily contained within project titles, short project descriptions (which briefly outline the aim of the project) and long project descriptions (which provide more detailed accounts of project components). The most current AidData research release (1.9.2), which was released on the 15th of April 2010 (Findley et al, 2010b), was used. The dataset used in this study was built thus:

1.) All projects for the year 2008 that contain either of the words 'HIV' and 'AIDS' in their short descriptions, long descriptions or titles were extracted. Since not all projects are described in English, projects whose descriptions include either 'VIH' or 'SIDA' – the French, Spanish, Portuguese and Italian equivalents of 'HIV' and 'AIDS' – were also extracted.
2.) This delivered a total of 3609 projects, most of them from the CRS. However, some CRS projects were missed - those that, for some reason, do not contain reference to the AIDS keywords in their descriptions. In a separate exercise, thus, all records from AidData relating to the CRS purpose codes 'STD control including HIV/AIDS' and 'Social mitigation of HIV/AIDS' were extracted, regardless of the information contained in their descriptions. Those CRS projects that were missed in the original search were then added to the database.
3.) The database was searched project by project and those projects that fit the keywords but have no relevance to AIDS were excluded. For example, many projects related to higher education contain the word 'universidad', while the French for 'aid for winter' is 'aide d'hiver'. Entries in languages other than English were translated with the help of Yahoo Babelfish (Yahoo, 2011: online).
4.) Remaining projects were colour-coded in three groups. Red projects were defined as those not directed towards AIDS or those that mention it only incidentally. Many Tuberculosis projects, for example, mention susceptibility of AIDS sufferers to the disease, while a large number of irrelevant projects contain generic descriptions of

millennium development goals or donor agency priorities. Orange projects were defined as those projects that contain reference to AIDS, but only as one among several goals - projects aimed at HIV/TB comorbidity, for example, and those supporting microfinance schemes with AIDS education components. Those programmes aimed primarily at AIDS were coded in white. Commonly encountered examples of projects coded in each colour are presented in Appendix 1.2 to give a sense of the analytical approach adopted in this study.

The above exercise delivered a detailed database of some 4000 projects from which to build information on AIDS spending. Red projects were excluded on the basis that they had no clear relation to AIDS. While many orange projects contain AIDS components, it is unclear what proportion of their spending is directed towards AIDS activities. Further, including spending on a project split between AIDS and another disease would require inclusion of a portion of that other disease's DALYs in calculations. Again, the proportions are unknown. Orange projects were thus excluded. By far the majority of projects are for CRS records under 'STD Control including AIDS' and 'Social Mitigation of HIV/AIDS'. Interestingly, only four or five 'social mitigation' projects, and no 'STD control' projects, could be coded orange and none at all could be coded red – though a few hundred projects do contain unhelpful descriptions of the broad aims of PEPFAR that reveal very little. Since there were no trends of unwarranted inclusion, the choice was made to defer to the official classification and to not exclude the few orange 'social mitigation' projects. Though it would have been very informative, a lack of descriptive specificity meant that it was not possible to ascertain how many projects classed under these two codes involve broader healthcare elements (something of direct relevance to the entire AIDS funding debate). Interestingly, many projects that explicitly mention AIDS as their primary focus (coded in white) are placed under CRS codes such as Culture and Recreation, Health Education, Infectious Disease Control, Social/Welfare Services and Reproductive Health Care. A total of 162 such projects were included, totalling $26.2 million.

Constructing the 'AidData' estimate of total AIDS funding still required several more steps. Since no projects related to the two AIDS-related CRS purpose codes were excluded, AIDS spending figures sourced directly from the CRS - as described under the previous heading – were used. AidData should include these CRS entries, but the official source is preferable. Projects for which AidData replaced CRS figures in favour of more complete records were

then considered. Significant discrepancies (above $100) appeared for only a handful of countries: Afghanistan ($1.3 million more than CRS record), Guinea-Bassau ($1.4 million more), Kenya ($4.7 million more) and Macedonia ($13 000 more). These amounts were added to the relevant CRS country totals. Next, the 162 additional projects identified by our keyword searches were summed by recipient and added to the relevant country totals. The above delivered yet another estimate of total AIDS spending figures from *international* sources. As under the previous heading, this was added to UNAIDS data on AIDS spending from domestic sources to arrive at the final totals used in this study.

Summary

The above may appear quite convoluted. An example may help clarify matters. Take the hypothetical country Spendia. According to UNAIDS data, Spendia spends $100 of its domestic health budget, largely financed by taxing its citizens (Spendians), on AIDS. It spends a further $50 from international donors on AIDS. The CRS, however, estimates that Spendia has received $65 in AIDS funding – not $50 – from international donors. AidData, meanwhile, notes that $10 worth of projects directed at AIDS are not captured by the CRS (being classed in the purpose code 'Reproductive Health'). Further, AidData has found better data for two CRS projects. Together, these projects actually cost $5 *more* than the CRS estimates. The Spendia expenditure on AIDS is represented thus:

UNAIDS = $150 (UNAIDS domestic sources + UNAIDS international sources)
CRS = $165 (UNAIDS domestic sources + CRS international sources)
AidData = $180 (UNAIDS domestic sources + CRS international sources + extra donor projects not included by CRS + difference between CRS and AidData for some projects)

The data used represent the state of the health resource tracking art. With the exception of the AidData figures, all data stem from official sources and have not been subjected to any imputations, predictions or extrapolations. While neither the colour-coding exercise nor the data provided by AidData bear the signature of the OECD, they provide an idea of the magnitude of funds not captured by this official source that nonetheless may be relevant to AIDS spending. A summary of data sources and indicators is included in Table 2.1:

Table 2.1: Indicators and data sources

	DALYs (disease burden)	Total health exp. (Public + Non-profit)	AIDS spending (Public + International)			
Alternative estimates	-	-		**UNAIDS**	**OECD**	**AidData**
Measured in	# 2004 DALYs	2008 USD	2008 USD			
Data source*	World Health Organization Global Burden of Disease Project 2004 update (2008)	World Health Organization National Health Accounts Country Reports	UNAIDS 'domestic HIV spending from international sources'			
			UNAIDS 'domestic HIV spending from public sources'			
			CRS ODA ('STD Control including HIV/AIDS'+'Social Mitigation of HIV/AIDS')			
			CRS projects replaced by AidData			
			AidData projects not coded as AIDS-related			
Relevant precedent	MacKeller (2005), Shiffman (2006), Ravishankar et al (2009), Nattrass and Gonsalves (2010), Amico et al (2010)	Amico et al (2010), Nattrass and Gonsalves (2010)		Amico et al (2010), Nattrass and Gonsalves (2010)	MacKeller (2005), Shiffman (2006,2007), Ravishankar et al (2009), Bongaarts and Over (2010)	None

***Shading indicates that estimate includes adjacent data source**

Data coverage

Complete DALY, total health expenditure and UNAIDS AIDS expenditure data for 2008 were available for 118 countries. Of these 118, adjustments (as outlined above) could be made with OECD international data for 87. Of these 87, AidData adjustments could be made for 39. Data on the number of people living with HIV in 2008 were available for a total of 93 countries (UNAIDS, 2010b). Results are presented for different data sources (see below and Appendix 1.3). It was not possible to impute HIV population data for other missing countries, as data were also missing on their prevalence rates and for previous and later years. High and low estimates for 2009 were available for the Democratic Republic of Congo, Brazil and China. As no alternatives were available for these countries, the medians of these estimates were used (UNAIDS, 2010a). Data on the number of people living with HIV in all regions in 2008 were sourced from the UNAIDS 2009 Epidemic Update, and were used in order to calculate the percentage covered by the dataset (UNAIDS, 2009b). As the missing data biases coverage of the world's HIV positive population downwards, the dataset includes *at least* the following levels of coverage:

- 76.3% globally
- 77.6% in Sub-Saharan Africa
- 71.7% in Southern Africa (including Zambia and Angola)

To this author's knowledge, this is the most comprehensive investigation of the proportionality of AIDS spending to disease burden undertaken to date – Amico et al (2010), for example, only include 65 countries.

While UNAIDS data is organised by country, a significant amount of funding in the OECD data is classified simply by region or as 'bilateral aid' (see Appendix 1.1 for these figures). This has two implications. Firstly, total regional expenditure exceeds the sum of country expenditure in the OECD and AidData data. This is simply a result of adding the OECD expenditure for 'Africa, South of Sahara', say, to that region's total and not to any specific countries. Further, owing to the fact that some data are classified simply as 'bilateral aid', world expenditure exceeds the sum of regional expenditure (again with OECD and AidData data). Secondly, it has been ensured that the definition of each region follows that in the

OECD data. This is a simple but important way of ensuring consistency – there is no one answer, after all, to which countries should be included in regions such as South and Central Asia.

A full list of countries included, labelled by region and according to data source and availability of HIV population data, appears in Appendix 1.1.

2.2 - Results

Analysis begins with aggregate statistics and moves into ever greater levels of specificity. All expenditure figures represent total spending from both public and international sources. Where 'overspending', 'underspending' or the need to 'reallocate' is mentioned, this only refers to deviations from the proportionality condition as has been defined. Such terms as are used are employed for a clearer understanding of the data and do not represent conclusions about what individual countries should or should not do. It is of the utmost importance the following is clarified: it will not be suggested, here or elsewhere, that *existing* AIDS funds be taken from any AIDS programmes. If anything, remarks about spending above or below proportionality will provide a useful way to think about the allocations of future funds.

World results, regional results and trends

Table 2.2: Global AIDS expenditure vs. AIDS DALYs (millions 2008 US$)

	UN	OECD	AIDDATA
Total	10534.34	10791.64	10824.71
AIDS spend (% of World health spend)	1.16	1.35	1.36
AIDS DALYs (% of World DALYs)	3.46		

First, let us measure the world. One can see that, according to all sources, the share of global expenditure spent on AIDS is significantly lower than its disease burden. There is not much to add on this point.

Table 2.3: 2008 Regional AIDS expenditure as a percentage of total health expenditure vs. AIDS DALYs as a percentage of all DALYs

		UNAIDS	OECD	AID DATA	HIV % ALL DALYS
WORLD		1.16	1.19	1.19	3.46
AFRICA		**11.94**	**12.35**	**12.42**	**10.49**
	SUB-SAHARAN AFRICA	18.39	18.90	19.01	11.32
	NORTH AFRICA	0.18	0.18	0.18	0.23
AMERICA		**1.11**	**1.13**	**1.13**	**1.57**
	NORTH AND CENTRAL AMERICA	1.16	1.22	1.23	1.87
	SOUTH AMERICA	1.08	1.08	1.08	1.45
ASIA		**0.71**	**0.74**	**0.74**	**1.02**
	FAR EAST ASIA	0.67	0.68	0.68	0.99
	MIDDLE EAST	0.42	0.39	0.39	0.41
	SOUTH AND CENTRAL ASIA	0.97	1.05	1.05	1.07
EUROPE		**0.59**	**0.59**	**0.59**	**1.14**
OCEANIA		**2.30**	**4.26**	**4.26**	**0.17**

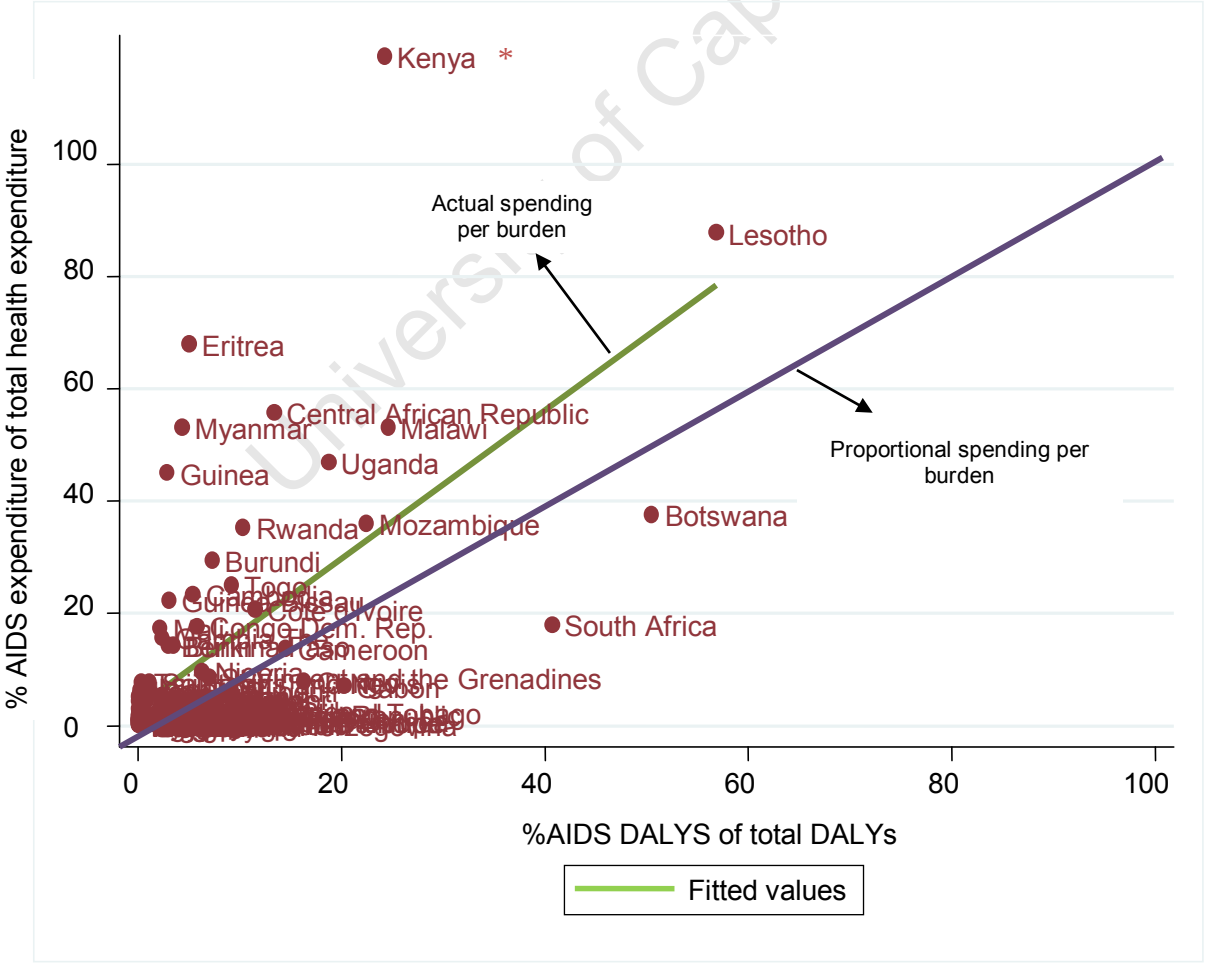
The above regional figures include all 118 countries across all three data sources. The 'OECD' and 'AidData' columns represent adjustments (that is, replacing UNAIDS data with either OECD or AidData estimates) made only to those countries for which OECD or AidData data were available. This gives an idea of how the overall picture changes when alternative data are used for the limited number of countries for which these are available. Red indicates overspending.

Regionally, the results firmly show that Sub-Saharan Africa and Oceania are overspending. UNAIDS data holds that the Middle East is overspending, but only by 0.01 percentage points. Sub-Saharan Africa spends rather wildly out of proportion to disease burden and would need to reallocate approximately 40% of its spending to other diseases in order to spend proportionately. Though there is large disagreement between UNAIDS and the other two data sources in the region, Oceania seems the biggest overspender by all accounts. In the best case scenario (UNAIDS), it would have to reallocate 93% of AIDS spending to achieve proportionality. All other regions underspend. Noteworthy in this regard are the cases of

North and Central America - which would have to increase spending by more than 50% - and Europe – which would have to nearly double its AIDS spending to achieve proportionality.

The following regression reflects the trends evident in UNAIDS data and are a kind of 2008 update of the figure provided by Nattrass and Gonsalves. Both use WHO data for total health expenditure (though Nattrass and Gonsalves, as mentioned, include all private health expenditure), both use UNAIDS data for AIDS spending and both use DALY data from the same 2004 update. The vertical axis measures that percentage of total health expenditure spent on AIDS for each country, while the horizontal axis measures that percentage of total DALYs accounted for by AIDS for each country. OECD and Aiddata data indicate similar trends and are shown, along with trends for Sub-Saharan Africa, in Appendix 1.3.

Figure 2.4: AIDS spend (% overall health spend) vs. AIDS DALYs (% overall DALYs), 2008 (UNAIDS data)



*This anomalous result is discussed below

Main findings: country-specific results

Table 2.4 summarises the most important findings of the proportionality exercise: those at the country level. Data from all three AIDS spending data sources are reported. Though there are many to choose from, three key indicators have been selected that this author deems most helpful for interpretation of results. Firstly, whether a country has over- or under-spent is indicated with either a tick (√) or a cross (X) respectively. Secondly, that percentage of AIDS spending that would have to be increased or decreased in order for the proportionality condition to be satisfied is presented for each country. Decreases are shown with a negative sign. Thirdly, the dollar amount each country would have to increase or decrease spending by in order to satisfy proportionality is indicated. Finally, those countries that are sensitive to choice between UNAIDS and OECD data by more than $5 million are underlined. Blank spaces in the OECD column represent countries for which no OECD data were available. Blank spaces in the AidData column represent those countries for which no alterations or additions were made to OECD data. Complete findings are presented in Appendix 1.1.

Table 2.4: Country-specific proportionality results

	Overspenders (√) and underspenders (X)			Percentage increases/decreases for proportionality			Cuts/increases (millions 2008 US$) for proportionality		
	UN	OECD	AID	UN	OECD	AID	UN	OECD	AID
AFRICA									
SUB SAHARAN AFRICA									
Angola	X	√	√	76.3	-0.2	-0.2	24.2	-0.1	-0.1
Benin	√	√		-79.3	-75.4		-16.5	-13.2	
Botswana	X	√		34.2	-1.0		116.4	-4.6	
Burkina Faso	√	√		-76.0	-76.1		-36.5	-36.6	
Burundi	√	√	√	-75.3	-74.7	-74.9	-19.6	-19.0	-19.2
Cameroon	X	X	X	5.2	69.8	61.4	2.1	17.3	16.0
Cape Verde	√	√		-95.4	-90.7		-2.5	-1.2	
Central African Republic	√	√		-76.1	-74.9		-15.4	-14.5	
Chad	X	X		18.7	85.9		2.6	7.6	
Congo	X	X		105.1	168.3		12.2	15.0	
Democratic Rep. of Congo	√	√	√	-67.4	-60.8	-61.3	-58.0	-43.5	-44.4
Côte d'Ivoire	√			-44.8			-27.8		
Djibouti	X			48.8			1.6		
Equatorial Guinea	X	X		617.3	438.0		17.5	16.5	
Eritrea	√	√		-92.6	-94.0		-13.4	-16.7	
Gabon	X	X		184.4	164.0		21.9	20.9	
The Gambia	√	√	√	-84.8	-77.9	-78.3	-4.2	-2.7	-2.7
Ghana	X	X		92.3	67.6		35.0	29.4	
Guinea	√	√		-93.7	-88.8		-12.4	-6.6	
Guinea-Bissau	√	√	√	-86.5	-80.1	-87.3	-3.2	-2.0	-3.4
Kenya	√	√	√	-79.7	-65.9	-66.5	-525.8	-259.6	-265.7
Lesotho	√	√	√	-35.3	-35.6	-36.0	-28.7	-29.1	-29.6
Madagascar	√	√	√	-93.9	-94.5	-94.5	-11.2	-12.5	-12.5
Malawi	√	√	√	-53.8	-67.8	-68.0	-57.4	-103.9	-104.7
Mali	√	√	√	-87.6	-85.8	-85.9	-35.4	-30.2	-30.5
Mozambique	√	√	√	-37.7	-57.9	-58.0	-54.7	-123.9	-124.8
Niger	√	√	√	-88.2	-85.2	-86.5	-11.0	-8.4	-9.4
Nigeria	√	√	√	-35.3	-37.5	-37.5	-139.3	-153.0	-153.1
Rwanda	√	√	√	-70.8	-75.8	-75.8	-78.5	-101.2	-101.2
Sao Tome and Principe	√	√		-91.2	-98.9		-0.1	-0.7	
Senegal	√	√	√	-81.1	-78.9	-79.0	-20.7	-18.0	-18.2
Seychelles	√	√		-35.2	-25.7		-0.2	-0.1	
South Africa	X	X	X	127.4	120.6	119.1	2157.5	2105.4	2093.7
Togo	√	√	√	-63.5	-27.6	-27.9	-9.8	-2.1	-2.2
Uganda	√	√	√	-60.1	-55.3	-55.4	-178.3	-146.2	-146.7
NORTH AFRICA									
Algeria	X	X		700.6	491.2		26.6	25.3	
Egypt	√	√		-64.1	-63.5		-4.8	-4.7	
Morocco	√	√		-34.8	-19.4		-4.4	-2.0	
AMERICA									
NORTH AND CENTRAL AMERICA									
Antigua and Barbuda	X	X		235.4	324.9		0.8	0.8	
Bahamas	X			341.3			15.2		

	Overspenders (√) and underspenders (X)			Percentage increases/decreases for proportionality			Cuts/increases (millions 2008 US$) for proportionality		
	UN	OECD	AID	UN	OECD	AID	UN	OECD	AID
Costa Rica	√	√		-19.5	-16.1		-3.9	-3.1	
Cuba	√	√	√	-59.2	-53.0	-53.4	-27.6	-21.5	-21.8
Dominica	X	X		148.1	1334.3		0.3	0.4	
Dominican Republic	X	X	X	190.6	123.0	110.7	44.6	37.5	35.8
El Salvador	√	√	√	-28.1	-18.9	-19.0	-11.0	-6.6	-6.6
Grenada	X	√		5.6	-20.5		0.0	-0.1	
Guatemala	√			-57.8			-29.7		
Honduras	√	√		-0.6			-0.1		
Mexico	X	X		6.0	5.3		15.9	14.2	
Nicaragua	√	√	√	-81.6	-83.0	-83.1	-12.2	-13.4	-13.5
Panama	X	X	X	325.9	375.8	374.3	44.4	45.8	45.8
Saint Kitts and Nevis	√			-85.8			-1.3		
St Vincent & the Grenadines	√	X		-19.7	180.8		-0.3	0.8	
Trinidad and Tobago	X	X		179.7	147.0		27.0	25.0	
SOUTH AMERICA									
Argentina	√	√	√	-24.1	-24.5	-24.5	-60.1	-61.1	-61.2
Bolivia	√	√	√	-55.7	-66.1	-69.0	-3.0	-4.7	-5.3
Brazil	X	X		35.0	35.3		218.2	219.4	
Chile	√	√		-58.0	-58.4		-51.0	-52.0	
Colombia	X	X		127.5	125.6		132.0	131.2	
Ecuador	√		√	-18.2			-4.7		
Paraguay	√	√	√	-18.9	-31.1	-31.3	-1.8	-3.4	-3.4
Peru	X	X	X	123.0	203.3	203.2	50.5	61.4	61.4
Venezuela	X	X		59.7	59.5		42.8	42.7	
ASIA									
FAR EAST ASIA									
Cambodia	√	√		-77.1	-79.2		-40.0	-45.2	
China	√	√	√	-4.4	-6.2	-6.4	-14.1	-20.4	-21.1
Indonesia	√	√		-90.3	-91.3		-44.8	-50.3	
Laos	√	√		-97.7	-97.7		-4.9	-4.9	
Malaysia	X	X	X	223.4	227.0	226.3	54.3	54.5	54.5
Mongolia	√	√		-98.4	-98.5		-5.0	-5.01	
Philippines	√	√	√	-92.6	-94.2	-94.2	-6.1	-7.9	-8.0
Singapore	√			-28.7			-4.4		
Thailand	X	X		384.8	363.3		804.7	795.0	
Timor Leste	√			-97.1			-1.8		
Vietnam	√	√		-27.3	-8.6		-29.7	-7.5	
MIDDLE EAST									
Iran	X	X	X	4.5	2.5	2.3	1.6	0.9	0.9
Kuwait	X			63.3			3.0		
Lebanon	X	X		12.7	156.0		0.9	5.0	
Syria	√	√		-97.0	-97.3		-1.9	-2.1	
SOUTH AND CENTRAL ASIA									
Afghanistan	√	√	√	-99.9	-99.8	-99.9	-3.2	-1.8	-3.1
Armenia	√	√		-70.2	-75.2		-1.8	-2.3	

	Overspenders (√) and underspenders (X)			Percentage increases/decreases for proportionality			Cuts/increases (millions 2008 US$) for proportionality		
	UN	OECD	AID	UN	OECD	AID	UN	OECD	AID
Azerbaijan	√	√		-80.3	-82.3		-4.0	-4.6	
Bangladesh	√		√	-99.5			-37.1		
Georgia	√	√		-94.9	-92.9		-7.6	-5.4	
India	X	X	X	97.6	69.0	68.9	142.0	117.5	117.3
Kyrgyzstan	√	√	√	-97.5	-98.4	-98.4	-8.6	-13.4	-13.6
Myanmar	√	√		-91.9	-80.5		-30.1	-10.9	
Pakistan	√	√	√	-78.2	-86.2	-86.2	-11.1	-19.4	-19.4
Sri Lanka	√	√		-61.6	-51.6		-1.0	-0.6	
Tajikistan	√	√	√	-95.9	-97.5	-97.6	-5.9	-10.1	-10.1
EUROPE									
Belarus	X	X		34.9	45.2		6.5	7.8	
Belgium	√			-39.5			-44.2		
Bosnia and Herzegovina	√	√		-76.7	-83.3		-2.1	-3.2	
Bulgaria	√			-90.0			-8.3		
Croatia	√	√		-95.3	-95.3		-9.5	-9.4	
Czech Republic	√			-93.3			-60.0		
Estonia	√			-37.3			-6.8		
Greece	√			-72.4			-69.6		
Hungary	√			-31.0			-1.1		
Macedonia	√	√	√	-95.6	-96.6	-96.6	-3.5	-4.6	-4.6
Moldova	√	√		-89.9	-81.5		-11.6	-5.7	
Montenegro	√			-35.9			-0.2		
Poland	X			20.5			12.8		
Romania	X			32.9			28.7		
Russian Federation	√			-33.8			-262.6		
Spain	√			-77.0			-706.1		
Sweden	X			865.0			191.6		
Switzerland	X			6913.6			1030.0		
Ukraine	√	√	√	-82.0	-83.2	-83.2	-82.0	-89.0	-89.3
United Kingdom	√			-79.1			-732.5		
OCEANIA									
Fiji	√	√		-88.1	-66.1		-2.21	-0.58	
Marshall Islands	√			-96.7			-0.56		
Micronesia	√			-94.1			-0.33		
Nauru	√			-40.3			-0.03		
Palau	√			-78.4			-0.04		
Solomon Islands	√			-97.3			-0.58		
Tonga	√			-97.0			-0.20		
Tuvalu	√			-97.6			-0.05		
Vanuatu	√	√		-99.7	-99.5		-1.09	-0.7	

According to UNAIDS data, 71% of countries (84 out of 118) overspend on AIDS relative to its share of their disease burden. The use of OECD instead of UNAIDS data only switches the overspend/underspend conclusion for four countries: Angola (UNAIDS under by $24.2 million, OECD over by $0.1 million), Botswana (UNAIDS under by $116.4 million, OECD over by $4.6 million), Grenada (UNAIDS under by $0.03 million, OECD over by $0.1 million) and St. Vincent and the Grenadines (UNAIDS over by $0.3 million, OECD under by $0.8 million). As one can see, however, this minor shuffling only changes the number of overspending countries by 2 – from 84 in UNAIDS data to 86 in OECD data. Further, no switches occur when using AidData as opposed to OECD data. The finding, thus, that over 70% of countries overspend is robust across all three data sources. The claim made by Bongaarts and Over (2010: 177) – that UNAIDS data underestimates the *number* of overspending countries – is correct in 2008, but an additional two countries is a very small win.

Switching data sources does matter, however, for conclusions about how much reallocation needs to take place. A total of 104 countries are sensitive to changes between UNAIDS and OECD data by more than $1 million, while 30 (underlined) are sensitive by more than $5 million. Of these, 12 countries are sensitive to changes by more than $10 million:

Table 2.5: Countries sensitive to change in data source from UNAIDS to OECD by more than $10 million

OECD US$ Million Smaller(S)/Bigger(B) Cut(C)/Increase(I) than UNAIDS					
Kenya	266.20	SC	India	24.59	SI
Mozambique	69.26	BC	Rwanda	22.72	BC
South Africa	52.09	SI	Vietnam	22.20	SC
Malawi	46.55	BC	Myanmar	19.20	SC
Uganda	32.13	SC	Cameroon	15.22	BI
Angola	24.33	Switches category entirely			
Botswana	121.03	Switches category entirely			

*SC or 'smaller cut', for example, means that OECD data imply less money that needs to be reallocated in order for proportionality to be achieved

It must be noted that the UNAIDS data for Kenya produce an anomalous result – namely, that 119% of the country's total health expenditure is spent on AIDS. This is clearly impossible, and in this case the OECD data (which posit an AIDS spending share of 71%) are perhaps to be preferred. AidData data only deviate from OECD data by more than $1 million in 7 countries: South Africa, Dominican Republic, Guinea-Bissau, Afghanistan, Niger, Cameroon and Kenya. Of these, only South African figures deviate by more than $10 million, calling for an $11.71 million smaller increase in spending to reach proportionality than those of the OECD.

All countries have been ranked in terms of their degree of over-spending and under-spending. It would be onerous to list specific ranks as they change between data sources, so full rankings are presented in Appendix 1.4 and only the following interesting results noted (rankings and figures refer to UNAIDS data unless otherwise stated). Afghanistan, Vanuatu and Bangladesh are the top three biggest overspenders (relative to their health budgets and disease burdens) and would need to reallocate upwards of 99% of AIDS spending in order to reach proportionality. Cape Verde, Madagascar and Guinea are the three highest relative overspenders in Africa, with reallocation figures upwards of 90%. The three countries that would need to reallocate the most money are the United Kingdom ($733m), Spain ($706m) and Kenya ($526m). The three corresponding top three African countries are Kenya, Uganda ($179m) and Nigeria ($139m). Switzerland is unquestionably the biggest relative underspender, and would have to boost AIDS spending by 6914% to reach proportionality. It is followed by Sweden (865%) and Algeria (701%). Algeria, Equatorial Guinea (617%) and Gabon (184%) are the top three relative underspenders in Africa. South Africa is unanimously, and by an astounding margin, the country that requires the largest amount of extra AIDS spending to reach proportionality – all data sources imply spending increases of around $2.1 billion or 120%. The next two countries requiring the most drastic increases are Switzerland ($1.03 billion) and Thailand ($804m). The corresponding top three African underspenders are South Africa, Botswana ($116m, though OECD deems this country an overspender) and Ghana ($35m).

Such rankings as have been referred to are interesting, but the most meaningful results are undoubtedly those that involve the countries with the highest AIDS burdens. According to UNAIDS data, approximately 13.8 million HIV positive people in the 118 countries included

lived in overspending countries in 2008. This figure decreases by approximately 10 000 when one uses OECD data where available. This represents approximately 54% of all HIV positive people contained within the dataset. HIV population data are missing for 20 overspending countries but only 4 underspending countries (5 in OECD data). 54%, thus, is likely to be a significant underestimate. The following are the results for the top 20 countries that contain the most HIV positive individuals:

Table 2.6: Proportionality results – 20 countries most heavily affected by HIV

		Overspenders (√) and underspenders (X)			Percentage increases/decreases for proportionality			Cuts/increases (millions 2008 US$) for proportionality			HIV+ population ('000s)
		UN	OECD	AID	UN	OECD	AID	UN	OECD	AID	
1	South Africa	X	X	X	127.4	120.6	119.1	2157.48	2105.39	2093.68	5600
2	Nigeria	√	√	√	-35.3	-37.5	-37.5	-139.33	-153.04	-153.06	3200
3	India	X	X	X	97.6	69.0	68.9	142.05	117.46	117.32	2400
4	Kenya	√	√	√	-79.7	-65.9	-66.5	-525.77	-259.56	-265.67	1400
5	Mozambique	√	√	√	-37.7	-57.9	-58.0	-54.68	-123.94	-124.82	1300
6	Uganda	√	√	√	-60.1	-55.3	-55.4	-178.32	-146.19	-146.73	1100
7	Russian Federation	√			-33.8			-262.62			940
8	Malawi	√	√	√	-53.8	-67.8	-68.0	-57.37	-103.92	-104.68	910
9	China	√	√	√	-4.4	-6.2	-6.4	-14.09	-20.36	-21.09	740
10	Brazil	X	X		35.0	35.3		218.18	219.37		635
11	Cameroon	X	X	X	5.2	69.8	61.4	2.07	17.29	15.99	590
12	Thailand	X	X		384.8	363.3		804.72	795.03		550
13	Côte d'Ivoire	√			-44.8			-27.77			470
14	Ukraine	√	√	√	-82.0	-83.2	-83.2	-82.03	-88.98	-89.32	350
15	Democratic Rep. of Congo	√	√	√	-67.4	-60.8	-61.3	-57.96	-43.46	-44.43	315
16	Botswana	X	√		34.2	-1.0		116.39	-4.64		310
17	Lesotho	√	√	√	-35.3	-35.6	-36.0	-28.72	-29.11	-29.57	280
18	Indonesia	√	√		-90.3	-91.3		-44.75	-50.26		270
19	Vietnam	√	√		-27.3	-8.6		-29.69	-7.49		270
20	Ghana	X	X		92.3	67.6		35.01	29.43		260

65% (13) of these countries spend more on AIDS than its disease burden warrants (12 or 60% in OECD data). Indonesia, Ukraine and Kenya need to reallocate the largest percentages of AIDS spending; while Kenya, Russia and Uganda need to reallocate the most money to achieve proportionality. Thailand is the largest relative underspender, requiring remarkable

AIDS spending increases of 385% (UNAIDS) or 363% (OECD). South Africa and India are next in line, both requiring an approximately two-fold increase in AIDS spending. South Africa, Thailand and Brazil require the greatest monetary increases in AIDS spending in order to reach proportionality.

When one considers the spending reallocations/increases required per HIV positive individual, the picture does not change significantly. According to UNAIDS data Thailand ($1.463m UNAIDS, $1.446m OECD), South Africa ($0.385m UNAIDS, $0.376m OECD), and Botswana ($0.375m UNAIDS, $0.015m **in overspending per person** in OECD) need the most per person; while Kenya ($0.376m UNAIDS, $0.185m OECD), Russia ($0.279m UNAIDS, no OECD data) and Ukraine ($0.234m UNAIDS, $0.254m OECD) need to reallocate the most per HIV positive person. The choice of data, as mentioned, affects the overspend/underspend conclusion for Botswana.

One might be tempted from the above to conclude that the world is spending disproportionately 'too much' on AIDS – after all, the majority of countries are. This would, however, represent a kind of first-past-the-post framing of the problem: whichever side gets the most countries wins. This author prefers another electoral system; one of proportional representation. When the total amount of overspending is weighed against the total amount of underspending, an extremely interesting result arises. According to UNAIDS data, the total amount for all overspending countries in excess of proportional spending is $3.84 billion. The total amount falling short of proportional spending in underspending countries, however, is $5.29 billion. The corresponding figures when OECD adjustments are made where possible are $3.65 billion and $5.01 billion respectively. Put another way, there is approximately $1.44 billion (or $1.43 billion) in global net underspending. Though most countries overspend, in total overspending is considerably less severe than underspending.

Summary

There is a global trend towards disproportionate overspending on AIDS relative to its disease burden. The direction of the trend is not sensitive to choice of data source. Most HIV positive individuals live in countries that overspend. This conclusion, too, is not sensitive to choice of data source. Choosing between OECD and UNAIDS data does matter for country-specific

conclusions, specifically for the 12 countries previously noted. Further, while overspending is the norm, those countries that underspend typically do so quite vastly. Indeed, tallying surpluses and deficits shows that there is approximately $1.4 billion *more* underspending than there is overspending. South Africa illustrates this most vividly. Even if *all* those countries that overspend were to reallocate their surpluses to South Africa, the country would still fall short of proportionality by approximately $700 million.

Choice of data source

Much has been made of the differences (or lack thereof) between OECD and UNAIDS data, but little guidance has been provided on which source to prefer. The issue is not an easy one. OECD data provide a more thorough, official account of resources flowing from DAC donors. Moreover, statistical work carried out by the DAC is useful for long-term analysis of trends in donor spending. This data does, however, come with a nine to twelve month lag and is "not suited to real-time political resource decision-making, a purpose for which it is not intended" (UNAIDS, 2005: 3). UNAIDS data, meanwhile, is specifically aimed at providing current, 'nimble' data (with a three to six month lag) that can be applied readily in rapidly changing policy and financial environments. Many questions can't wait almost a year to be answered, and in these cases UNAIDS will be the obvious (and only) choice. Moreover, the country-level data it provides is a greater aid to decision-making than the OECD data, which is peppered with unspecified bilateral and regional allocations. It must be remembered, however, that the country teams responsible for UNAIDS data collections may miss some donor funding flowing outside of government.

Even given such gaps in UNAIDS data, in trying to account for all AIDS resource flows within a given country it should capture much funding from DAC as well as non-DAC members. This may recommend it over OECD data. While the 2010 Development Cooperation Report (OECD, 2010c) does explicitly mention ongoing cooperation in data collection efforts between the DAC and non-DAC donors, to date information on the extent of South-South cooperation is slim. Some non-DAC members do report to the OECD - their net disbursements totaled $9.48 billion in 2008 (OECD, 2010c: 259) – but it is not clear how much of this went to AIDS. Some $87.6 million was contributed to the Global Fund by reporting non-DAC donors in 2008 (OECD, 2010d: online) but, again, this is only partial

information. It is not absolutely clear which official data source provides the most comprehensive picture of AIDS spending – this is, after all, why both have been reported. Since UNAIDS data are meant to include all AIDS spending that OECD data include, but not vice versa, it may be logical to assume that OECD data are more reliable in countries where its estimate exceeds that of UNAIDS. Further, since UNAIDS data are meant to capture more spending than OECD data (because of non-DAC contributions), it may be logical to assume that UNAIDS data are more reliable in countries where its estimate exceeds that of the OECD. A guideline, albeit a loose one, could be to 'pick the highest number'.

Getting an idea of where the official sources stand is important, but the AidData estimates are also helpful for a better understanding of the totality of AIDS funding. Since little information is available on non-DAC donors *anywhere*, they – like the UNAIDS and OECD data – do not include funds flowing from potentially important South-South collaborations. Still, it is useful to see that some projects not classified under 'STD Control including HIV/AIDS' or 'Social mitigation of HIV/AIDS' do seem to involve mainly AIDS components. Whether it is appropriate to include these or not is up to the individual user. Importantly, the steps taken in building the AidData database preempt accusations against OECD data of the type Bongaarts and Over leveled at UNAIDS data – namely, that they may miss a significant amount of AIDS spending. Since the AidData adjustments did not make much of a difference, one can reject the claim that a significant amount of donor funds is being missed by the two AIDS-related CRS purpose codes.

2.3 – Discussion and weaknesses

The analysis conducted excludes some potentially important countries due to unavailability of either total health spending or AIDS spending data – Zimbabwe, Zambia, Namibia and Swaziland, for example. Further, as has been mentioned, the measure of disease burden used, the DALY, incompletely captures the complexity of the AIDS virus. It does not deal well with comorbidity and thus underestimates true affliction caused by the disease. Infection with HIV increases one's chances of contracting TB, for example (Corbett et al, 2003; Goodman, 1995). Technically, if AIDS could be said to be the direct cause of 3% of TB cases, 3% of TB's DALYs should be included. No such data exists, however. There is also the problem of the socioeconomic impacts of AIDS (Haacker, 2004; Canning, 2006) which are not captured.

Again, there is very little that can be done about this. Finally, the many AIDS cases *prevented* by the initiatives enabled by existing AIDS funding have not been captured. If effective prevention strategies are keeping the AIDS burden of disease low, optimal spending may appear as overspending.

All these concerns are relevant, but do not belong to AIDS alone. DALYs are incomplete, but they are at least consistently so. There is little reason to imagine that they underestimate the burden of AIDS in ways that they do not in other, equally vicious conditions. ART provides an exception to this rule, however. Because those AIDS sufferers on ART suffer less disability (0.167) than those not on ART (0.505), AIDS DALYs in a given country will decline as more people are placed on ART. Thus, if a country spends proportionally in one year and uses funding to expand treatment, it will 'overspend' the next year because treatment has led to a decline in DALYs. This leads to the absurd problem that if funding were made contingent on proportionality, it would lead to a perverse disincentive to expand ART. Ideally, the measure of proportionality used should be adjusted in such a way as to account for the presence of ART. In the case at hand, however, it is perhaps fortunate that the latest DALY data available are for the year 2004 – a time when global ART coverage was minimal (approximately 12% [UNAIDS and WHO, 2005: 11]). This problem is thus unlikely to affect results as much as it would in more recent years. It should, however, be kept in mind when the current WHO update is complete and more recent DALYs are published.

The felicity associated with using 2004 DALYs, unfortunately, stops at ART. Because 2008 and not 2004 expenditure is used, the above exercise tacitly ignores the effects of any developments in the relative disease burden of AIDS from 2004 to 2008. This could affect the results for each country in one of two ways. Firstly, if the AIDS disease burden has worsened relative to other conditions since 2004, they will underestimate the amount of AIDS spending required for proportionality. In these cases, overspending will be less and underspending more dramatic. Alternatively, if the burden of other diseases has worsened relative to the AIDS burden, results will overestimate the amount of AIDS spending required for proportionality. In these cases, overspending will be more and underspending less dramatic. The question hinges on which development is more likely within each country.

In the extreme case of South Africa, it seems likely that the size of the epidemic, coupled with the vast funding deficit, may have led to a worsening of the AIDS burden relative to other conditions. In other countries, however, it is more difficult to tell. As noted in the beginning, past studies on proportionality found that AIDS has consistently received more funding per DALY than any other disease. It may be reasonable, then, to assume that this surge in funding has actually led to an improvement (ie. decrease) of the AIDS disease burden relative to other, more underfunded diseases. Unfortunately, without updated DALY data there is no way to tell either way. Since DALYs rely on more than mere incidence levels, even calculating the changes in the spread of each disease won't provide an answer. The question is whether burdens have reshuffled so much between 2004 and 2008 so as to switch the overspend/underspend conclusions for those countries that differ significantly from proportionality – these are, after all, the main focus. Since deviations are often extreme, this author does not believe this is likely.

As mentioned initially, it is important to recognize that the issue of proportionality is one talking point among many in the AIDS spending debate. This analysis has not stepped into the important field of cost-effectiveness, which at least in principle allows for maximizing the effects on disease burden at the margin. Then again, it is precisely because there is limited data for this kind of study and none at all at the international level that this paper has focused on proportionality. It is this author's hope that clarity on proportionality will provide groundwork for future cost-effectiveness analysis. Another issue not touched upon is that raised by those such Girard et al (2010) and Barry and Townsend (2010). They contend that the real issue in the AIDS funding debate is not proportionality but insufficient global health spending - rather than cutting down on AIDS resources, they argue, efforts should be directed to increasing spending across the board. This, however, does not address the question of where additional resources should be directed and which diseases need them most. Again, clarity on proportionality can provide a good starting point for this.

The analysis has also not ventured into the question of vertical (focused on a specific condition) versus horizontal (focused on building broader health systems) health programmes (see Ooms et al, 2008, in particular; as well as Nattrass and Gonsalves, 2010; Reddi and Leeper, 2010; Asiimwe et al, 2010; MacKeller, 2005; and Bongaarts and Over, 2010). To the extent that AIDS spending was being used to build broader healthcare systems in 2008, the

analysis in this paper overestimates the share of funding exclusively directed towards AIDS. Many of the AIDS projects read through in the AidData database did contain reference to broader healthcare initiatives but, as mentioned, it was quite impossible to determine whether AIDS plays well with others in the health playground. This is the one area, perhaps, that will provide the most fruitful avenue for further research.

An issue that deserves some attention is that regarding the political realities of reallocating expenditure. The shifting of any planned future expenditure from AIDS to other diseases or broader healthcare programmes should not be blind to issues of monitoring and accountability. It is all well and good to say that more funds should be diverted to battling bilharzia, say, but who monitors the incidence of the disease? How does one analyse whether prevention efforts are working? Who is responsible for ensuring that infected rivers are clearly signposted? Who gets fired when they are not? In the absence of clearly defined, measurable targets and clear channels of responsibility, money shifted to other healthcare programmes may disappear into opaque management systems that fix few problems and even fewer people. The 2004 World Development Report speaks at length of the importance of accountability to service delivery, and introduces an analytic framework for thinking about the concept involving five key elements: delegation, finance, performance, information about performance and enforceability. The link between them is explained with a simple example:

> "In buying a sandwich you ask for it (*delegation)* and pay for it (*finance*). The sandwich is made for you (*performance*). You eat the sandwich (which generates relevant *information* about its quality). And you then choose to buy or not buy a sandwich another day (*enforceability*), affecting the profits of the seller" (World Bank, 2004: 47).

Proper information and enforcement capabilities are required if proper performance is to come from finances delegated.

The machinery of AIDS activism mentioned at the very beginning not only pieces money together, but also sounds loud sirens when money is being misallocated and misspent. It has done so on many occasions, an apt example being the Treatment Action Campaign's constitutional court battle with the South African government over the latter's limited rollout of Nevirapine (Heywood, 2003). This cannot be ignored and represents an important caveat

in any discussions about reallocation. Nattrass and Gonsalves (2010) summarise the point well:

> "In the absence of easily measurable outputs and clear, politically feasible and sustainable mechanisms to hold government to account, funds can all too easily be misappropriated [De Renzio, 2006] or shifted away from priority health interventions—as was the case in Zambia when the TB program collapsed after being "integrated" into the general health care system [Bosman, 2000]. AIDS spending, by contrast, can be linked to specific targets and has a constituency (treatment activists) with a strong incentive to hold governments accountable...Undercutting HIV funding, ostensibly in order to build a better health care system, could dismantle the most organized and effective health care consumer constituency in existence in developing countries" (2010: 175).

This applies to other diseases and healthcare initiatives as well as to the components of AIDS spending itself. The 2010 Global HIV Prevention Progress Report Card (GHPWG, 2010) notes that few prevention programmes have clear, well-defined targets or monitoring mechanisms. Indeed, it states that "analysis of data indicates that the world is doing a poor job of implementing sound, evidence-based, well planned programmes" (2010: 1). Such evidence needs to be taken into account when calling for a greater focus on prevention versus treatment (see Over, 2008, for example), ostensibly in order to fast-track eradication of the epidemic.

Finally, it must be noted that proportionality may not be useful in cases where health spending is extremely low in every sphere. In such cases, it may be that a certain minimum of healthcare infrastructure needs to be put in place for the initiation of a coherent response to the AIDS epidemic. Moreover, spending from a low base will have to gather momentum in one or a few areas until talk about reallocation will be meaningful. It is impractical to suggest that a very poor country should concentrate on all things at once, from the first. Despite these qualifications, it is very useful to see that certain countries – particularly South Africa, Brazil, Thailand, Kenya, Nigeria and Uganda – are not spending even remotely in line with their AIDS disease burdens. In these countries, there is certainly space to examine spending allocations and, in extreme cases of disproportionate overspending, *open* the question of whether some conditions could use additional funds more than AIDS.

2.4 - Conclusion

The results generated do not solve the problem of precisely if, where and how much future spending should be reallocated within countries. They do, however, lend a measure of clarity to a metric that has been, and doubtless will continue to be, used to argue on both sides of the AIDS funding debate. In particular, we have seen that OECD and UNAIDS data do indeed produce different spending figures at the country level, and that choice of data source has very real implications for any exercise aimed at gauging how much money is really being allocated to each country's fight against AIDS. Bongaarts and Over (2010: 76) were right to flag the issue (2010: 177), but their analysis was too cursory to support their implication that UNAIDS data are likely to underestimate AIDS spending. The exercise conducted in this chapter has shown that the relationship between the two data sources is considerably more complex than these authors suggest. Further investigation is required to determine why certain countries exhibit severe discrepancies. Nattrass and Gonsalves (2010: 175), meanwhile, put forward arguments based on figures that, because of the massive increases in AIDS spending between 2007 and 2008, are currently outdated. The flat-lining of funding between 2008 and 2011 means that the results presented in this study are far more relevant to present conditions.

Chapter 3 - Critique of AIDSCost

AIDSCost , the AIDS costing and projection model designed by Mead Over and Owen McCarthy and released by the Centre for Global Development, adds to the tool belt of those wishing to estimate the costs of global antiretroviral therapy (ART). Not only is the model easy to use, but it also allows projections for a large number of countries with significant levels of HIV infection. However, it remains important that those wishing to use this model understand the logical underpinnings and shortcomings thereof. While its simplicity is laudable, its parsimony comes with various oversimplifications and misrepresentations that call into question its cost projections. This is not merely a question of curiosity. Mead Over has recently used the model to argue that, should the United States continue to support the expansion of ART in developing countries, the financial burden thereof will become overwhelming – there will arise a 'ballooning entitlement', as shall be discussed in more detail later. Over has argued that, in lieu of this, the United States should shift focus away from treatment and towards prevention. Considering the gravity of the issue at hand – namely, the provision of life-saving drugs to multitudes of people by the world's largest AIDS donor – it is of vital importance that the reliability of Over's cost estimates be interrogated.

This chapter will proceed as follows. Section 3.1 contains a brief overview of the workings of AIDSCost. Section 3.2 analyses the model's main shortcomings and recommends suitable alterations. Section 3.3 compares the model's outputs for South Africa with those of ASSA2003 for the period 2007-2016, in order to attain some measure of the former's quality. As ASSA2003 employs a large variety of data and is calibrated to fit actual trends in AIDS deaths by age, gender and race, it may be referred to as a kind of gold standard. McCarthy and Over have openly solicited comparisons of their model with others, ASSA2003 among them (2009: 29). It is this author's hope that the following analysis will aid AIDSCost's creators in improving their model where necessary.

3.1 - The mechanics of AIDSCost

AIDSCost actually comprises two programmes: AIDSProj and AIDSDif. AIDSProj provides all the key outputs of concern to this investigation (incidence, prevalence, treatment costs and the like), while AIDSDif facilitates comparison between the costs and benefits of different AIDSProj scenarios. Since AIDSDif is not relevant to this chapter, AIDSProj will henceforth be referred to as AIDSCost. For ease of understanding, let the reader assume that he/she is looking at the world through the eyes of the model. Fresh from the programming laboratory, it has been given its first job: to calculate the future global burden of ART. To do this, it decides that it needs to track HIV positive individuals through a progression of states – being AIDS sick, needing first-line treatment and receiving second-line treatment, for example. It approaches the problem in the following way:

1.) How many *new* people are infected with HIV each year; in other words, how does a model like me estimate incidence? I have data on total number infected for 2007, but what about beyond that? Let me assume that, each year, incidence will be some multiple of the incidence in the previous year but will not exceed it. Let me create a variable that the user can adjust, *incmult*, with values between 0 and 1 (1 being 100% of the previous year's incidence).

2.) I now have the stock of HIV positive people each year, but need to calculate how many of these are actually AIDS-sick, ie. eligible for ART. Let me define *erate* as the parameter that indicates what proportion (again between 0 and 1) of HIV positive people become newly AIDS-sick each year, and *ndrate* as the parameter that indicates what proportion of AIDS-sick not receiving treatment die each year. Those AIDS-sick that survive but do not receive treatment constitute *unmet need* for ART each year.

3.) Next, I need to calculate how much of this need for ART is satisfied each year. I thus create the parameter *uptake* with values between 0 and 1. If *uptake* is 0.85, for example, in any given year 85% of AIDS-sick people not already on ART and needing treatment receive it. I assume that no one is taken off of ART until they die, and call this claim to lifelong treatment 'entitlement'. I recognise that *uptake*

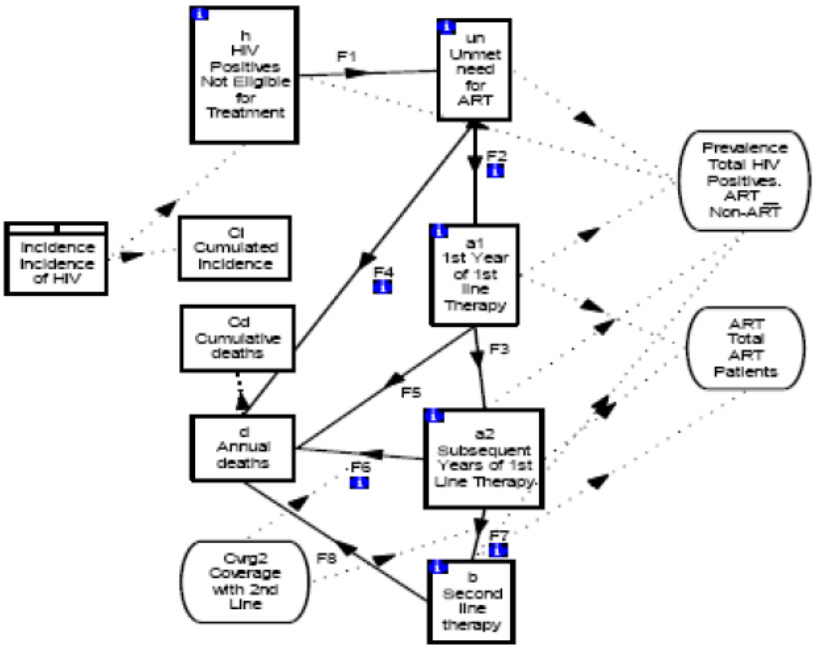
is an extremely important and highly variable policy target, and so assign it no default.

4.) I need to be more specific about treatment – after all, there is a massive difference in cost between first- and second-line treatment. The number of those on their first year of first-line treatment is labelled *a1*, and is simply the number of those new to ART each year. I recognise that the first year of first-line therapy is one in which treatment failure can be high. I thus create *adrate* to capture the death rate on *a1*, and calculate the number of those on post-first-year-first-line therapy each year as *a2*. This includes the number of the previous year's surviving *a1* minus those *a2* who have failed first-line therapy and thus become eligible for second-line therapy. *Adrate2* gives this latter proportion (see Figure 3.2).

5.) To calculate those on second-line therapy, I need to determine how many people who need it actually get it each year. I have already seen that those that need second-line therapy are those that fail first-line therapy. I define the proportion of these that are given this treatment each year as *cvrg2*. The number of those on second-line therapy then becomes this proportion minus those who die on second-line therapy each year, the latter being given by *bdrate*.

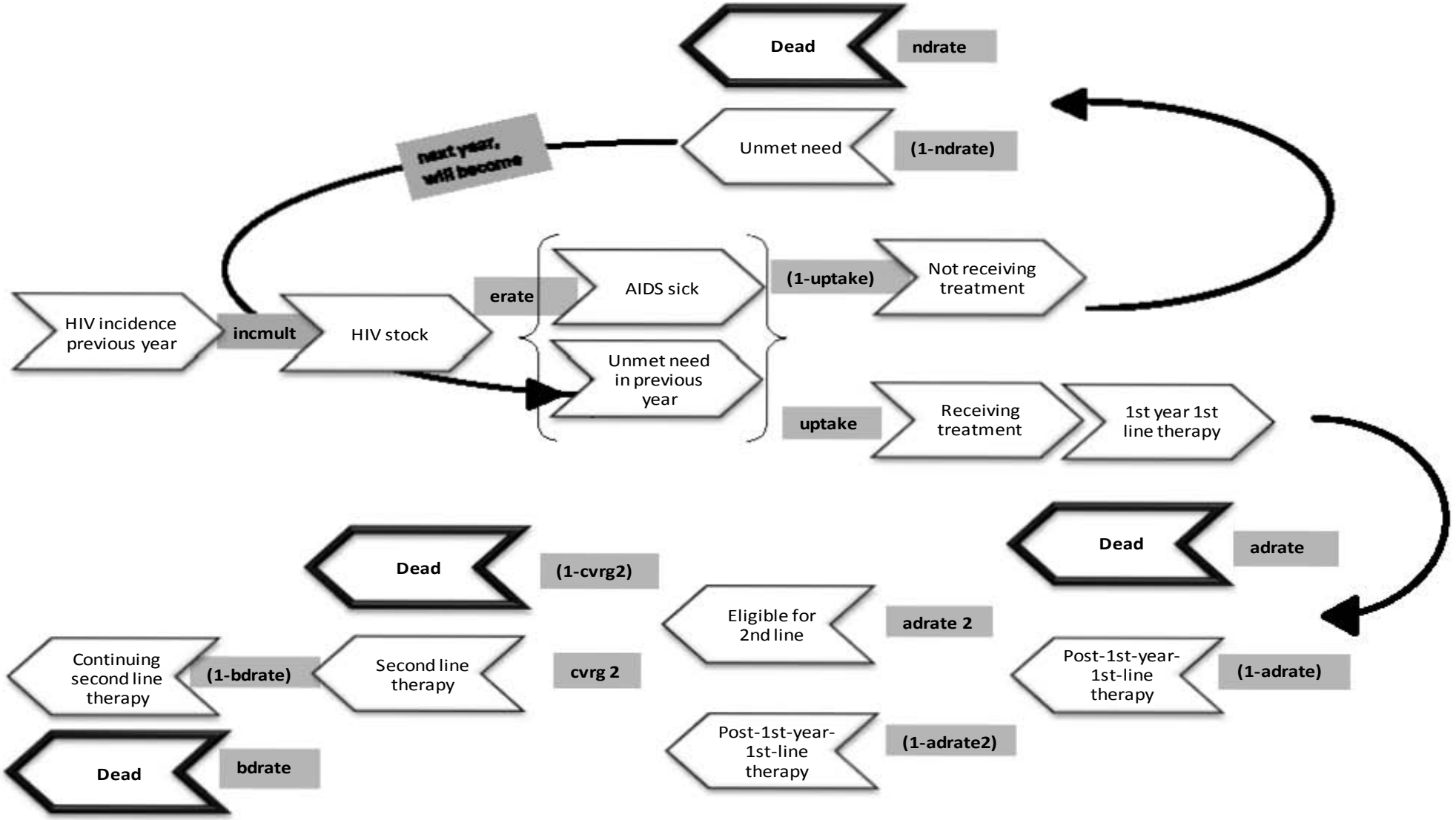
We now have a basic idea of how AIDSCost works. McCarthy and Over provide a small diagram of the mechanisms involved (2009: 39):

Figure 3.1: Structure of the AIDSCost model (as per model manual)



The following alternative depiction, however, is more intuitive:

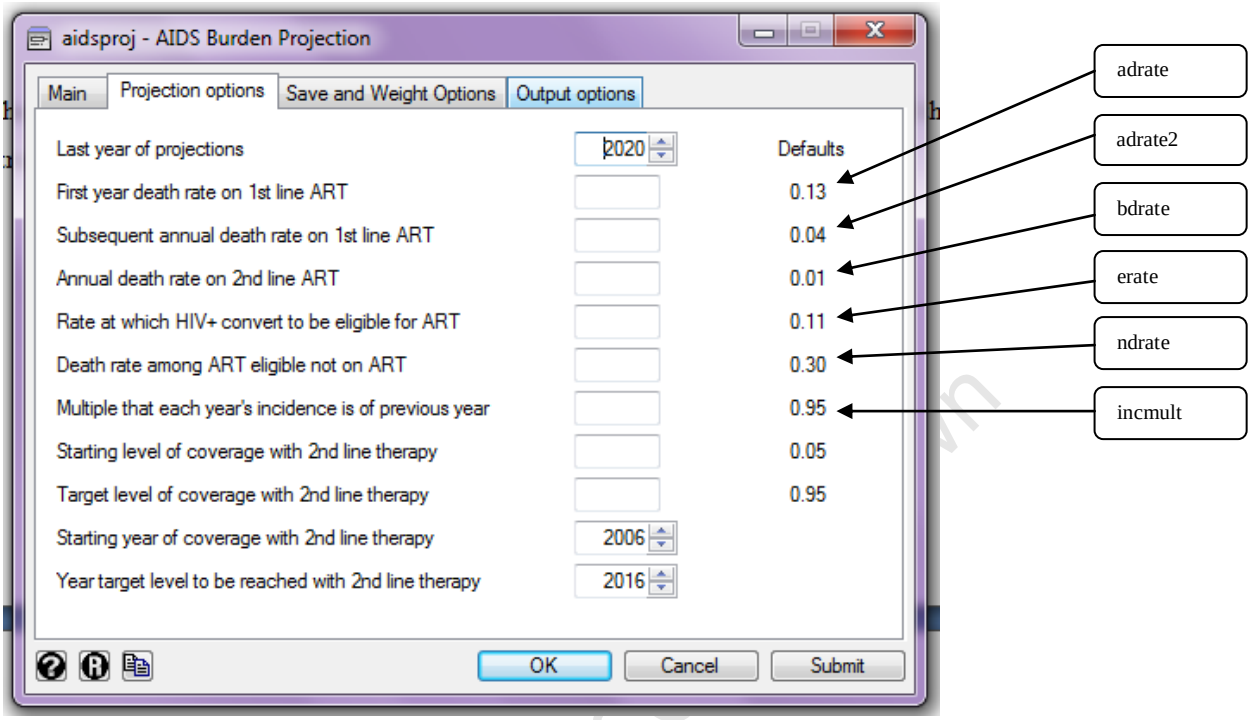
Figure 3.2: The structure of AIDSCost (alternative diagram)



Source: Author's construction

The model presents users with the following interface and default values:

Figure 3.3: User interface and defaults



The user is able to adjust each of the parameters above as he/she sees fit, while a previous screen allows for the tweaking of the *uptake* parameter. The importance of this *uptake* must be stressed. This is the only parameter that does not have a default value and is a pivotal input in determining the number of patients on, and thus the cost of, ART. Note that *uptake* (the rate at which people who need ART, but are not already on ART, gain access to ART) is not the same as ART coverage (which includes the numbers already on ART both in the numerator and the denominator). As we shall see, a positive *uptake* rate invariably tends to 100% coverage over time. This is because the model does not allow the user to specify a starting level of first-line coverage, nor does it allow for a target level of first-line coverage. Only second-line starting levels and targets can be specified. It is also important to note that each of the above parameters stays constant over time. Setting an *uptake* rate of 0.85, for example, commits the area in question (country, region or world) to meeting 85% of unmet need each year until the last year of projection. Lastly, when estimating across different countries and regions, the model does not allow for variability in the parameters. If different values of the parameters are required for different countries or regions, individual runs are required.

Using the output data, AIDSCost then calculates the total cost of ART in region i and year j according to a simple cost function:

$$TC_{ij} = ART1 * C_{ART1} + ART2 * C_{ART2}$$

Where ART1 and ART2 are the number of people on first-line and second-line ART respectively, and C_{ART1} and C_{ART2} are the unit costs of the two treatments (including pharmaceutical and non-pharmaceutical costs).

3.2 - Problems and areas for further research

Exploring the mechanics of the AIDSCost model reveal a number of troubling issues, many of which have potentially catastrophic (the word is not used lightly) implications for the projection of ART costs. There are several pressing issues that deserve attention.

ART specification

As mentioned above, AIDSCost does not allow the user to specify target overall coverage levels, only target *uptake* rates and second-line coverage targets. Total coverage tends to 100% over time. This has to do with the fact that *uptake* is specified as a constant rate of need satisfaction amongst those not already on ART. As this can be confusing, it is worth summarising the difference between ART coverage and ART uptake:

$$ART\ uptake = new\ to\ ART(t) / unmet\ need\ for\ ART\ (t-1)$$

$$Total\ coverage\ (\%)(t) = \frac{total\ number\ on\ ART\ (up\ to\ and\ including\ t)}{total\ need\ for\ ART\ (t)} * 100$$

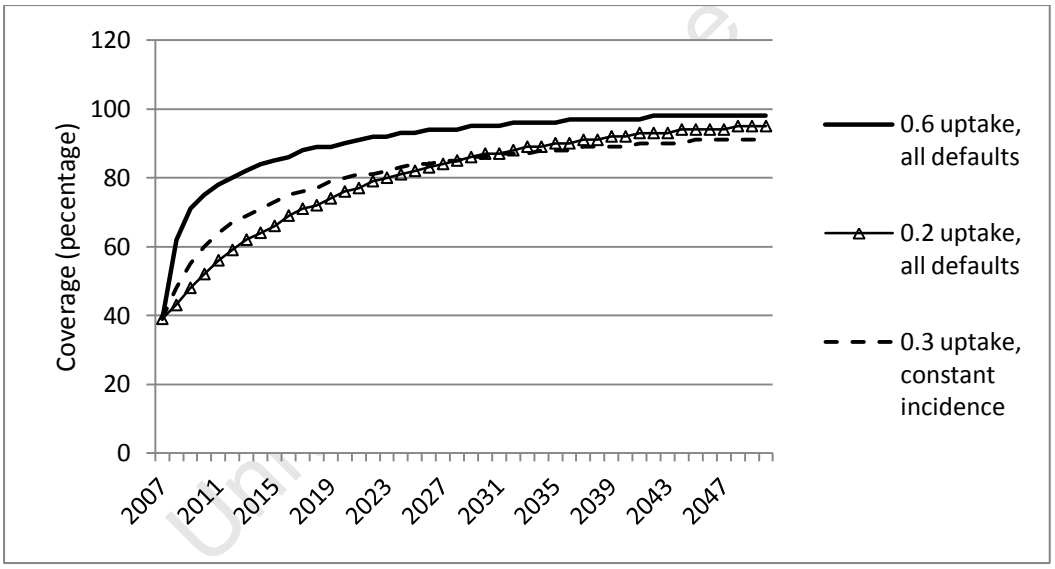
$$Total\ number\ on\ ART = ART\ already\ enrolled + new\ to\ ART$$

$$Total\ need\ for\ ART = total\ number\ on\ ART + unmet\ need\ for\ ART$$

$$\therefore Total\ coverage\ (\%) = \frac{ART\ already\ enrolled + new\ to\ ART}{ART\ already\ enrolled + new\ to\ ART + unmet\ need\ for\ ART} * 100$$

The coverage shortfall is given by unmet need for ART; as this tends to zero, total coverage tends to 100%. In other words, if there is no unmet need everyone who needs ART gets it. If one thinks back to the model diagram, one sees that unmet need must decline consistently over time. This is because each year fewer people are infected (declining incidence) and thus fewer new people each year that need ART (since the number of AIDS sick is calculated as a constant proportion of those with HIV). Moreover, some of those that need ART but don't get it die and do not form part of unmet need in the next year. Put another way, since the level of satisfaction of need amongst those not on ART does not decline (being a constant proportion, *uptake*), as time passes we are satisfying a given percentage of a declining number. Total ART coverage, thus, will tend to 100%. Graphically, the process is depicted thus:

Figure 3.4: The push to 100% total coverage



While it is possible to specify an extremely low *uptake* rate that will effectively place 100% ART coverage outside of the 2050 projection range, this forces the user into a rather absurd trade-off (between limiting overall coverage and rapidly scaling up treatment) that is unlikely to present itself in the real world.

The inability to set total coverage targets renders the model inappropriate for calculations involving countries like South Africa, where, for any given period, policy targets are stated as levels of coverage and not rates of annual *uptake*. In such cases, it becomes difficult for users

to determine, ex ante, the appropriate values to assign to the parameters. The costs of a target ART coverage level of 80% for the year 2015, for example, cannot be directly estimated. Rather, users must specify some target value of *uptake* and then read the corresponding total coverage level from the AIDSCost outputs. Thus, in the comparison with ASSA2003 (discussed in the next section), this author had to specify a number of *uptake* rates until the desired level of coverage (80%) by 2012 (the actual policy target) was reached. While it is possible to reverse engineer the output and, in so doing, retrieve the correct coverage for the correct date, this process is time consuming and impractical.

Another problem, perhaps due to the above, is that total ART coverage can expand in an unrealistic manner. Again considering the forthcoming comparison to ASSA, total coverage made a jump from 27% in 2007 to 72% in 2008 (discussed in more detail below). It is doubtful, especially given the need for measured budgetary planning over a number of years, whether real-world ART scale-up would be so sudden at the outset. Further, it takes an extremely optimistic view of the ability of developing countries to roll out treatment - a problem likely to be exacerbated by the unwillingness of some individuals suffering from AIDS to go onto ART (see, for instance, Steinberg, 2008).

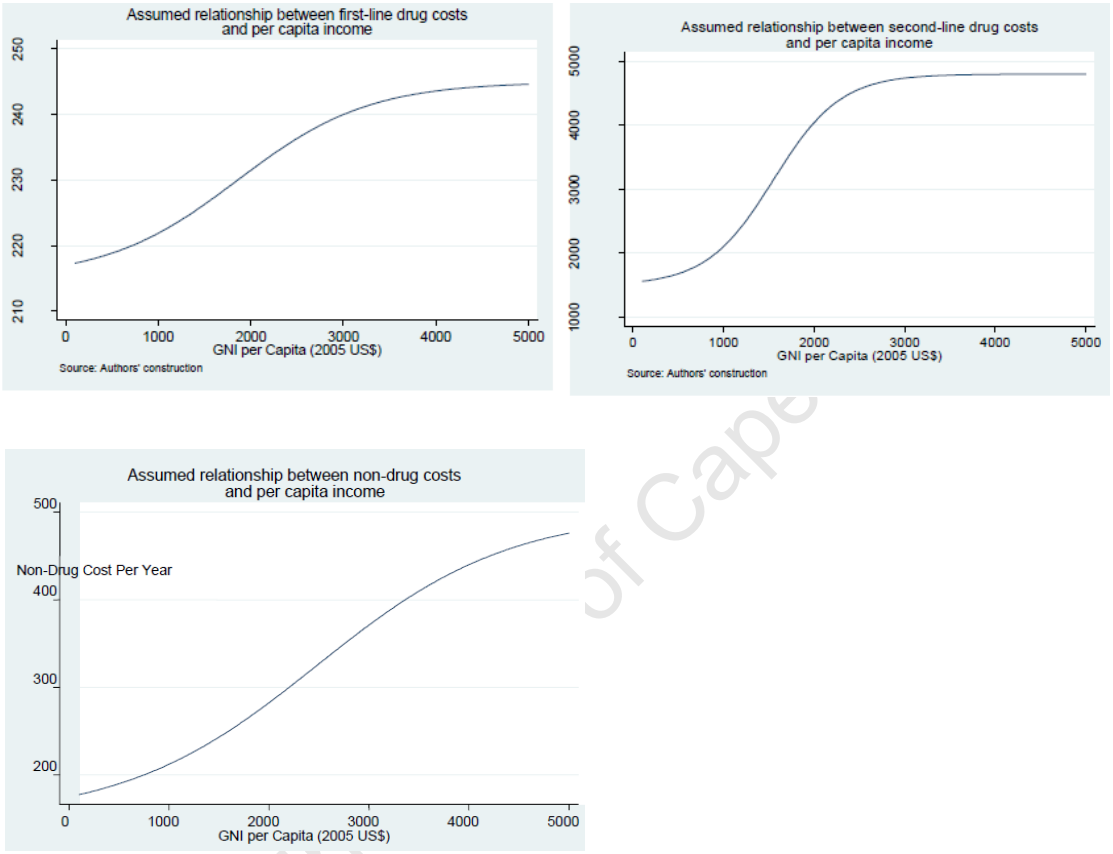
Considering the above, the following changes are recommended for investigation by the model designers:

- Adding adjustable target levels and rates of total ART coverage
- Allowing for the direct adjustment of levels and rates of *uptake* of 1st line treatment
- Allowing for coverage levels to remain constant beyond a certain date
- Providing for a more gradual progression from initial rates to target rates of coverage, possibly in the form of a 'linear/exponential' option

Costing assumptions

McCarthy and Over (2009) assume that costs follow logistic functions of the following forms, and vary according to Gross National Income per capita:

Figure 3.5 – Costs and GNI



Source: (McCarthy and Over, 2009: 7)

However, there are a number of reasons to believe that these assumed relationships are too simple. Firstly, in low-income settings, non-drug costs may be considerably higher than these curves suggest due to the costs of setting up previously nonexistent primary healthcare infrastructure. Neglecting these costs is likely to lead to serious underestimation of ART rollout costs in very low income settings. Secondly, it seems unlikely that costs are so neatly related to GNI per capita alone. Such a measure neglects the effects the size of the epidemic in a given country may have. Large epidemics, even in middle income countries, could prompt the mobilisation of international civil society behind cost-lowering movements (eg. in South Africa), increase demand for generics and provide economies of scale (the latter issue being discussed at length, and specifically with regard to mathematical modelling, by

Kumaranayake [2008]) – all of which may contribute to lower per patient drug costs than AIDSCost would predict.

Perhaps the most disconcerting assumption of AIDSCost is that regarding the way that costs change over time – the assumption, that is, that they do not change at all. Future changes in the costs of ART are impossible to predict with any precision. It is, however, unlikely that costs will not change over time. In the case of Brazil, for example, there was significant variation in the costs of antiretrovirals (ARVs) between 2001 and 2005 (Nunn et al, 2007). In the past, the entry of China and India as producers of ARVs has significantly lowered AIDS treatment costs. ARV producers in countries such as Thailand, Brazil and South Africa, for example, rely heavily on raw materials sourced from these two countries (Grace, 2004). As evidenced by this very debate, the epidemic is not yet under control and the drive to expand access to affordable treatment is still underway.

The Clinton Health Access Initiative, for example, brings together pharmaceutical companies and governments to facilitate bulk orders of combination ARV therapies. Since 2003, the initiative has negotiated pricing agreements with forty formulations of ARVs, together with eight companies, with seventy countries having access to reduced prices for these medicines (Clinton Foundation 2010: online). Its work continues. UNITAID's Medicines Patent Pool initiative, established in July 2010, is doing similarly admirable work in securing ARV price reductions for developing countries (see UNITAID, 2010: online). As another example, on the 14th of December 2010 South Africa's Department of Health announced a new tender for ARV drugs that will see costs decline significantly in the country (TAC, 2010: online). Such examples are illustrative of how substantial price reductions can be achieved through better coordination and bargaining activities - without compromising the incentive to produce drugs. There seems to be no reason to believe that the market for ARVs has reached any kind of stable price equilibrium. This is especially so since ART represents a lifelong commitment to treatment; since it preserves life, increased rollout is only going to provide bigger and bigger markets.

Bongaarts and Over, however, assume that "the effects of greater competition have largely been exhausted for the last generation of first-line drugs. The next generation will cost more because they are still under patent" (2010: 177). This point was also made by Grace (2004). Perhaps this is true. There still, however, seem to be ways of decreasing costs related to this

last generation of drugs. Mozambique has just unveiled plans to build the first public factory for ARVs in Africa, which is set to begin producing its own pills by 2012 (Timeslive, 2010: online). Regardless of whether drug prices will rise or fall, the point is that they will change. AIDSCost cannot afford to ignore this.

The following changes are recommended:

- An option to discount or inflate prices should be added. Price changes would have perhaps the most obvious and significant effect on the future cost-effectiveness of ART. Gauging the effects of different pricing assumptions, thus, is pivotal.
- It would be helpful if users were allowed the option of inputting actual price data for individual countries and years rather than relying on assumed cost curves. Spectrum (another AIDS projection model), for instance, allows users to input national survey data through which modelled results are forced (Stover, 2004). Even a few actual numbers would increase the precision of the estimates. Further, without this option no use can be made of future advances in ARV costing and data collection.

Incidence assumptions

AIDSCost assumes that incidence in each year is some constant multiple of incidence in the previous year. The default value for *incmult* is 0.95, or a 5% decline in incidence each year. This, however, completely neglects any effect that ART might have on prevention. Much evidence has been presented in support of the proposition that high ART coverage rates reduce HIV incidence – see, for example, De Cock et al (2009), Castilla et al (2005), Reynolds et al (2009), Janssen et al (2001) and Montaner et al (2006). Mathematical modelling – by Blower and Farmer (2003), for example – has added further weight to this proposition. In Brazil, between 2000 and 2001, widely available ART led to a 58% decline in new cases of HIV (Blower and Farmer, 2003); Granich et al (2009), meanwhile, posit that universal ART coverage in Sub-Saharan Africa would reduce incidence by 95%. In May of 2011, the United States International Institutes of Health announced the results of a trial ('HPTN 052') that "show[s] antiretroviral therapy to be 96% effective in reducing HIV transmission in couples where one partner has HIV [more than 1700 such couples were involved in the trial]" (UNAIDS, 2011: online).

While expanding ART coverage keeps people alive longer, thereby increasing HIV prevalence, treatment decreases viral load and thus renders each individual significantly less infectious. De Cock et al give a succinct summary of the logic:

> "Transmission only occurs from infected persons who are numerically far fewer than HIV-negative susceptible persons; viral load is the greatest risk factor for all modes of transmission; ART [Antiretroviral Treatment] lowers viral load; prevention of mother-to-child transmission offers proof of concept; and there is observational evidence of reduced transmission from discordant heterosexual couples when the index partner is on ART" (2009: 488).

Large-scale behavioural disinhibition – ie. when those on ART engage in more risky sexual behaviour because they perceive themselves to be less infectious – could counteract this effect. Crepaz et al (2004), however, conducted a meta-analysis of the literature on the subject during the period 1996-2003 and found no evidence to suggest that people receiving Highly Active Antiretroviral Therapy (HAART) exhibited an increase in sexually risky behaviour. Kennedy et al (2007), too, conducted a review of the relevant literature during the period 1990-2006 and, similarly, found no evidence that ART is associated with sexually risky behaviour in developing countries. Though there is certainly space for more work in this area – Kennedy et al found only three primary articles that met their criteria – there is as yet little reason to believe that ART is firmly associated with behavioural disinhibition. Another issue is that the preventative effects of ART may depend on high and sustainable levels of coverage. However, an assumption of *universal ART coverage* in AIDSCost's defaults *still* delivers the same decline in HIV incidence of 5% each year. In light of the various pieces of research available on the relationship between ART and HIV incidence, the exclusion of any kind of dynamically estimated incidence variable represents a sizeable error. It is recommended that such dynamism is included.

Death rates vs. failure rates

The AIDSCost manual gives a rather confusing explanation of *adrate2*. Initially, *adrate2* is described as "the rate at which people fail first-line therapy and therefore become eligible for second-line therapy" (2009: 35). When the model is run, however, the definition for *adrate2* is "ART death rate during subsequent years on 1st line". To resolve this, consider the equation for post-first-year-first-line therapy (McCarthy and Over, 2009: 35):

(1)

$$\Delta a2 = \big((1 - \boldsymbol{adrate}) * a1\big) - (\boldsymbol{adrate2} * a2))$$

The second term, meanwhile, is decomposed thus:

(2)

$$\boldsymbol{adrate2} * a2 = (\boldsymbol{adrate2} * (1 - cvrg2) * a2) + (\boldsymbol{adrate2} * cvrg2 * a2)$$

Equation (2), using the first definition, merely states that the number of those from the post-first-year-first-line ART group needing second-line ART is made up of those needy receiving second-line ART and those needy not receiving second-line ART. This makes sense. A quick look at these equations will confirm that *adrate2* does not make sense if read as a straightforward death rate. If it denoted such a rate, equation (1) would state that changes to *a2* were made up of all those surviving first-year-first-line ART minus all those that died in *a2*. If death were the only outflow from *a2*, however, no one would move to second-line therapy. Patients, it seems, first fail post-first-year-first-line therapy and *then* either move on to second-line therapy or die. Therefore, as long as *cvrg2* is positive the number of patients that die will always be less than the number of those that fail post-first-year-first-line therapy, since the latter includes the former. This is not a trivial error, as the incorrect definition is the one presented in both the model interface and model printout. Since death rates and failure rates can be very different, users are likely to both misuse and misread AIDSCost. It is recommended that this inaccuracy be addressed.

3.3 - Comparing AIDSCost to ASSA2003

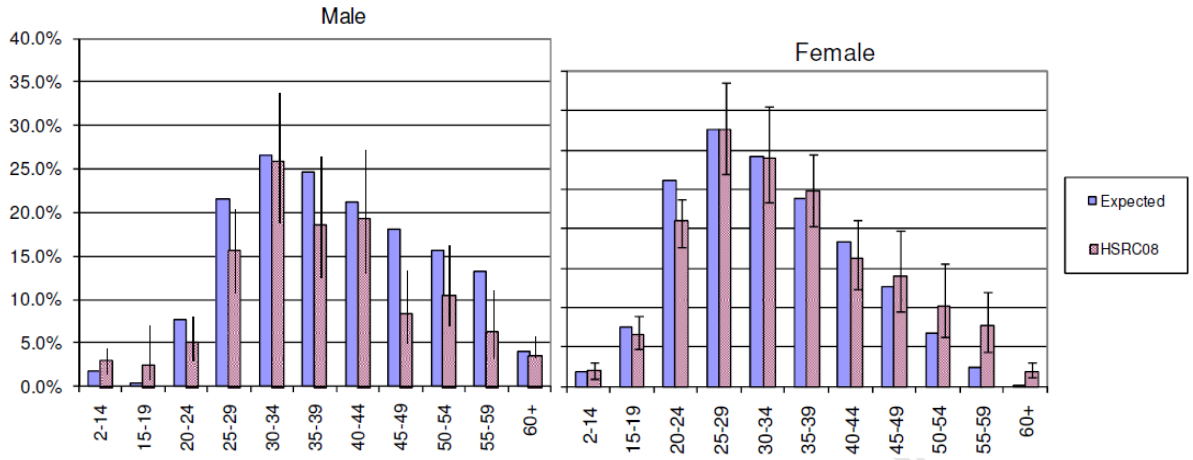
This section compares AIDSCost's outputs with those of the ASSA2003 model for South Africa. ASSA2003 is an epidemiological model of the South African HIV/AIDS epidemic developed by the Actuarial Society of South Africa (ASSA) which can be used to project the course of the epidemic with and without ART. It was released in 2006 but, because it used HIV prevalence data from Antenatal clinics up until 2003, it is known as ASSA2003. The model makes use of a substantial amount of demographic data and has been calibrated to fit actual death rates by age, race and gender (see Nattrass, 2007). As discussed below, its projections are consistent with national HIV surveys of population-level HIV prevalence and it is hence seen as a very reliable model of the South African AIDS epidemic. Comparing the demographic projections of AIDSCost with those of ASSA2003 for South Africa is thus an appropriate test of the model's reliability.

Methodology

In the tables below, the outputs of the AIDSCost model for South Africa for the period 2007-2016 are compared to those of ASSA2003 (henceforth ASSA) for the same period. Since AIDSCost allows for the adjustment of only a few parameters, and owing to discrepancies between the models, it is not possible to estimate both using precisely the same assumptions. ASSA, for example, does not differentiate between first- and second-line treatment, while AIDSCost does not allow for the specification of a target level for ART coverage (as previously discussed) as ASSA does. The models, thus, are not directly comparable. This, of course, does not change the fact that both will be used, and have been used, to leverage competing arguments that are of vital importance for policy-making (see, for example, Over, 2008 and Nattrass and Geffen, 2005). So even though the models' infrastructure is not directly comparable, their outputs – which are broadly the same – are.

Considering the South African case allows for the use of ASSA as a reliable benchmark – as it was designed to apply only to South Africa, it uses much more specific data than AIDSCost. The model's estimates correlate well with actual survey data. The 2008 Human Sciences Research Council household prevalence survey, for example, follows the ASSA projections quite closely:

Figure 3.6 – ASSA2003 estimates for HIV prevalence in 2008 vs. HSRC's national survey of HIV prevalence in 2008



Source: Dorrington (2009: 632)

This point is echoed by Rehle and Shisana (2009: 634). This consistency was also in evidence after the 2006 HSRC survey (see Gallo et al, 2006 and ASSA, 2006, for example). Kibel et al, meanwhile, go so far as to refer to the model as "the gold standard" (2010:132). While, as with any model, there are issues – Dorrington (2009: 631), for example, mentions that the model may slightly overestimate male prevalence – it has proven itself robust in estimating the aggregated outputs that AIDSCost provides. Insofar as AIDSCost's country-specific outputs may be viewed as a proxy for its overall quality, and insofar as the assumption regarding ASSA's reliability holds, large discrepancies with ASSA can be seen as indicators of AIDSCost's flaws.

The National Strategic Plan for HIV/AIDS calls for the provision of 'adequate treatment' (which includes ART) to 80% of all those that need it by 2011 (Department of Health, 2007: 14). With half the year gone, however, it seems unlikely that this target will be met. Thus, a target of 80% coverage, to be reached by 2012, is specified for both models. This is still rather optimistic, but does capture the thrust of actual policy in South Africa. Furthermore, it is prudent not to leave the analysis open to the charge of underestimating costs. AIDSCost is run using all default assumptions except for those regarding target coverage for second-line treatment, which is specified as 80% (*cvrg2)* to be reached by 2012 (target year). As mentioned, different *uptake* values were experimented with until the one that corresponded to 80% overall coverage in 2012 was retrieved. Though the uncertainty adds a certain edge to

the unspectacular business of using Stata, one imagines that the fun would disappear after a very short while. The correct value turned out to be 0.6, or 60% *uptake* each year. The following results are of interest (the full results are included in Appendix 2.1):

Table 3.1: AIDSCost cost projections 2007-2016

	% overall ART coverage	% 2nd line coverage	# 1st year 1st line	# Subsequent years 1st line ART	# 2nd line ART	Cost 1st line treatment (000s 2006 US$)	Cost 2nd line treatment (000s 2006 US$)
2007	27	5	153,333	281,111	25,555	316,709	135,032
2008	60	17.5	744,001	403,266	27,267	836,357	144,078
2009	70	30	472,320	1,034,416	31,834	1,098,410	168,210
2010	75	42.5	395,778	1,403,958	49,100	1,312,007	259,444
2011	78	55	372,498	1,692,127	79,497	1,505,111	420,062
2012	80	80	362,978	1,948,515	132,850	1,685,078	701,979
2013	82	80	356,352	2,186,366	193,874	1,853,641	1,024,430
2014	84	80	349,747	2,408,937	261,899	2,011,080	1,383,874
2015	86	80	342,507	2,616,860	336,366	2,157,378	1,777,357
2016	87	80	334,576	2,810,166	416,741	2,292,516	2,202,059

Note the ever-increasing overall ART coverage.

ASSA is then used to generate projections of three different scenarios:

1. **ASSA 1** – 80% ART coverage reached by 2012. This scenario most closely resembles AIDSCost's own assumptions regarding ART. As noted, it is not possible to align all of the models' assumptions. ASSA does, however, provide great flexibility and transparency with regard to its ART assumptions, and allows for the input of custom ART coverage levels – in this case, those given by AIDSCost. Since AIDSCost does not allow for investigation of coverage rates before 2007 (where coverage was 27%), and since the analysis seeks to mimic the model's assumptions as closely as possible, ASSA is tweaked thus:

Table 3.2: Tweaking ASSA2003 to fit AIDSCost

	Original ART coverage assumptions	Tweaked		Original ART coverage assumptions	Tweaked
2000	2	2	**2009**	No default	70
2001	4	4	**2010**	No default	75
2002	6	6	**2011**	No default	78
2003	8	8	**2012**	No default	80
2004	23	23	**2013**	No default	82
2005	30	27	**2014**	No default	84
2006	37	27	**2015**	No default	86
2007	44	27	**2016**	No default	87
2008	50	60			

It may seem puzzling that coverage was kept at 27% for 2005, 2006 and 2007. This has to do with the fact that AIDSCost, as mentioned, only gives information on coverage from 2007. Since it is important to mimic AIDSCost's assumptions, this forces a guess at pre-2007 coverage rates. Now, one could have used ASSA's defaults up until 2007 and then switched over to AIDSCost's. ASSA's defaults, however, already exceed 27% total coverage in 2005, with coverage being 30% and 37% in 2005 and 2006 respectively (the ASSA modeller's best estimate of what ART coverage was actually likely to be in those years). Since it is better to avoid the unrealistic assumption that coverage will drop from 37% in 2006 to 27% in 2007 (when the switch is made to AIDSCost's assumptions), coverage is kept constant at 27% for 2005 and 2006. There is little reason to replace ASSA's pre-2005 coverage with some other imagined figures. Further, alternative options available (say, 24% in 2005 and 26% in 2006) do not vary much from those which have been chosen. This seems an imperfect but plausible estimation of AIDSCost's own pre-2007 coverage rates. Beyond 2006, AIDSCost's exact coverage figures are used (using a 0.6 *uptake* value and 2012 *uptake* target).

2. **ASSA 2** – 80% target reached by 2012, gradual scale-up. This scenario employs AIDSCost's assumptions of ART coverage up to 2007 – as above - but then assumes gradual linear rollout of ART until 2012 (Appendix 2.2).

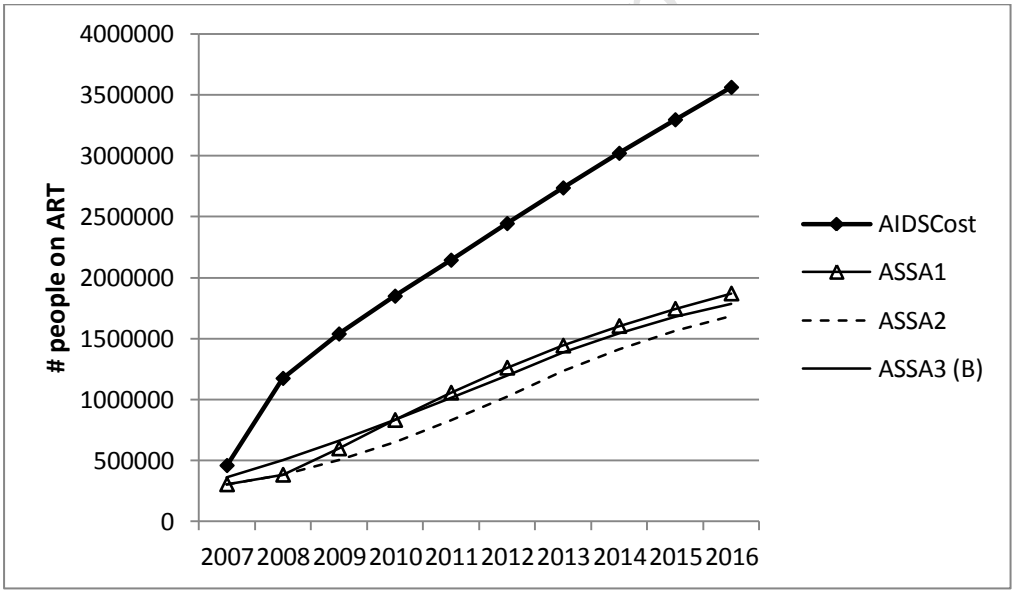
3. **ASSA 3 (baseline)** – Employs ASSA's default ART assumptions, but assumes gradual linear scaling up of ART from 50% in 2008 to a target of 80% in 2012, after which its level remains constant. This scenario arguably represents the best benchmark against which to measure the quality of AIDSCost, as it most clearly demonstrates the full strength of ASSA to model South African reality (Appendix 2.2).

Finally, AIDSCost's results are compared to all three ASSA scenarios.

Results

While the full results of these comparisons are included in Appendix 2.3, the following findings are of interest:

Figure 3.7: Number on ART



Firstly, AIDSCost seems to posit an unrealistically high number of people on ART for almost all periods under consideration and compared to all ASSA scenarios. Adam and Johnson (2009), for example, estimate that 568 000 individuals were enrolled in ART in 2008 (ASSA's baseline projection was 504 548), whereas AIDSCost estimates this figure to be 1 174 534.

Figure 3.8: HIV positive, not AIDS sick

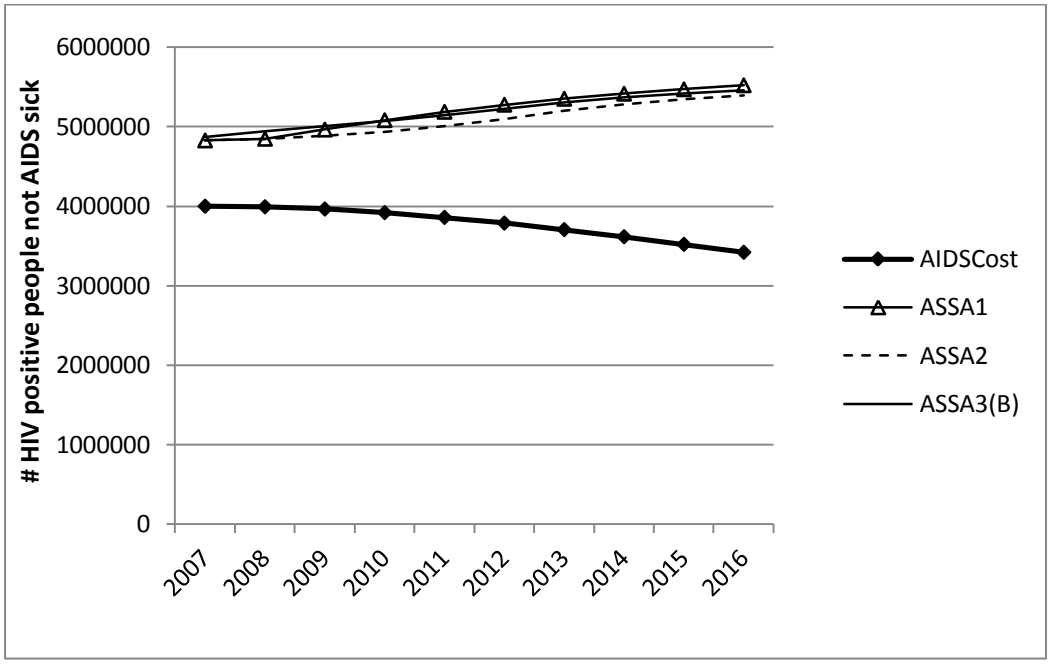
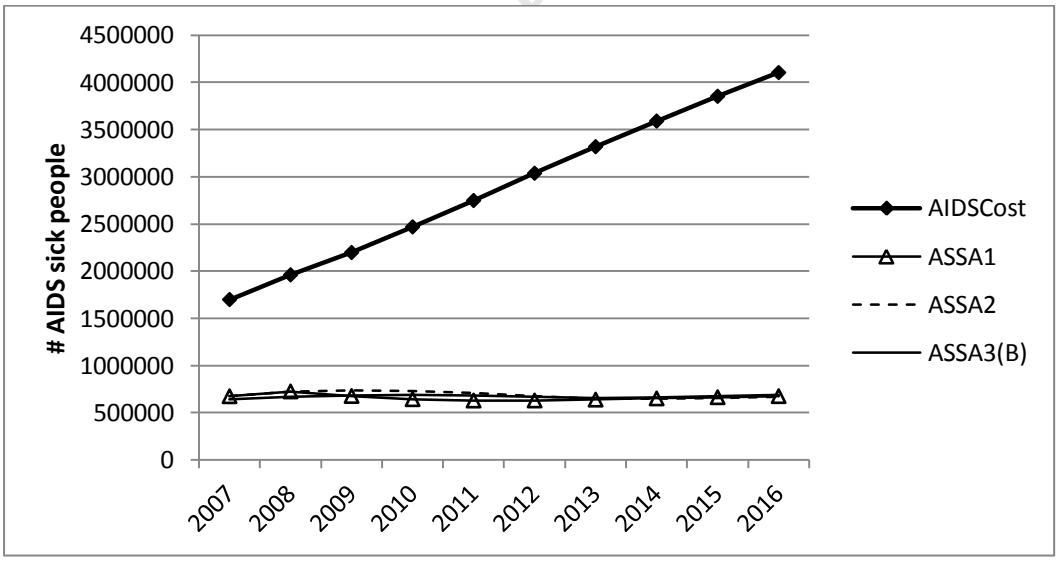
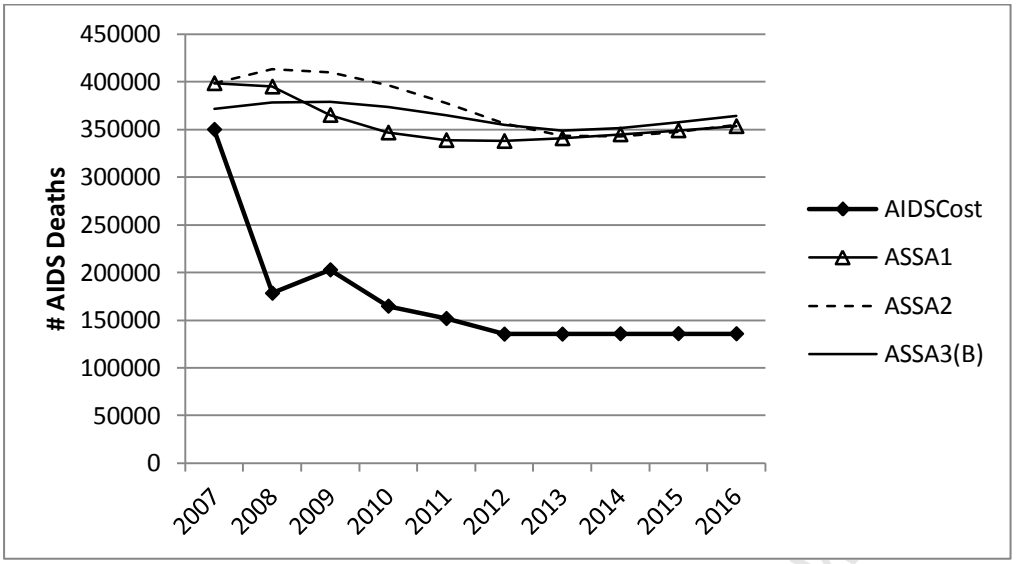


Figure 3.9: AIDS sick



Secondly, AIDSCost posits that an extremely high proportion of those living with HIV are AIDS sick – ie. requiring ART. ASSA's estimates for 2007 and 2008 are 675 431 and 726 477 respectively. AIDSCost's estimates for 2007 and 2008, by contrast, are 1 700 000 and 1 961 734 respectively. It is these assumptions that feed into the extremely high numbers on ART we have just seen.

Figure 3.10: AIDS Deaths



Thirdly, AIDSCost seems to take a very optimistic picture of AIDS deaths, assuming them to decline drastically. This is perhaps an indicator of its default death rates – 13% for first-year-first-line ART, 4% for those that fail 'subsequent years' first-line ART and do not receive second-line treatment, and 1% for second-line ART. Cleary et al (2006), referring to a study undertaken in the Western Cape of South Africa, cite an 86.9% survival rate after 12 months of ART (irrespective of drug regimen), which seems more or less in line with AIDSCost's assumption. Between 12 and 24 months, however, this rate drops to 83.4%, while between 24 and 36 months it drops to 79.5% and between 36 and 48 months it drops to 76.2%. In other words, relative to these numbers, AIDSCost does not assume sufficient numbers of people die. Even assuming that its second-line death rates are plausible (Cleary et al's study included mostly first-line ART), those for first-line certainly don't seem to be. As one can see, even controlling for the drastic increase in treatment coverage between 2007 and 2008 (**ASSA1**), ASSA's death estimates are far above AIDSCost's. To again refer to costs, underestimating the tally of the dead will overestimate the costs of treating the living.

The spike in the curve is peculiar. Using the equation for total deaths given by McCarthy and Over (2009: 36), manual calculations were conducted and indicated that total deaths in any given year are a function of the previous year's treatment figures. If the second-line death rate is 1% and in 2007 5000 people are on second-line treatment, total second-line deaths will be 50 in 2008. It seems that the kink is a result of the massive amount of people flowing into their first year of first-line therapy in 2008. Death rates in this group are high (13%) and, as

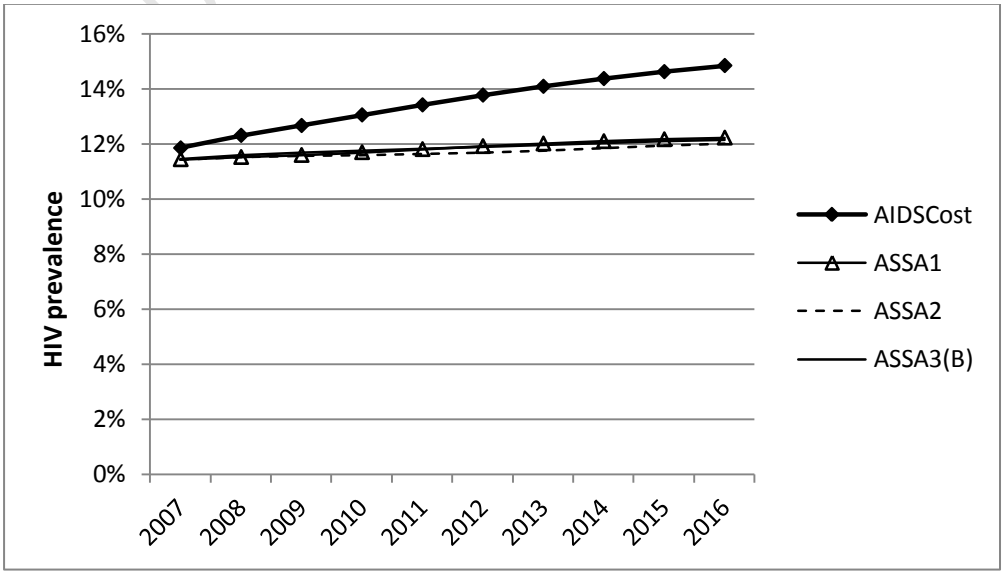
their deaths are recorded in 2009, deaths are temporarily boosted in this year. It may seem counterintuitive that putting more people on ART could increase deaths, especially given the 30% death rate among those not receiving treatment. It must be remembered, however, that 60% of one year's 'unmet need' group are placed on treatment the next year. This effectively takes the death rate of this group to 12% (only 40% do not receive treatment, while only 30% of these die). In 2007, thus, there were roughly 1.2 million people in the 'unmet need' group, but only 12% of these died in 2008. In 2008, however, there were 744 000 people in their first year of first-line therapy (as opposed to 153 000 in 2007), 13% of whom died in 2009.

Table 3.3: Deaths by treatment regimen, 2008 and 2009

	Without treatment	1st year 1st line	Subsequent 1st line	2nd line	Total
2008	148,800	19,933	9,277	256	178,266
2009	94,464	96,720	11,291	273	202,748

It is also worth noting that the model's outputs incorrectly list the second-line coverage for 2007 as 0%, when the death calculations clearly take it to be 0.175%. Note that the 2008 figure is also 0.175%, which is at odds with the otherwise constantly increasing levels of second-line coverage.

Figure 3.11: Prevalence (%)



Lastly, AIDSCost's estimates regarding AIDS deaths affect HIV prevalence rates. AIDSCost's underestimate of AIDS deaths implies that more people each year are available to be classified as HIV positive.

3.4 – Cost implications

The difference in dollars

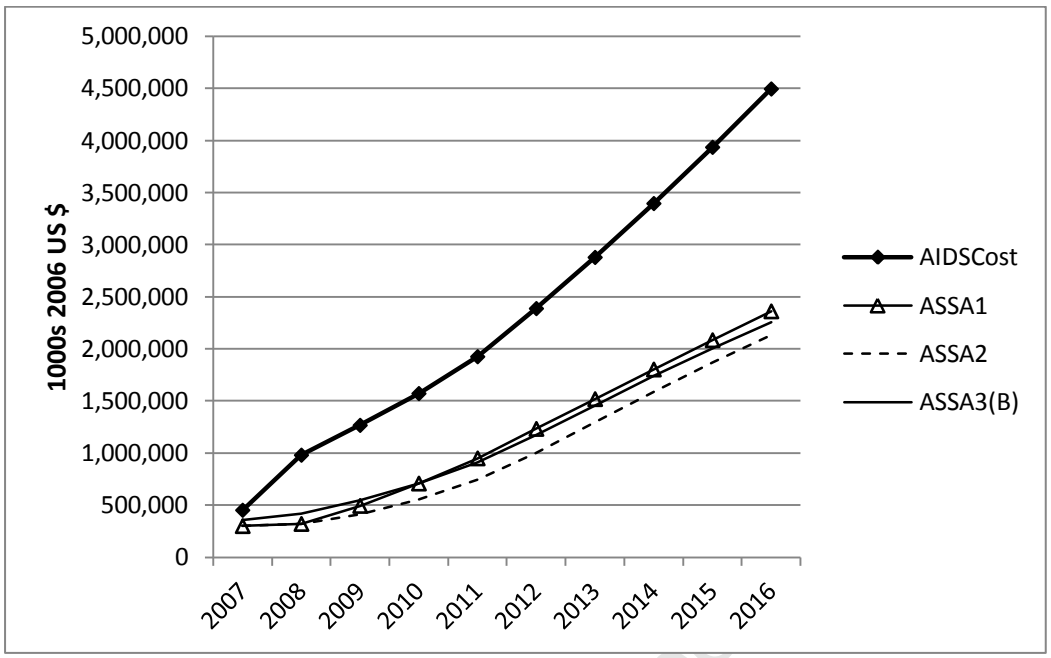
The above gives us an idea of the discrepancies between the models' outputs, but how will these affect cost projections? First, let us consider what happens when AIDSCost does what it was designed to do; namely, assign dollars to the disease. Its cost assumptions for South Africa are as follows:

Table 3.4: AIDSCost per patient per annum costs for South Africa (1000s 2006 US$)

	1st line	2nd line
ARV costs	245	4800
Non-ARV costs	484	484
Total	**729**	**5284**

As data on second-line treatment is not presented in ASSA, AIDSCost's outputs are used to calculate ratios between first and second-line treatment in each year (Appendix 2.3) and multiply them by ASSA's annual estimates of the number of those on ART. Again, this is done to mimic AIDSCost's own assumptions as closely as possible. Next, the above costing assumption is applied to the ASSA scenarios. The following results are generated:

Figure 3.12: Projected ART costs for South Africa (1), 2007-2016 (1000s 2006 US$)



	Year	AIDSCost	ASSA1	ASSA2	ASSA3(B)
Cumulative costs	2016	23,284,823	11,769,091	10,211,377	11,563,967
Percentage of AC	2016	100%	50.54%	43.85%	49.66%
Cumulative costs	2012	8,582,484	4,004,145	3,328,950	4,107,696
Percentage of AC	2012	100%	46.65%	38.79%	47.86%

As can be seen, the ASSA baseline projection estimates the costs of expanding ART in South Africa to 80% by 2012 to be approximately half those estimated by AIDSCost at the end of 2016. The exaggeration is even more marked at the end of 2012. Note that even ASSA1, the scenario that most closely mimics AIDSCost's assumptions, estimates costs that are far lower than those put forward by AIDSCost.

Next, an alternative set of costs is considered. These are based on Cleary et al's extensive four-year study of 1729 patients in the Western Cape area of Khayelithsa (2006). The study presents quarterly costs per Markov state (differentiated by treatment regimen and stage of disease) that include clinic visits, days in hospital, ARV costs, Tuberculosis treatment and safety and monitoring laboratory costs (2006: 8). Fortunately, these costs are also presented in 2006 US Dollars. Cleary et al go into some detail regarding the different costs associated with patients of varying CD4 counts. However, as neither ASSA nor AIDSCost offer any means of differentiating beyond the first-line/second-line split it is not possible to utilise this

detail. Instead, costs are averaged across all first-line and second-line patients to arrive at the following annual estimates (AIDSCost's estimates are included for comparison):

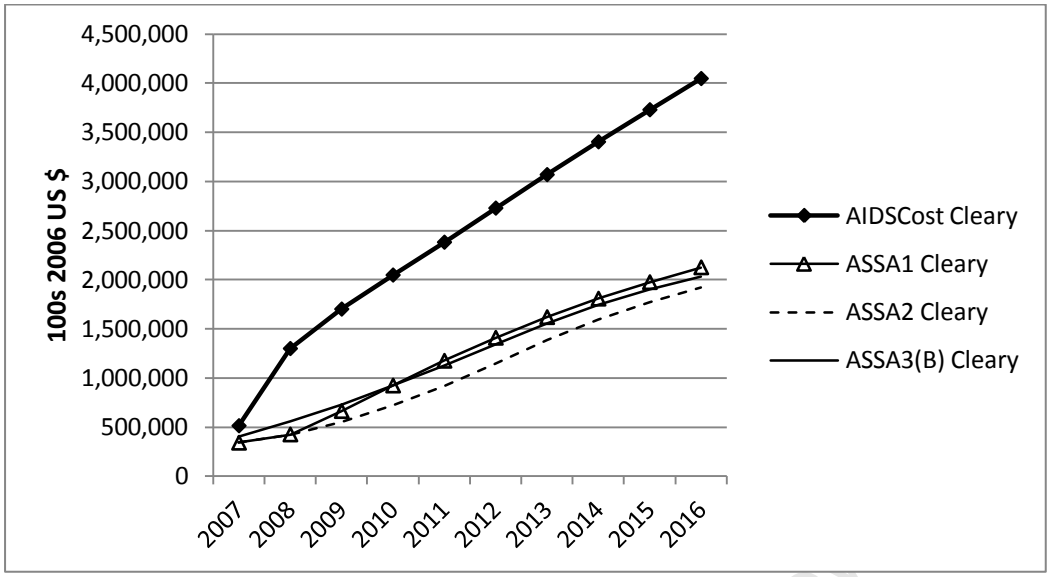
Table 3.5: Cleary et al - per patient per annum costs ('000s 2006 US$)

	Cleary et al		AIDSCost	
	1st line	**2nd line**	**1st line**	**2nd line**
ARV costs	290.8	952	245	4800
Non-ARV costs	808.2	468	484	484
Total	**1099**	**1420**	**729**	**5284**

AIDSCost's ARV costs for first-line treatment seem roughly in line with Cleary et al's, as do second-line non-ARV costs. Second-line ARV costs, however, seem grossly exaggerated relative to Cleary et al's, while first-line non-ARV costs seem heavily underestimated. The latter assumption seems to support the comments made in Section 3.2; namely, that non-ARV costs are likely to be higher than AIDSCost assumes in developing countries. Tuberculosis may have a significant role to play in this. People infected with the HIV/AIDS epidemic are at greater risk of tuberculosis (see, for example, Arbulu et al, 1993; Chaisson et al, 1987; Corbett et al, 2003; and Goodman, 1995) and, in countries where health resources are strained, the two diseases may develop alongside one another and add to treatment costs.

When these costing assumptions are applied to the models' outputs, the following results are obtained:

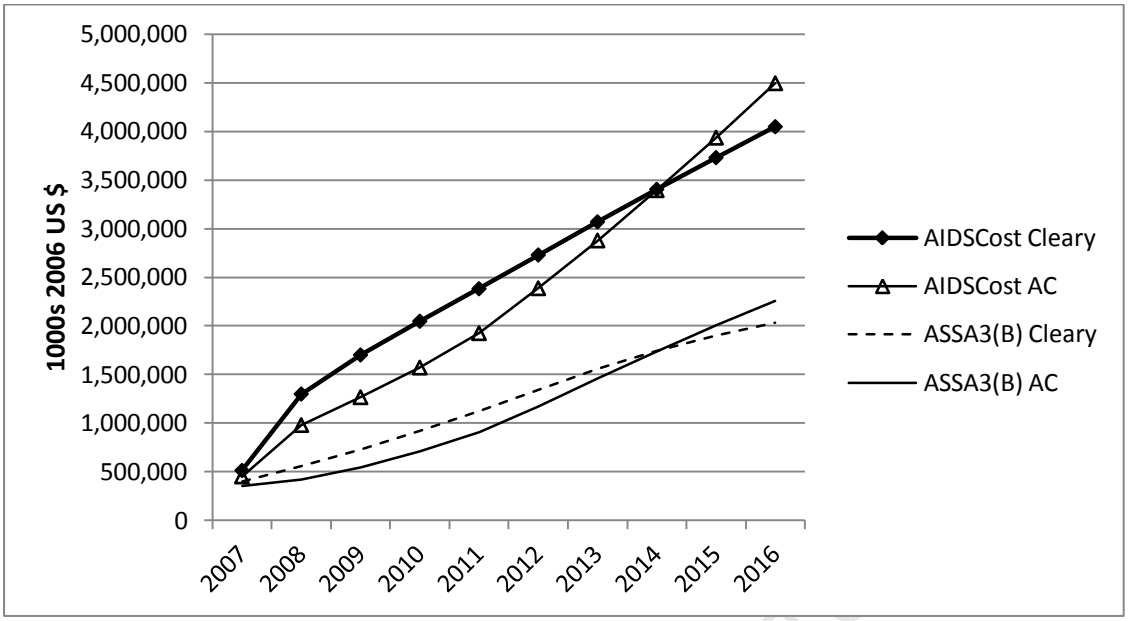
Figure 3.13: Projected ART costs for South Africa (2), 2007-2016 (1000s 2006 US Dollars)



	Year	AIDSCost Cleary	ASSA1 Cleary	ASSA2 Cleary	ASSA3(B) Cleary
Cumulative costs	2016	24,924,199	12,463,001	10,767,360	12,307,560
Percentage of AC Cleary	2016	100%	50%	43.20%	49.38%
Percentage of AC	2016	107.04%	53.52%	46.24%	52.86%
Cumulative costs	2012	10,672,933	4,935,362	4,103,167	5,078,061
Percentage of AC Cleary	2012	100%	46.24%	38.44%	47.58%
Percentage of AC	2012	124.36%	57.51%	47.81%	59.17%

Again, AIDSCost overestimates cumulative costs by approximately 100% in 2016 and slightly more in 2012. The 'Percentage of AC' row denotes each scenario's costs as a percentage of AIDSCost's original cost estimates. It is interesting to note that Cleary et al's costing assumptions imply greater cumulative costs than those of AIDSCost. This has to do with the higher proportion of those on first-line treatment – Cleary et al's first-line costs are much greater than AIDSCost's. Considering cumulative costs, however, obscures important dynamics in the projections. Consider the following figure, which shows the AIDSCost and ASSA baseline cost projections for both sets of cost assumptions ('AC' being AIDSCost's, 'Cleary' being Cleary et al's).

Figure 3.14: Total ART costs, Cleary et al costs vs. AIDSCost costs (1000s 2006 US$)



One can see that, as time progresses and the proportion of those on second-line treatment grows, AIDSCost's massive second-line ARV costs push up its estimates.

Implications for Over's arguments

In a 2008 paper, Mead Over used the AIDSCost model to argue that US-funded global AIDS treatment "could grow to as much as $12 billion a year by 2016 – more than half of what the United States spent on total overseas development assistance in 2006" (2008: 1). The latter figure is based on an 'aggressive' *uptake* rate of 95%. A figure of $4.5 billion applies to the historical *uptake* rate of PEPFAR (President's Emergency Plan for AIDS Relief), 17.9%. Over argues that, should treatment continue to expand, more and more of this funding will go toward so-called 'entitlement spending', which refers to spending on those already receiving ART. Since taking a person off ART is tantamount to unplugging them from life support, the US would risk severe damage to its reputation by cutting back on such spending. In order to avoiding saddling itself with ballooning commitments it can't get rid of, to put it crudely, the US should shift focus away from treatment and toward prevention. It is not the focus of this paper to critique the notion of 'entitlement', and nor is it this author's place to voice concerns about the trivialisation of human life into the language of political expediency. It is, however, of concern that the projected magnitude of these entitlements is based on all of AIDSCost's defaults. Considering the discussion above, it is doubtful whether the numbers Over presents

are reliable. This author is of the firm opinion that, in scenarios requiring careful examination of costs, AIDSCost is not to be trusted.

3.5 - Conclusion

Forming a clear idea of the future costs of ART represents the first step towards answering the vital (literally) question of the cost-effectiveness of ART. McCarthy and Over's attempts to model these costs, thus, are laudable. One would do well, however, to note that misinformation is often worse than no information at all, and that every model pretending its fair share of reality should be approached with similarly fair shares of critique and testing. Its authors' intentions notwithstanding, the preceding analysis has shown that there is good reason to believe that AIDSCost, in its current incarnation, is not a sufficiently reliable yardstick against which to measure policy. It produces outputs that reflect highly questionable assumptions, each of which feeds into multiple parameters and compounds problems of cost overestimation. In the case discussed, that of South Africa, AIDSCost showed severe discrepancies with the country's leading AIDS projection model, ASSA2003, its outputs implying an overestimation of costs in excess of 100%. The models do not merely disagree; they do not seem even to speak the same language. This is no idiosyncrasy of pricing. While it is true that South Africa is one among many countries, the flaws in the model have mostly to do with the way the number of those who need and are on treatment are calculated, not with country-specific cost assumptions. Until such flaws are attended to, the debate on which costs to use in the model will remain peripheral. AIDSCost needs to tinker on its spine before it begins choosing appendages.

As noted, McCarthy and Over have solicited comparisons with other models, ASSA2003 among them. This is constructive and, through the preceding critique, this paper has attempted to provide workable suggestions for the improvement of their model. It is curious, however, that Over made use of the model (in 2008) before these solicitations were made (in 2009). It is this author's opinion that, given the true gravity of the millions being weighed, using the model to support claims regarding the unmanageability of ART without its first being properly tested is both careless and irresponsible. Further research is required to investigate whether AIDSCost performs better in countries other than South Africa. Until then, however, its numbers regarding the ballooning 'entitlement' will contain more than a little hot air.

Conclusion

Talk, apparently, is cheap. Some forms of it, however, can be very expensive if left to wander into influential ears. This is especially so when such talk brandishes numbers that supposedly represent bits of truths about the world. There is a lot of talk at the moment about whether AIDS funding should be cut back or increased, urged along its current path or dramatically reengineered. Many people's lives literally depend on the funding AIDS receives; now more than ever, therefore, it is important that we obtain as much clarity as possible on the issues involved. The exercises conducted have contributed to the clarification of two very topical issues in this debate: proportionality and AIDS cost modeling. As we have seen, the precise implications of a country's standing in terms of proportionality are complex and largely unclear. However, there is now, for the first time, a clear picture of where the world lies in terms of proportionality. Debates will be ongoing about whether this picture deserves to hang prominently on the walls of the AIDS funding debate, but at least it has been put into focus. Considerable value lies within the raw tables generated in Chapter 1, quite apart from the limited analysis conducted in this paper. The availability of more recent DALY and health expenditure data will doubtless call for new investigation, but this is likely to take some time. Final 2008 estimates for the latter were only released in March 2011, after all, and the DALY update currently underway involves complex calculation and data collection. In the time being, the results presented above can provide guidance as to where diseases besides AIDS are likely to be badly underfunded. More detailed investigation is urgently required to see which of these is in most need in each country.

The focus on AIDSCost sheds revealing light on certain strong arguments made by one of its co-creators, Mead Over. Such arguments have been put forward quite brazenly; if listened to, the already dim prospects of the millions awaiting AIDS treatment will darken. Fortunately, there does not seem to be any reason why they *should* be listened to. Models, even if understood to be partial and imprecise, need to deliver results that are at least vaguely in line with reality – or our best guess of it - in order for them to be useful. AIDSCost fails to tow even this vague line, and it is thus this author's contention that it should be withdrawn from the public arena until it has been drastically redesigned. Such worrying findings should remind those interested in the future course of the epidemic to approach AIDS models with a healthy degree of skepticism. Much like their human counterparts, such models have

attractive facades. But regardless of how sophisticated, popular or easy-to-use they are, their interior mechanisms need to be thoroughly interrogated before they can be trusted. It does not seem that we can trust the AIDSCost model. Work should be ongoing to see if we should trust others in existence, such as Spectrum, as well as those that may appear in future.

Appendix 1.1 - Background data: AIDS spending (% total health spending) vs. AIDS DALYs (% all DALYs)

Note on regional and world totals for OECD and AIDDATA: (1) include those countries for which only UNAIDS data is available, (2) include regional figures not specified by country, eg. 'Sub-Saharan Africa, regional'
HIV population totals for World and Sub-Saharan Africa taken directly from UNAIDS 2010 Global Epidemic Update

	AIDS spending, public and international sources (millions 2008 US$)			HIV + population	HIV SPEND% VS DALY%				Overspend, Y/N?			Health expenditure (millions 2008 US$)			DALYs	
	UNAIDS	OECD	AIDDATA		UNAIDS	OECD	AIDDATA	%HIV all DALYs	U	O	A	GEN GOV	Non-profit	TOTAL	All DALYs (000s)	HIV DALYs (000s)
WORLD	**10534.34**	**10791.64**	**10824.71**	**33400**	**1.16**	**1.19**	**1.19**	**3.46**								
AFRICA	**4414.19**	**4567.76**	**4594.60**		11.94	12.35	12.42	10.49	**Y**	**Y**	**Y**					
SUB SAHARAN AFRICA	**4390.28**	**4512.64**	**4539.18**	**22400**	**18.39**	**18.90**	**19.01**	**11.32**	**Y**	**Y**	**Y**					
Angola	31.77	56.10	56.12	190	1.40	2.48	2.48	2.47	**N**	**Y**	**Y**	2264.58	0.00	2264.58	12469.91	308.31
Benin	20.77	17.52		58	14.42	12.16		2.99	**Y**	**Y**		144.05	0.01	144.06	3530.51	105.44
Botswana	339.87	460.89		310	37.62	51.01		50.50	**N**	**Y**		796.10	107.37	903.47	893.87	451.41
Burkina Faso	48.01	48.18		110	14.29	14.34		3.43	**Y**	**Y**		334.53	1.50	336.03	7402.20	254.13
Burundi	26.06	25.41	25.60	180	29.48	28.75	28.96	7.28	**Y**	**Y**	**Y**	60.40	28.00	88.41	4587.63	334.08
Cameroon	39.97	24.75	26.05	590	13.74	8.51	8.95	14.45	**N**	**N**	**N**	281.42	9.54	290.97	7969.03	1151.38
Cape Verde	2.57	1.28			4.63	2.31		0.22	**Y**	**Y**		55.51	0.00	55.51	85.16	0.18
Central African Republic	20.28	19.37		130	55.70	53.20		13.33	**Y**	**Y**		33.79	2.63	36.41	2273.33	303.06
Chad	13.90	8.87		200	4.97	3.18		5.90	**N**	**N**		271.24	8.10	279.34	5889.20	347.66
Congo	11.63	8.89		76	7.95	6.07		16.30	**N**	**N**		146.35	0.00	146.35	1296.76	211.35
Congo Dem. Rep.	85.96	71.46	72.44	315	17.68	14.70	14.90	5.76	**Y**	**Y**	**Y**	463.92	22.26	486.18	37312.69	2149.07
Côte d'Ivoire	62.01			470	20.76			11.47	**Y**			237.43	61.20	298.63	11110.58	1274.05
Djibouti	3.22			14	6.19			9.21	**N**			52.04	0.00	52.04	280.00	25.78
Equatorial Guinea	2.83	3.77		18	1.02	1.36		7.32	**N**	**N**		277.09	0.00	277.09	267.08	19.55
Eritrea	14.46	17.80		25	68.11	83.87		5.02	**Y**	**Y**		21.23	0.00	21.23	1195.35	59.98
Gabon	11.85	12.77		45	7.10	7.65		20.20	**N**	**N**		166.91	0.00	166.91	400.22	80.83
Gambia The	4.99	3.43	3.49	15	15.62	10.74	10.94	2.37	**Y**	**Y**	**Y**	21.63	10.28	31.92	566.03	13.43

	AIDS spending, public and international sources (millions 2008 US$)			HIV positive population	HIV SPEND% VS DALY%				Overspend, Y/N?			Health expenditure (millions 2008 US$)			DALYs	
	UNAIDS	OECD	AIDDATA		UNAIDS	OECD	AIDDATA	%HIV all DALYs	U	O	A	GEN GOV	Non-profit	TOTAL	All DALYs (000s)	HIV DALYs (000s)
Ghana	37.93	43.51		260	3.95	4.53		7.59	N	N		918.61	42.27	960.88	7530.46	571.63
Guinea	13.18	7.45		79	45.00	25.42		2.84	Y	Y		28.45	0.85	29.30	3929.56	111.56
Guinea-Bissau	3.65	2.47	3.87	21	22.32	15.12	23.71	3.01	Y	Y	Y	7.16	9.18	16.34	925.43	27.89
Kenya	659.87	393.66	399.77	1400	119.25	71.14	72.25	24.24	Y	Y	Y	466.42	86.91	553.33	14720.22	3567.46
Lesotho	81.31	81.70	82.16	280	87.84	88.26	88.75	56.81	Y	Y	Y	78.39	14.18	92.57	809.20	459.73
Madagascar	11.95	13.24	13.26	23	3.93	4.36	4.36	0.24	Y	Y	Y	291.57	12.32	303.88	6466.05	15.49
Malawi	106.72	153.27	154.03	910	53.16	76.35	76.73	24.58	Y	Y	Y	157.82	42.92	200.74	7574.92	1862.20
Mali	40.39	35.18	35.54	77	17.41	15.16	15.32	2.16	Y	Y	Y	231.98	0.00	231.98	7065.87	152.53
Mozambique	144.95	214.21	215.08	1300	36.04	53.25	53.47	22.44	Y	Y	Y	345.38	56.85	402.23	9655.50	2166.82
Niger	12.46	9.90	10.91	60	6.84	5.44	5.99	0.81	Y	Y	Y	181.44	0.71	182.15	9995.23	80.57
Nigeria	394.66	408.38	408.40	3200	9.67	10.01	10.01	6.26	Y	Y	Y	4072.75	8.73	4081.48	77690.31	4860.25
Rwanda	110.81	133.53	133.56	160	35.34	42.58	42.59	10.32	Y	Y	Y	211.10	102.47	313.57	5404.42	557.49
Sao Tome and Principe	0.09	0.75			0.99	7.93		0.09	Y	Y		5.69	3.70	9.39	50.67	0.04
Senegal	25.57	22.86	23.02	56	5.93	5.30	5.34	1.12	Y	Y	Y	419.13	12.11	431.24	4481.87	50.18
Seychelles	0.57	0.50			1.61	1.41		1.04	Y	Y		28.86	6.72	35.58	13.83	0.14
South Africa	1694.00	1746.09	1757.79	5600	17.91	18.46	18.58	40.72	N	N	N	9035.87	423.67	9459.54	20988.18	8545.40
Togo	15.37	7.75	7.79	120	25.08	12.66	12.71	9.16	Y	Y	Y	45.43	15.85	61.28	2539.88	232.74
Uganda	296.65	264.52	265.07	1100	46.94	41.85	41.94	18.72	Y	Y	Y	241.03	390.97	632.00	14145.83	2648.56
NORTH AFRICA	**23.91**	**22.95**	**22.95**		**0.18**	**0.18**	**0.18**	**0.23**	**N**	**N**	**N**					
Algeria	3.80	5.15		16	0.05	0.06		0.38	N	N		8037.24	2.42	8039.66	5215.39	19.75
Egypt	7.54	7.43		9.5	0.22	0.22		0.08	Y	Y		3345.88	7.17	3353.05	13317.61	10.76
Morocco	12.57	10.17		24	0.73	0.59		0.48	Y	Y		1714.58	0.00	1714.58	5030.63	24.05
AMERICA	1739.88	1779.05	1782.21		**1.11**	**1.13**	**1.13**	**1.57**	**N**	**N**	**N**					
NORTH/CENTRAL AMERICA	522.97	549.57	551.91		1.16	1.22	1.23	1.87	**N**	**N**	**N**					
Antigua and Barbuda	0.33	0.26			0.85	0.67		2.84	N	N		38.89	0.00	38.89	13.15	0.37
Bahamas	4.44			6.5	1.84			8.12	N			238.30	3.00	241.30	59.48	4.83
Costa Rica	19.88	19.09		9.4	1.05	1.01		0.85	Y	Y		1868.43	18.63	1887.07	532.44	4.52
Cuba	46.62	40.48	40.86	6.7	0.65	0.56	0.57	0.26	Y	Y	Y	7189.00	0.00	7189.00	1567.48	4.15
Dominica	0.18	0.03			1.26	0.22		3.13	N	N		14.06	0.00	14.06	10.91	0.34
Dominican Republic	23.42	30.52	32.29	56	2.03	2.65	2.80	5.91	N	N	N	963.69	188.25	1151.94	1986.41	117.35
El Salvador	39.23	34.82	34.84	33	4.94	4.39	4.39	3.56	Y	Y	Y	793.40	0.00	793.40	1240.71	44.14

	AIDS spending, public and international sources (millions 2008 US$)			HIV positive population	HIV SPEND% VS DALY%				Overspend, Y/N?			Health expenditure (millions 2008 US$)			DALYs	
	UNAIDS	OECD	AIDDATA		UNAIDS	OECD	AIDDATA	%HIV all DALYs	U	O	A	GEN GOV	Non-profit	TOTAL	All DALYs (000s)	HIV DALYs (000s)
Grenada	0.48	0.64			2.12	2.82		2.24	N	Y		22.19	0.59	22.78	19.77	0.44
Guatemala	51.35			59	5.32			2.25	Y			899.80	64.81	964.61	2730.49	61.30
Honduras	24.32	26.37		39	4.57	4.96		4.55	Y	Y		517.17	14.52	531.69	1341.05	60.96
Mexico	266.04	267.68		220	0.89	0.89		0.94	N	N		29956.60	0.00	29956.60	15192.74	142.97
Nicaragua	14.91	16.11	16.21	6.4	4.44	4.79	4.82	0.82	Y	Y	Y	325.22	10.91	336.14	941.34	7.68
Panama	13.63	12.20	12.24	20	1.17	1.05	1.05	4.99	N	N	N	1161.20	1.00	1162.20	466.60	23.30
Saint Kitts and Nevis	1.49				7.72			1.10	Y			19.27	0.00	19.27	8.63	0.09
St Vincent and the Grenadines	1.63	0.46			8.63	2.47		6.93	Y	N		18.83	0.00	18.83	22.21	1.54
Trinidad and Tobago	15.03	17.02		14	2.54	2.88		7.10	N	N		591.47	0.48	591.95	260.15	18.48
SOUTH AMERICA	1216.92	1211.71	1212.53		1.08	1.08	1.08	1.45	N	N	N					
Argentina	248.77	249.83	249.93	110	1.38	1.38	1.38	1.05	Y	Y	Y	17354.40	699.71	18054.11	5985.45	62.56
Bolivia	5.39	7.04	7.71	12	1.14	1.49	1.63	0.51	Y	Y	Y	459.03	12.57	471.60	2301.26	11.65
Brazil	623.13	621.94		635	1.00	1.00		1.35	N	N		60907.31	1336.05	62243.36	35896.05	485.19
Chile	88.01	88.94		39	1.49	1.51		0.63	Y	Y		5630.99	276.54	5907.53	2095.36	13.11
Colombia	103.56	104.43		160	0.85	0.86		1.94	N	N		11979.60	136.74	12116.34	8483.40	164.95
Ecuador	25.97			37	1.92			1.57	Y			1230.00	120.00	1350.00	2288.10	35.99
Paraguay	9.30	10.95	10.98	12	2.26	2.67	2.67	1.84	Y	Y	Y	403.80	7.02	410.82	974.73	17.90
Peru	41.06	30.19	30.20	76	1.17	0.86	0.86	2.60	N	N	N	3431.14	90.62	3521.76	4764.20	123.85
Venezuela	71.72	71.81			0.87	0.88		1.40	N	N		7545.41	658.06	8203.47	4217.56	58.87
ASIA	1116.55	1170.94	1173.66		0.71	0.74	0.74	1.02	N	N	N					
FAR EAST ASIA	801.27	810.43	811.29		0.67	0.68	0.68	0.99	N	N	N					
Cambodia	51.85	57.08		65	23.40	25.77		5.36	Y	Y		148.60	72.93	221.53	5002.99	268.27
China	323.83	330.11	330.83	740	0.35	0.36	0.36	0.33	Y	Y	Y	92529.45	0.00	92529.45	200524.24	671.26
Indonesia	49.56	55.07		270	0.79	0.88		0.08	Y	Y		6286.58	1.83	6288.42	53248.83	40.75
Lao PDR	5.02	4.97		7.1	6.42	6.35		0.15	Y	Y		37.02	41.17	78.20	1627.74	2.40
Malaysia	24.29	24.02	24.07	97	0.57	0.57	0.57	1.85	N	N	N	4211.77	23.90	4235.67	3682.09	68.28
Mongolia	5.04	5.08		0.5	3.11	3.13		0.05	Y	Y		157.78	4.64	162.42	520.10	0.25
Philippines	6.58	8.39	8.46	6.8	0.30	0.38	0.38	0.02	Y	Y	Y	2130.19	71.49	2201.68	16179.66	3.59
Singapore	15.34			3.3	0.69			0.50	Y			2202.85	5.31	2208.15	450.60	2.23
Thailand	209.12	218.81		550	2.54	2.65		12.30	N	N		8200.78	45.09	8245.88	12841.71	1578.90
Timor Leste	1.83				2.50			0.07	Y			57.56	15.49	73.04	284.66	0.21
Vietnam	108.81	86.61		270	4.26	3.39		3.09	Y	Y		2540.51	16.47	2556.97	12849.88	397.61

	AIDS spending, public and international sources (millions 2008 US$)			HIV positive population	HIV SPEND% VS DALY%				Overspend, Y/N?			Health expenditure (millions 2008 US$)			DALYs	
	UNAIDS	OECD	AIDDATA		UNAIDS	OECD	AIDDATA	%HIV all DALYs	U	O	A	GEN GOV	Non-profit	TOTAL	All DALYs (000s)	HIV DALYs (000s)
MIDDLE EAST	49.99	47.05	47.12		0.42	0.39	0.39	0.41	Y	N	N					
Iran	36.01	36.69	36.76	91	0.45	0.46	0.46	0.47	N	N	N	7908.83	22.09	7930.92	12029.07	57.06
Kuwait	4.70				0.21			0.35	N			2203.64	0.00	2203.64	257.22	0.89
Lebanon	7.30	3.21		3.7	0.59	0.26		0.67	N	N		1224.52	6.89	1231.41	720.05	4.81
Syria	1.99	2.21			0.34	0.38		0.01	Y	Y		583.30	0.00	583.30	2511.97	0.25
SOUTH AND CENTRAL ASIA	265.29	284.99	286.79		0.97	1.05	1.05	1.07	N	N	N					
Afghanistan	3.24	1.75	3.07		1.12	0.61	1.06	0.00	Y	Y	Y	277.71	10.75	288.45	18437.13	0.22
Armenia	2.60	3.12		1.8	1.29	1.55		0.38	Y	Y		195.64	6.19	201.83	570.29	2.19
Azerbaijan	5.00	5.58		3.2	1.01	1.13		0.20	Y	Y		402.86	91.74	494.60	1573.59	3.14
Bangladesh	37.26			5.1	4.30			0.02	Y			830.60	35.37	865.96	39993.13	7.82
Georgia	8.04	5.81		3.0	2.34	1.69		0.12	Y	Y		343.44	0.38	343.82	709.84	0.85
India	145.59	170.18	170.32	2400	0.64	0.75	0.75	1.26	N	N	N	17307.02	5477.13	22784.14	305111.89	3851.90
Kyrgyzstan	8.80	13.61	13.83	7.5	5.45	8.44	8.58	0.14	Y	Y	Y	141.87	19.39	161.26	1188.50	1.62
Myanmar	32.80	13.60		240	53.15	22.03		4.30	Y	Y		43.41	18.30	61.71	13710.57	589.50
Pakistan	14.19	22.48	22.49	93	1.15	1.82	1.82	0.25	Y	Y	Y	1237.02	0.00	1237.02	40560.76	101.57
Sri Lanka	1.57	1.24		2.6	0.21	0.17		0.08	Y	Y		724.68	16.37	741.04	4668.77	3.79
Tajikistan	6.18	10.35	10.36	8.3	7.76	12.99	13.01	0.32	Y	Y	Y	70.80	8.86	79.66	1616.83	5.15
EUROPE	3258.19	3263.62	3263.96		0.59	0.59	0.59	1.14	N	N	N					
Belarus	18.62	17.29		16	0.72	0.67		0.97	N	N		2451.14	131.27	2582.41	2173.98	21.13
Belgium	111.78			14	0.30			0.18	Y			37636.27	233.65	37869.92	1341.35	2.39
Bosnia and Herzegovina	2.76	3.86			0.25	0.35		0.06	Y	Y		1110.33	0.00	1110.33	627.95	0.36
Bulgaria	9.21			3.6	0.43			0.04	Y			2117.24	16.08	2133.31	1426.12	0.61
Croatia	9.96	9.87		1	0.22	0.21		0.01	Y	Y		4628.76	0.00	4628.76	697.73	0.07
Czech Republic	64.28			1.9	0.51			0.03	Y			12309.47	184.58	12494.06	1460.50	0.50
Estonia	18.37			9.6	1.64			1.03	Y			1120.11	0.26	1120.37	254.83	2.62
Greece	96.06			8.7	0.45			0.12	Y			21321.90	0.00	21321.90	1310.28	1.63
Hungary	3.67			2.9	0.05			0.03	Y			7736.97	189.82	7926.79	1814.37	0.58
Macedonia	3.66	4.77	4.78		0.80	1.04	1.04	0.03	Y	Y	Y	457.16	1.69	458.85	340.62	0.12
Moldova	12.87	7.02			3.91	2.13		0.39	Y	Y		326.35	2.77	329.11	820.04	3.24
Montenegro	0.60				0.22			0.14	Y			254.26	11.30	265.57	1767.01	2.54
Poland	62.59			26	0.25			0.10	Y			24966.66	394.56	25361.22	5703.09	5.48
Romania	87.24			16	0.99			0.30	Y			8769.25	8.21	8777.46	3842.18	11.42
Russian Federation	777.02			940	1.47			1.32	Y			51622.00	1149.34	52771.34	40347.87	532.86

	AIDS spending, public and international sources (millions 2008 US$)			HIV positive population	HIV SPEND% VS DALY%				Overspend, Y/N?			Health expenditure (millions 2008 US$)			DALYs	
	UNAIDS	OECD	AIDDATA		UNAIDS	OECD	AIDDATA	%HIV all DALYs	U	O	A	GEN GOV	Non-profit	TOTAL	All DALYs (000s)	HIV DALYs (000s)
Spain	916.74			130	0.91			0.97	N			99998.57	870.94	100869.51	4858.16	47.36
Sweden	22.15			7.9	0.06			0.21	N			35120.03	95.30	35215.33	1032.76	2.16
Switzerland	14.90			18.0	0.05			0.61	N			31819.44	525.93	32345.37	794.27	4.82
Ukraine	100.00	106.96	107.30	350	1.45	1.55	1.56	3.23	N	N	N	6884.87	1.71	6886.58	11200.42	361.82
United Kingdom	925.71			82	0.46			0.26	Y			191933.33	9294.44	201227.78	7718.34	20.15
OCEANIA	5.53	10.27	10.27		2.30	4.26	4.26	0.17	Y	Y	Y					
Fiji	2.51	0.88		1	2.53	0.89		0.30	Y	Y		97.48	1.52	98.99	146.09	0.44
Marshall Islands	0.58				2.79			0.09	Y			20.70	0.00	20.70	13.65	0.01
Micronesia	0.35				1.16			0.07	Y			30.52	0.08	30.60	16.47	0.01
Nauru	0.08				1.22			0.73	Y			5.21	1.43	6.64	2.60	0.02
Palau	0.06				0.36			0.08	Y			15.30	0.69	15.99	3.46	0.00
Solomon Islands	0.60				1.83			0.05	Y			32.13	0.51	32.64	88.75	0.04
Tonga	0.21				1.86			0.05	Y			10.91	0.38	11.28	14.66	0.01
Tuvalu	0.05				1.89			0.05	Y			2.87	0.00	2.87	2.61	0.001
Vanuatu	1.09	0.67			5.16	3.19		0.02	Y	Y		20.39	0.76	21.15	37.33	0.01

Unspecified regional expenditure (millions of 2008 US$)

	OECD	AIDDATA		OECD	AIDDATA
Africa, regional	32.18	32.48	Far East Asia, regional	3.12	3.14
North of Sahara, regional	0.21	0.21	Middle East, regional	0.25	0.25
South of Sahara, regional	127.93	128.45	West Indies, regional (North and Central America)	12.06	12.06
America, regional	17.77	17.77	Europe, regional	3.49	3.49
North & Central America, regional	14.55	14.55	States Ex-Yugoslavia	0.03	0.03
South America, regional	0.61	0.61	Oceania, regional	6.78	6.78
Asia, regional	28.47	28.47	Bilateral, unspecified	1485.23	1485.99
Central Asia, regional	3.66	3.66			
South & Central Asia, regional	2.96	2.96			
South Asia, regional	0.74	0.74			

Appendix 1.2 - Examples of the way AidData was coded for the purposes of this study

Directed towards AIDS not captured by AIDS-related CRS purpose codes

AIDS as one among several project goals

AIDS not a significant driver of project

	Title	Long title	CRS purp. code	CRS p. name	CRS id
	Fredskorpset	Through this project the partners aim to strengthen their relations, organise young people, and use sports as a tool for health/HIV/AIDS information, education and community development.	16061	Culture and recreation	2008002142
	SCIAF - Income Generation and Health Support for People Living with HIV/AIDS	SCIAF - Income Generation and Health Support for People Living with HIV/AIDS	16010	Social/welfare services	2008800361
	Advocacy HIV/AIDS	Advocacy on HIV and AIDS, travel to participate in seminars, prepare information materiel for campaigns and support initiatives.	15162	Human rights	2008002419
	FIGHT AGAINST HIV/AIDS AND HEALTH EDUCATIONAL PROGRAM	THE PROJECT AIM TO CONTRIBUTE TO THE FIGHT AGAINST HIV/AIDS AND TO PROMOTE HEALTH AND LIFE CONDITIONS OF THE POPULATION IN NYANZA ZONE	12191	Medical services	2007000148
	Disaster Prevention and Climate Change Mitigation 2008-2009	1) Empowerment to prevent/mitigate disasters such as floods droughts and hiv/aids 2) Fulfillment of right to food through sustainable sources of supplementary food nutrition and income for vulnerable households	72010	Emergency/distress relief	2008001086
	Relief and Rehabilitation in Zimbabwe 2008-2009	Specific Project Objectives: 1) Sustainable sources of basic food and income for vulnerable households 2) Community empowerment to mitigate spread of hiv/aids	72010	Emergency/distress relief	2008001085
	Local Cooperation Fund (LCF) in Kenya	Environmental Education and Action. The project will promote the use of puppetry as a viable means of enhancing learning_ promoting creativity and innovativeness_ developing social skills and team work to alleviate weakness in teaching and learning in schools. It will concentrate on environmental education and action_ civics and citizenships_ HIV/AIDS and violence against girls using puppetry as a tool.	41081	Environmental education/training	2008080519

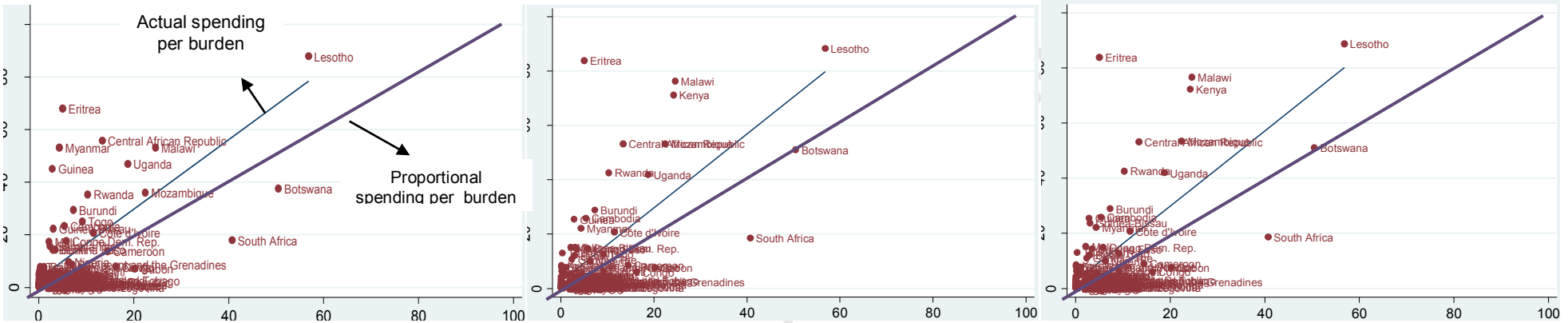
	Title	Long title	CRS purpose code	CRS p. name	CRS id
	Frame agreement with NGO (Frikyrklig samverkan FS rf)	Social center_ Education & recreation center_ Suriname. Cources in capacity building for women in the slum with education regarding healt_ HIV/AIDS_ family life and family violence. Personal counceling and coaching.	16050	Multisector aid for basic soc. serv.	2008080431
	U.S. Peace Corps In-Country Funding	U.S. Peace Corps In-Country Funding for On Board Strength of 73. On Board Strengthincludes Trainees, Volunteers, and Peace Corps Response (formerly Crisis Corps) Volunteers. Peace Corpsvolunteers work primarily in the areas of agriculture, business development, education, environment,health and HIV/AIDS and youth.	43010	Multisector aid	2008026523
	Frame agreement with NGO (World Vision)	Kituntu Integrated Community Development Project. The objective of the programme is to improve the quality of life of 19_769 people of Kituntu sub-county. Access to quality primary and secondary education and adult literacy will be increased. Access to better health services and hygiene/sanitation will be improved and both health and socio-economic impact of HIV/AIDS at individual_ household and community levels mitigated. Household Food Security and resilience and community capacity to manage their own development will be improved.	43040	Rural development	1996960099
	Sudan - Emergency HC in East - Plan 2008	Plan will provide emergency health assistance to communities still affected by the conflict in eastern Sudan, especially IDPs or refugees forced to flee their homes. It will specifically aim to save the lives of women and children through the provision of Emergency Obstetric Care - effectively providing trained medical staff, appropriate equipment and supplies, and a referral system. Awareness raising will be undertaken around reproductive health, family planning, HIV/AIDS, sexually transmitted infections, gender-based violence, and traditional practices which can be harmful, such as female genital mutilation and early marriage. Plan expects to reach an estimated 210,000 women of reproductive age (15 - 49) with this projectCountries: Sudan (100%) Sectors: 072010 (100%)	72010	Emergency/distress relief	2008000747
	CAR - WFP PRRO 10189.2	CAR - WFP PRRO 10189.2: Since 2003, the Central African Republic (CAR) has been characterized by recurrent insecurity. The security situation in CAR continued to worsen in 2007 with continuous clashes between rebels and regular troops. The humanitarian needs in the country drastically increased leading to more than 1 million conflict-affected people in the Northern regions of the country. Ongoing insecurity has interrupted the agricultural cycle, seeds and other inputs to production, which are lacking, with a consequent dramatic decrease in agricultural production and an erosion in people#s coping capacity.Basic needs of conflict and disaster affected communities in developing countries are metExpected Outcomes: The specific objectives of the Protracted Relief and Recovery Operation (PRRO 10189.1) are to (i) protect the livelihoods of food-insecure target groups in post-conflict zones; (ii) improve the nutritional status and health of vulnerable populations, with a special focus on people living with HIV/AIDS	72040	Emergency food aid	2008000371

Appendix 1.3 - Proportionality regressions: World and Sub-Saharan Africa (different data sources)

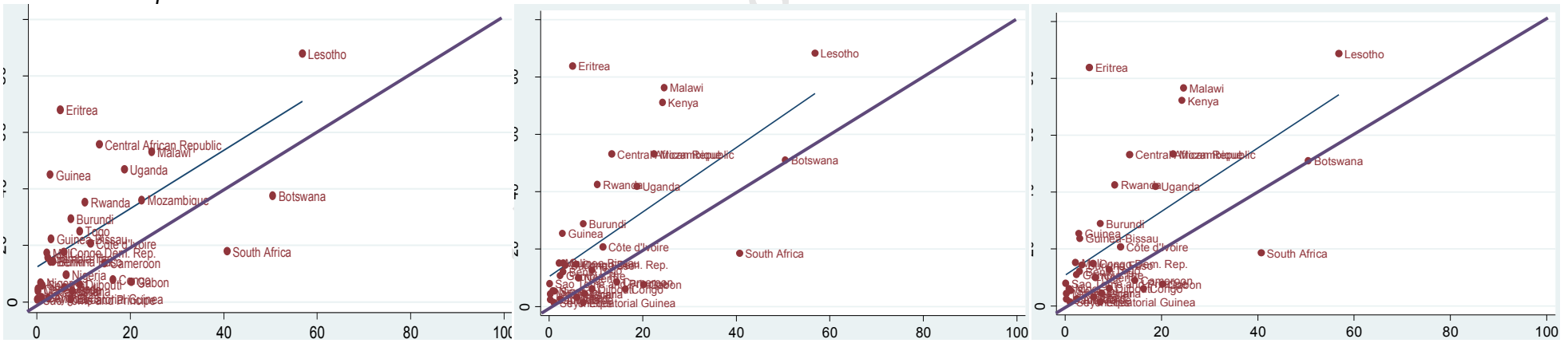
Vertical axis: Percentage of total health expenditure spent on AIDS. Horizontal axis: Percentage of total DALYs accounted for by AIDS

UNAIDS *OECD* *AIDDATA*

World



Sub-Saharan Africa



Appendix 1.4 - Rankings (%Δ AIDS spending required for proportionality – largest to smallest)

(1) Overspenders

	UNAIDS	OECD	AIDDATA
Afghanistan	1	1	1
Vanuatu	2	3	3
Bangladesh	3	2	2
Mongolia	4	5	5
Laos	5	7	7
Tuvalu	6	8	8
Kyrgyzstan	7	6	6
Solomon Islands	8	10	10
Timor Leste	9	12	12
Tonga	10	13	13
Syria	11	11	11
Marshall Islands	12	14	14
Tajikistan	13	9	9
Macedonia	14	15	15
Cape Verde	15	24	24
Croatia	16	16	16
Georgia	17	22	22
Micronesia	18	19	19
Madagascar	19	17	17
Guinea	20	26	26
Czech Republic	21	21	21
Eritrea	22	20	20
Philippines	23	18	18
Myanmar	24	36	37
Sao Tome and Principe	25	4	4
Indonesia	26	23	23
Bulgaria	27	25	25
Moldova	28	35	36
Niger	29	30	28
Fiji	30	52	54
Mali	31	29	30
Guinea-Bissau	32	37	27
Saint Kitts and Nevis	33	28	31
The Gambia	34	42	42
Ukraine	35	32	33
Nicaragua	36	33	34
Senegal	37	40	40
Azerbaijan	38	34	35
Kenya	39	54	53
Benin	40	46	46
United Kingdom	41	39	39
Palau	42	41	41
Pakistan	43	27	29
Cambodia	44	38	38
Spain	45	43	43
Bosnia and Herzegovina	46	31	32
Central African Republic	47	48	48
Burkina Faso	48	44	44
Burundi	49	49	49
Greece	50	50	50
Rwanda	51	45	45
Armenia	52	47	47
Democratic Rep. of Congo	53	56	56
Egypt	54	55	55
Togo	55	74	74
Sri Lanka	56	62	62
Uganda	57	60	60
Cuba	58	61	61
Chile	59	57	57
Guatemala	60	59	59
Bolivia	61	53	51
Malawi	62	51	52
Côte d'Ivoire	63	63	63
Nauru	64	64	64
Belgium	65	65	65
Mozambique	66	58	58

(2) Underspenders

	UNAIDS	OECD	AIDDATA		UNAIDS	OECD	AIDDATA		UNAIDS	OECD	AIDDATA
Estonia	67	67	67	Switzerland	1	1	1	Ghana	19	23	22
Montenegro	68	68	69	Sweden	2	3	3	Angola	20	86th over	86th over
Lesotho	69	69	68	Algeria	3	4	4	Kuwait	21	24	23
Nigeria	70	66	66	Equatorial Guinea	4	5	5	Venezuela	22	25	25
Seychelles	71	75	75	Thailand	5	7	7	Djibouti	23	26	26
Morocco	72	78	78	Bahamas	6	8	8	Brazil	24	28	28
Russian Federation	73	70	70	Panama	7	6	6	Belarus	25	27	27
Hungary	74	72	72	Antigua and Barbuda	8	9	9	Botswana	26	84th over	84th over
Singapore	75	73	73	Malaysia	9	10	10	Romania	27	29	29
El Salvador	76	79	79	Dominican Republic	10	18	19	Poland	28	30	30
Vietnam	77	82	82	Gabon	11	14	14	Chad	29	20	20
Argentina	78	76	76	Trinidad and Tobago	12	16	16	Lebanon	30	15	15
St Vincent & the Grenadines	79	12th under	12th under	Dominica	13	2	2	Mexico	31	31	31
Costa Rica	80	81	81	Colombia	14	17	17	Grenada	32	77th over	77th over
Paraguay	81	71	71	South Africa	15	19	18	Cameroon	33	21	24
Ecuador	82	80	80	Peru	16	11	11	Iran	34	32	32
China	83	83	83	Congo	17	13	13				
Honduras	84	85	85	India	18	22	21				

Appendix 2.1 - AIDSCost projections 2007-2016

AIDSCost with tweaks: 2nd line coverage level (80%) and target year (2012). All cost figures are in thousands of 2006 US Dollars

	HIV not AIDS sick	Unmet need	# on ART	% coverage - ART	People living with HIV	New infections	Adults needing ART	AIDS deaths	# 1st year 1st line	# Subsqnt years 1st line ART	# 2nd line ART
2007	4,000,000	1,240,001	459,999	27	5,700,000	432,857	1,700,000	350,000	153,333	281,111	25,555
2008	3,992,857	787,200	1,174,534	60	5,954,591	411,214	1,961,734	178,266	744,001	403,266	27,267
2009	3,964,857	659,630	1,538,570	70	6,163,057	390,653	2,198,200	202,748	472,320	1,034,416	31,834
2010	3,919,375	620,831	1,848,836	75	6,389,042	371,120	2,469,667	164,667	395,778	1,403,958	49,100
2011	3,859,364	604,964	2,144,122	78	6,608,450	352,564	2,749,086	151,713	372,498	1,692,127	79,497
2012	3,787,398	593,920	2,444,343	80	6,825,661	334,936	3,038,263	135,352	362,978	1,948,515	132,850
2013	3,705,720	582,911	2,736,592	82	7,025,223	318,189	3,319,503	135,374	356,352	2,186,366	193,874
2014	3,616,280	570,844	3,020,583	84	7,207,707	302,280	3,591,427	135,705	349,747	2,408,937	261,899
2015	3,520,769	557,627	3,295,733	86	7,374,129	287,166	3,853,360	135,859	342,507	2,616,860	336,366
2016	3,420,651	543,420	3,561,483	87	7,525,554	272,808	4,104,903	135,740	334,576	2,810,166	416,741

	Total cost of ART	Funding gap - ART	Discretionary spending	Discretionary spending (% total)	Entitlement spending	Entitlement, 1st line	Entitlement spending (% total)	2nd line coverage	Cost 1st line (000s 2006 US$)	Cost 2nd line (000s 2006 US$)	
2007	451,741	0	0	0	451,741	316,709	100	0.0	316,709	135,032	
2008	980,435	622,887	542,376	55	438,059	293,981	45	0.175	836,357	144,078	
2009	1,266,620	540,534	344,321	27	922,299	754,089	73	0.3	1,098,410	168,210	
2010	1,571,451	578,300	288,522	18	1,282,929	1,023,485	82	0.425	1,312,007	259,444	
2011	1,925,173	574,552	271,551	14	1,653,622	1,233,560	86	0.55	1,505,111	420,062	
2012	2,387,057	504,497	264,611	11	2,122,446	1,420,467	89	0.8	1,685,078	701,979	
2013	2,878,071	507,310	259,781	9	2,618,290	1,593,860	91	0.8	1,853,641	1,024,430	
2014	3,394,954	508,567	254,965	8	3,139,989	1,756,115	92	0.8	2,011,080	1,383,874	
2015	3,934,735	508,341	249,687	6	3,685,048	1,907,691	94	0.8	2,157,378	1,777,357	
2016	4,494,575	506,773	243,906	5	4,250,669	2,048,610	95	0.8	2,292,516	2,202,059	

Appendix 2.2 - ASSA2003 vs. AIDSCost

Year	AIDSCost	**ASSA1**	ASSA2	**ASSA3**	AIDSCost	**ASSA1**	ASSA2	**ASSA3**	AIDSCost	**ASSA1**	ASSA2	**ASSA3**
	HIV+, not AIDS sick*				**Unmet need ART****				**# on ART*****			
2007	4,000,000	4,826,839	4,826,839	4,871,134	1,240,001	591,801	591,801	546,114	459,999	305,154	305,154	360,479
2008	3,992,857	4,847,552	4,847,552	4,942,828	787,200	620,839	620,839	530,429	1,174,534	383,933	383,933	504,548
2009	3,964,857	4,963,371	4,883,760	5,007,241	659,630	513,516	601,596	501,486	1,538,570	599,628	501,415	661,441
2010	3,919,375	5,081,511	4,937,253	5,073,573	620,831	415,077	550,815	456,697	1,848,836	833,299	651,379	832,455
2011	3,859,364	5,186,479	5,008,192	5,144,224	604,964	338,633	479,711	401,109	2,144,122	1,057,517	827,368	1,012,951
2012	3,787,398	5,275,640	5,095,831	5,220,683	593,920	281,841	396,380	338,817	2,444,343	1,262,114	1,023,452	1,199,016
2013	3,705,720	5,350,069	5,198,724	5,303,602	582,911	240,109	306,564	272,996	2,736,592	1,443,532	1,234,661	1,387,754
2014	3,616,280	5,413,810	5,279,377	5,367,779	570,844	207,210	253,774	233,920	3,020,583	1,603,788	1,413,032	1,546,129
2015	3,520,769	5,469,862	5,342,934	5,417,788	557,627	179,690	221,784	209,874	3,295,733	1,745,265	1,562,759	1,678,065
2016	3,420,651	5,520,372	5,393,211	5,456,962	543,420	155,555	201,930	194,611	3,561,483	1,870,507	1,687,813	1,787,321

Year	AIDSCost	ASSA1	ASSA2	ASSA3	AIDSCost	ASSA1	ASSA2	ASSA3	AIDSCost	ASSA1	ASSA2	ASSA3
	# living with HIV				**New infections**				**Adults needing ART^**			
2007	5,700,000	5,502,269	5,502,269	5,515,866	432,857	498,654	498,654	496,102	1,700,000	675,431	675,431	644,733
2008	5,954,591	5,574,029	5,574,029	5,611,719	411,214	491,338	491,338	486,386	1,961,734	726,477	726,477	668,890
2009	6,163,057	5,641,567	5,623,507	5,690,735	390,653	478,507	482,936	477,408	2,198,200	678,196	739,747	683,495
2010	6,389,042	5,725,750	5,667,694	5,759,844	371,120	467,174	474,051	468,866	2,469,667	644,239	730,441	686,271
2011	6,608,450	5,816,653	5,716,289	5,825,223	352,564	458,332	465,477	461,207	2,749,086	630,174	708,097	680,999
2012	6,825,661	5,906,350	5,775,058	5,891,374	334,936	451,866	457,606	454,592	3,038,263	630,710	679,226	670,691
2013	7,025,223	5,990,197	5,846,944	5,961,315	318,189	447,359	450,631	449,023	3,319,503	640,128	648,220	657,713
2014	7,207,707	6,066,443	5,924,980	6,031,168	302,280	444,222	446,273	445,564	3,591,427	652,633	645,604	663,389
2015	7,374,129	6,135,221	5,999,014	6,094,700	287,166	441,911	443,502	443,355	3,853,360	665,358	656,080	676,912
2016	7,525,554	6,197,337	6,065,149	6,149,932	272,808	440,157	441,757	441,951	4,104,903	676,965	671,938	692,969

Corresponding ASSA variables and calculations:

***#HIV+ - AIDS sick **AIDS sick not on ART(Adults+Children) ***Adults + Children (ART) ^AIDS sick ^^#HIV+/ASSA population**

Year	AIDSCost	ASSA1	ASSA2	ASSA3	AIDSCost	ASSA1	ASSA2	ASSA3
	% coverage - ART				Prevalence^^			
2007	27.0	27.0	27.0	44.0	11.8%	11.4%	11.4%	11.5%
2008	60.0	60.0	37.6	50.0	12.3%	11.5%	11.5%	11.6%
2009	70.0	70.0	48.2	57.5	12.7%	11.6%	11.6%	11.7%
2010	75.0	75.0	58.8	65.0	13.0%	11.7%	11.6%	11.7%
2011	78.0	78.0	69.4	72.5	13.4%	11.8%	11.6%	11.8%
2012	80.0	80.0	80.0	80.0	13.8%	11.9%	11.7%	11.9%
2013	82.0	82.0	80.0	80.0	14.1%	12.0%	11.8%	12.0%
2014	84.0	84.0	80.0	80.0	14.4%	12.1%	11.9%	12.0%
2015	86.0	86.0	80.0	80.0	14.6%	12.2%	11.9%	12.1%
2016	87.0	87.0	80.0	80.0	14.8%	12.2%	12.0%	12.1%

	AIDSCost	ASSA1	ASSA2	ASSA3
Year	AIDS deaths			
2007	350,000	398,450	398,450	371,691
2008	178,266	394,937	413,018	378,256
2009	202,748	365,143	409,717	378,806
2010	164,667	346,746	396,330	373,728
2011	151,713	338,767	377,508	365,095
2012	135,352	337,837	356,417	354,515
2013	135,374	340,670	343,139	348,865
2014	135,705	344,798	342,615	351,582
2015	135,859	349,004	347,600	357,575
2016	135,740	353,441	354,706	364,525

Corresponding ASSA variables and calculations:

***#HIV+ - AIDS sick **AIDS sick not on ART(Adults+Children) ***Adults + Children (ART) ^AIDS sick ^^#HIV+/ASSA population**

Appendix 2.3 - Calculating first-line and second-line proportions from AIDSCost

	# on ART***	1st line 1st year	1st line subsequent	2nd line	Proportion 1st year 1st line	Proportion 1st line subsequent	Proportion 2nd line
2007	459,999	153,333	281,111	25,555	33.33%	61.11%	5.56%
2008	1,174,534	744,001	403,266	27,267	63.34%	34.33%	2.32%
2009	1,538,570	472,320	1,034,416	31,834	30.70%	67.23%	2.07%
2010	1,848,836	395,778	1,403,958	49,100	21.41%	75.94%	2.66%
2011	2,144,122	372,498	1,692,127	79,497	17.37%	78.92%	3.71%
2012	2,444,343	362,978	1,948,515	132,850	14.85%	79.72%	5.43%
2013	2,736,592	356,352	2,186,366	193,874	13.02%	79.89%	7.08%
2014	3,020,583	349,747	2,408,937	261,899	11.58%	79.75%	8.67%
2015	3,295,733	342,507	2,616,860	336,366	10.39%	79.40%	10.21%
2016	3,561,483	334,576	2,810,166	416,741	9.39%	78.90%	11.70%

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